GURU KASHI UNIVERSITY

Master of Science in Chemistry

Session: 2024-25

Department of Chemistry

Graduate Outcomes of the Programme

The graduates will be able to apply comprehensive knowledge and continuous learning of the emerging developments associated with the programme to solve the complex problems of the society. The graduates will build resilience to face the challenges in life and enhance their competencies to get involved in meaningful research.

Programme Learning Outcomes: After completion of the program, the learner will be able to:

1. 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.
2. Illustrate a sense of inquiry and ability to define problems; use research methods, analyze, interpret and draw conclusions from data.
3. Design, execute and report the results of an experiment or investigation in intra/interdisciplinary areas of chemistry.
4. Develop eco-friendly protocols and procedures for chemical processes in industry.
5. 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.
6. Demonstrate the knowledge and skills in various fields of chemistry for determining the molecular structure using various technique

Programme Structure

Semester: I						
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**Credits**
MCH101	Inorganic Chemistry	Core	4	0	0	4
MCH102	Organic Chemistry	Core	4	0	0	4
MCH104	Analytical Chemistry	Core	4	0	0	4
MCH105	Inorganic Chemistry Lab	Technical Skills	0	0	4	2
MCH114	Human Values & Professional Ethics	Value Added Course	2	0	0	2
MCH117	Numerical Methods	MD	3	0	0	3
Discipline Elective–I (Choose any one of the following)						
MCH110	Organometallic Chemistry	**Discipline Elective-I**	3	0	0	3
MCH112	Bioinorganic Chemistry					
MCH115	Environmental Chemistry					
Discipline Elective–II (Choose any one of the following)						
MCH111	Chemistry of Materials	**Discipline Elective-II**	3	0	0	3
MCH113	Chemistry of Natural Products					
MCH116	Biology for Chemists					
Total			**23**	**0**	**4**	**25**

Semester: II						
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**Credits**
MCH214	Advanced Organic Synthesis	Core	4	0	0	4
MCH215	Spectroscopy: Techniques of Analysis	Core	4	0	0	4
MCH225	Physical Chemistry	Core	4	0	0	4
MCH218	Physical Chemistry Lab	Technical Skills	0	0	4	2
MCH226	Organic Chemistry Lab	Technical Skills	0	0	4	2
MCH299	XXX	MOOC	-	-	-	2
Discipline Elective–III (Choose any one of the following)						
MCH216	Supramolecular Chemistry	**Discipline Elective-III**	3	0	0	3
MCH221	Surface and Polymer Chemistry					
MCH222	Green Chemistry					
Discipline Elective–IV (Choose any one of the following)						
MCH211	Chemistry of Cosmetics And Perfumes	**Discipline Elective-IV**	3	0	0	3
MCH217	Chemical Dynamics and Electro analytical Techniques					
MCH223	Biophysical Chemistry					
Total			**18**	**0**	**8**	**22**

Semester: III						
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**Credits**
MCH306	Basics of Research Methodology	Compulsory Foundation	4	0	0	4
MCH398	Research Proposal	Research Skill	0	0	8	4
MCH316	Ethics and IPR	Elective Foundation	2	0	0	2
MCH317	Computer Lab	Skill Based	0	0	2	1
MCH397	Proficiency in Teaching	Value Added Course	2	0	0	2
MCH396	Service Learning	Community Linkage	0	0	4	2
MCH320	Industrial Chemistry	Entrepreneurship	2	0	0	2
MCH321	Advanced Chemistry Lab	Compulsory Foundation	0	0	4	2
XXX		IDC	2	0	0	2
MCH399	xxx	MOOC	-	-	-	2
Total			**12**	**0**	**18**	**23**
Open Elective Courses (For other Departments)						
OEC047	Fuel Chemistry	OEC	2	0	0	2

Semester: IV						
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**Credits**
MCH402	Dissertation	Research Based Skill	-	-	-	20
MCH403	Seminar for confidence building	Ability Enhancement Course	0	0	2	1
Total						**21**
Grand Total			**55**	**0**	**26**	**92**

Evaluation Criteria for Theory Courses

A. Continuous Assessment: [25 Marks]

CA-1 Surprise Test (Two best out of three) - (10 Marks)

CA-2 Assignment(s) (10 Marks)

CA-3 Term paper /Quiz /Presentation (05 Marks)

B. Attendance (05 marks)

C. Mid Semester Test: [30 Marks]

D. End-Term Exam: [40 Marks]

SEMESTER-I

Course Title: Inorganic Chemistry

Course Code: MCH101

L	T	P	Credits
4	0	0	4

Total hours: 60

Learning Outcomes:

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

1. Apply the mechanism involved in transition metal complexes, Born Haber cycle to calculate lattice energy.
2. Get deep insight of the role of metal complexes in biological systems.
3. Analyze the common themes running through ionic, covalent and metallic descriptions of chemical bonding.
4. Evaluate the splitting orbitals helping them to explain properties of complexes.

Course Content

UNIT I **15 hours**

Chemical Bonding: The ionic bond, covalent bond, the variation method, ground state energy of hydrogen atom, the secular quations, the molecular orbital theory, electron distribution in hydrogen molecule ion, symmetric and anti symmetric energy states, the classical interaction energy, resonance contribution of ionic terms, sp^3 hybridisation, three centered bond, Linnetts doublet-quartet approach, the Pauli's exclusion principle.

UNIT II **14 hours**

Pi Bonding Ligand Complexes: Pi acid ligands CO as prototype, other pi acid ligands-isocyanide ligands, dinitrogen, CS ligands, the NO ligands; Theories of bonding in Transition Metal complexes; Qualitative Approach: Qualitative introduction to the molecular orbital theory, complexes with no pi bonding, complexes with pi-bonding, the crystal field & ligand field theories, orbital splitting and magnetic properties, the angular overlap model.

UNIT III **16 hours**

Structural and Thermodynamic Consequences of Partly Filled-shells: Ionic radii, Jahn - Teller effects, thermodynamic effects of d-orbital splitting, magnetic properties of chemical compounds, origin of magnetic behavior, magnetic susceptibility and types of magnetic behavior: diamagnetism, paramagnetism, ferromagnetism: types of paramagnetic behavior: Large multiplet separation, small multiplet separations, spin only, heavy atoms, high spin-low spin crossovers. spectral properties. Russel- Saunder's term, election rules, breakdown of selection rules, bandwidths & shapes, energy level diagrams and- d complex spectra, Orgel diagrams-weak fields, charge-

transfer spectra.

UNIT IV **15 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

- *Cotton, F. A., Wilkinson, G., Murillo, C. A., Bochmann, M., & Grimes, R. (2016). Advanced inorganic chemistry (Vol. 6, p. 1455). New York: Wiley.*
- *Shriver, D. F., Atkins, P. W., & Langford, C. H. (2019). Inorganic Chemistry.*
- *Hughes, M. N. (1981). The inorganic chemistry of biological processes 2nd edn. FEBSLETTERS.*
- *Cotton, F. A., (2008) Chemical Applications of Group Theory, 3rd Edition. Wiley.*

Web Sources

- *https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Inorganic_Chemistry_(Saito)*

Course Title: Organic Chemistry

Course Code: MCH102

L	T	P	Credits
4	0	0	4

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 stereo chemical aspects and modes of pericyclic, electro cyclic reactions and sigma tropic rearrangements.

Course Content

UNIT I **17 hours**

Carbocation: Generation, Structure, Stability, Application of NMR spectroscopy in the detection of Carbocation, allylic and benzylic carbocations; Stereochemistry and reactions; Non classical carbocations: Phenoniumion, norbornyl system, explanation based on rearrangement

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 **15 hours**

Nature of Bonding in Organic Molecules: Introduction to fullerenes, Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's Rule, anti-aromaticity, homo-aromaticity, PMO-approach; Bonding weaker than Covalent: Addition compounds, Crown ether complexes and Cryptands, inclusion compounds,Cyclodextrins, Catenanes and rotaxane.

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 **13 hours**

Elimination Reactions: E2, E1and E1CB mechanism, Stereochemistry product ratio, Orientation of double bond, Hofman Rule, Saytzeff Rule; Factors Governing E2 & E1Mechanism; Elimination versus Substitution Dehalogenation by zinc; Aromatic Elimination: Benzenes, Nucleophillic aromatic substitution, addition elimination.

UNIT IV **15 hours**

Pericyclic Reactions: Molecular Orbital symmetry, Frontier Orbitals of ethylene, 1, 3- butadiene, 1, 3, 5- hexatrience and allyl system; Classification of Pericyclic reactions; Woodward-Hoffman rule, correlation diagrams; FMO and PMO approach.

Electrocyclic reactions- conrotatory and disrotatory motions 4n, 4n+2 and allyl systems; Cycloadditions - antarafacial and suprafacial additions 4S+2S systems and 2S+2S additions ofalkene.

Sigmatropic rearrangement- suprafacial and antarafacial shift involving hydrogen carbonmoieties; [1,3], [1,5], [1,7] [3,3] and [5,5]-sigmatropic rearrangement, 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.*
- *Norman, R., & Coxon, J. M. (2017). Principles of organic synthesis. Routledge.*
- *Mukherji, S. M., & Singh, S. P. (1984). Reaction mechanism in organic*

chemistry. Macmillan.

Web Sources

- *https://chem.uCreditsedu/curricular-materials/textbook*
- *https://courses.lumenlearning.com/suny-potsdam-organicchemistry/*
- *https://nptel.ac.in/courses/104101115*
- *https://archive.nptel.ac.in/content/storage2/courses/104105038/answer.pdf*

Course Title: Analytical Chemistry

Course Code: MCH104

L	T	P	Credits
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 **17 hours**

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature, Concept of sampling, Importance of accuracy, precision and sources of error in analytical measurements, Presentation of experimental data and results from the point of view of significant figures

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators; Determination of pH of soil samples; Estimation of Calcium and Magnesium ions as Calcium carbonate by Complex metric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods; Determination of pH, acidity and alkalinity of a water sample; Determination of dissolved oxygen (DO) of a water sample.

Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration; Identification of adulterants in some common food items; coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses; Analysis of preservatives and coloring matter.

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: Columnion-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*

WEB SOURCES

- *https://www.chemcome.com/wpcontent/uploads/2020/11 /Analytical- Chemistry-by-Gary-D.-Christian-Purnendu-K.-Dasgupta-Kevin-A.-Schug-z- lib.org_.pdf*
- *https://www.chemcome.com/wp-content/uploads/2020/11/Physical-*

chemistry-by-R.-L.-Madan-z- lib.org_.pdf

- *chromeextension://efaidnbmnnnibpcajpcglclefindmkaj/https://archive.nptel.ac.in/content/storage2/courses/102103047/PDF/mod4.pdf*

Course Title: Inorganic Chemistry Lab

Course Code:MCH105

L	T	P	Credits
0	0	4	2

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 K_3 [Fe $(C_2O_4)_3$].
4. Estimation of iron.
5. Preparation of $(NH_3)_2Hg\ Cl_2$.
6. Estimation of Hg.
7. Preparation of K_3 [Cr $(C_2O_4)_3$].
8. Estimation of Cr and oxalate.

CHROMATOGRAPHIC SEPARATION OF IONS

1. Paper chromatography
2. Thin layer chromatography
3. Column chromatography

COMPLEXOMETRIC TITRATIONS

Determination of calcium in the presence of magnesium using EGTA as titrant.

REDOX TITRATIONS

9. Determination of chlorate, preparation of 0.1M cerium (IV) sulphate solution.
10. Determination of hydrogen sulphide.
11. 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.*

Course Title: Human Values and Professional Ethics

Course Code: MCH114

L	T	P	Credits
2	0	0	2

Total hours: 30

Learning Outcomes:

After the completion of this course the students will be able to**:**

1. Apply ethics in society
2. Discuss the ethical issues related to science and engineering and realize the responsibilities and rights in the society.
3. Enhance Senses of Ethics, Variety of moral issues.
4. Use Professional Rights, Employee Rights, Intellectual Property Rights.

COURSE CONTENT

UNIT-I **10 hours**

Morals, values and Ethics, Integrity, Work ethic, Service learning, Civic virtue, Respect for others, living peacefully, Caring, Sharing, Honesty, Courage, Valuing time, Cooperation, Commitment, Empathy, Self-confidence, Character, Spirituality, Introduction to Yoga and meditation for professional excellence and stress management.

UNIT-II **6 hours**

Senses of Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Consensus and Controversy, Models of professional roles, Theories about right action, Self, interest, Customs and Religion.

UNIT-III **6 hours**

Social Experimentation, Professionals as responsible Experimenters, Codes of Ethics, A Balanced Outlook on Law.

UNIT-IV **8 hours**

Professional Rights, Employee Rights, Intellectual Property Rights(IPR)Gender.

In equality, causes and consequences. Discrimination, Social understandings, Women and Men in the Organization, Consequences of sexual harassment and global issues like Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Professionals as Managers

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

SUGGESTED READINGS

- *MikeW.MartinandRolandSchinzinger(2003),"EthicsinEngineering", TataMcGrawHill,NewDelhi.*
- *GovindarajanM,NatarajanS,SenthilKumarV.S,(2004),"Engineering Ethics",PrenticeHallofIndia,NewDelhi.*
- *CharlesB.Fleddermann(2004),"EngineeringEthics",PearsonPrenticeHall,NewJersey.*
- *2.CharlesE.Harris,MichaelS.PritchardandMichaelJ.Rabins(2009)"EngineeringEthics–ConceptsandCases",Cengage Learning.*
- *3.JohnRBoatright(2003)"EthicsandtheConductofBusiness",PearsonEducation,NewDelhi.*
- *EdmundGSeebauerandRobertLBarry(2001),"FundamentalsofEthicsforScientistsandEngineers",OxfordUniversityPress,Oxford.*
- *LauraP.HartmanandJoeDesjardins(2013),"BusinessEthics:DecisionMakingforPersonalIntegrityandSocialResponsibility"McGrawHilleducation,IndiaPvt.Ltd.,NewDelhi.*

Course Title: Numerical Methods

Course Code: MCH117

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:

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

1. Develop critical thinking and problem-solving skills by analyzing and choosing appropriate numerical methods for various types of problems and datasets.
2. Apply numerical methods for solving systems of linear equations, performing matrix operations, and eigenvalue problems.
3. Compare different methods in numerical analysis with accuracy and efficiency of solution.
4. Implement numerical methods for a variety of multidisciplinary applications and a variety of numerical algorithms using appropriate technology.

Course Content

UNIT-I **11 hours**

Numerical Differentiation and Integration: Introduction, Numerical Differentiation, Numerical Integration, Euler-Maclaurin Formula, Adaptive Quadrature Methods, Gaussian Integration, Singular Integrals, Fourier Integrals, Numerical Double Integration.

UNIT-II **12 hours**

Numerical Solution of Ordinary Differential Equations: Introduction, Solution by Taylor's Picard's Method, Euler's Method, Runge-Kutta Methods, Predictor-Corrector Methods, the Cubic Spline Method, Simultaneous and Higher Order Equations, Boundary Value Problems: Finite-Difference Method, the Shooting Method.

UNIT-III **11 hours**

Numerical Solution of Partial Differential Equation: Introduction, Finite-Difference Approximations, Laplace's Equation: Jacobi's Method, Gauss-Seidel Method, SOR Method, ADI Method, Parabolic Equations, Iterative Methods, Hyperbolic Equations.

UNIT-IV **11 hours**

System of Linear Algebraic Equations: Introduction, Solution of Centro-symmetric Equations, Direct Methods, LU- Decomposition Methods, Iterative Methods, III-conditioned Linear Systems.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e-team teaching, Group discussion, e-team Teaching, Flipped classroom Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS

- *S.S.Sastry (2015), Numerical Analysis, Prentice Hall India*
- *G. Sankar Rao (2006), Numerical Analysis, New Age International Publishers.*
- *H.C. Saxena (2009), Finite Differences and Numerical Analysis by published by S. Chand and Company, Pvt. Ltd*
- *M.K.Jain et al. (2002), Numerical methods for scientific and engineering computation, New Age International Publishers.*

Course Title: Organometallic Chemistry

Course Code: MCH110

L	T	P	Credits
3	0	0	3

Total hours: 45

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 Estimation of 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 **13 hours**

Organometallic Compounds

Definition and classification of organometallic compounds basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe,Co and Ni using VBT. 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 **11 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 polymerization of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenkequilibrium.

UNIT III **10 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 **11 hours**

Catalysis by Organometallic Compounds Study of the following industrial processes and their mechanism

Alkene hydrogenation (Wilkinsons 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*

WEB SOURCES

- *https://chem.uCreditsedu/curricular-materials/textbook*
- *https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Introduction_to_Organometallic_Chemistry_(Ghosh_and_Balakrishna)*

Course Title: Bioinorganic Chemistry
Course Code: MCH112

L	T	P	Credits
3	0	0	3

Total hours: 45

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 **12 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 **11 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 **11 hours**

Bio redox 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 nitrogenizes model systems

Unit IV **11 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.*

WEB SOURCES

- https://books.google.com/books/about/Bioinorganic_Chemistry.html?id=bxFejgEACAAJ#v=onepage&q&f=false

Course Title: Environmental Chemistry

Course Code: MCH115

L	T	P	Credits
3	0	0	3

Total hours-45

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 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 valuesessential in industries releasing toxic wastes.

Course Content

UNIT-I **15 hours**

Commonly used terms, environmental segments, natural 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 **07 hours**

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

UNIT-III **10 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 **13 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: Chemistry of Materials

Course Code: MCH111

L	T	P	Credits
3	0	0	3

Total hours: 45

Learning Outcomes

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

1. Explore the connections between structure and properties of solids.
2. Apply the methods for the development of new materials with particular desired properties.
3. Predict simple properties like polymer molecular weight distributions based on knowledge of the reaction conditions.
4. Evaluate the properties, synthesis economic impact of the smart materials, design, and/or processes.

Course Content

Unit I **11 hours**

Solid State Chemistry :Types of solids, band and bond theories, crystal lattice energy, point defects in metals and ionic compounds, energy and entropy of defects, their concentration, diffusion and electrical conduction via defects, non-stoichiometry types, colour centres and electrical properties of alkali halides, electron theories for metal conduction in metals , in insulators, impurity semi conductors, reactions in organic solids, photochemical reactions, solid-solid reactions, decomposition and dehydration reaction.

Unit II **12 hours**

Macromolecules: Types of polymers, regular and irregular polymers, synthesis of polymers by chain and step reactions, physical properties of solid polymers (crystallinity, plasticity and elasticity), vulcanization of rubbers, molecular mass determination by osmometry, viscometry, light scattering and ultracentrifuge methods, number and mass average molecular masses, polymer solutions, factors affecting the solubility of polymers , conducting polymers, doping of polymers, mechanism of conduction, polarones and bipolarons

Unit III **11 hours**

Glasses and Ceramics : Factors affecting glass formation, oxide glasses, electronegativity and bond type, viscosity, structural effects(zachariasen's rule(1932), criteria of SUN and Rawson, thermodynamics of glass formation, behavior of liquids on cooling, kinetics of crystallization and glass formation, structure of glasses: vitreous silica, silicate glasses, vitreous B2O3 and borate glasses, viscosity, electrical conductivity of glasses and the mixed alkali effect, commercial silicate and borate glasses, metallic glasses , glass ceramics, refractories, important glass- ceramics compositions, properties of glass ceramics, applications.

Unit IV **11 hours**

Smart Materials

Methods of preparation- conventional ceramic methods, hot pressing and hot static pressing techniques, precursor method, gel method, co-precipitation method, glass crystallization methods, vacuum techniques- chemical vapor deposition method. , organic superconductors, magnetism in organic materials, magnetic nano materials, energy storage materials, nano materials for targeted drug delivery, fullerenes as superconductors. High temperature ceramic superconductors, electrical and magnetic
properties of superconductors, critical temperature Tc, thermodynamics of superconductors, London equation, BCS theory, applications.

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

SUGGESTED READINGS

- *Principles of polymer chemistry, P J Flory Cornell University Press*
- *Text Book of Polymer Science, F.W. Billmeyer, John Wiley*
- *P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill*
- *Physical chemistry of polymers—A J Tager, Mir Publishers*
- *Physical chemistry of Macromolecules Tanford*
- *Handbook of conducting polymers—T A Skotthem*
- *Solid state chemistry and its applications—A R West ,Wiley Publishers*
- *Chemistry of solid state—W.E.Garner Butterworth*
- *Thermotropic Liquid crystals Ed. G W Gray John Wiley*
- *Chemistry of polymers, Margarison and East*
- *Polymer Chemistry, Malcolm, P, Stevens, Oxford University Press.*
- *Principles of Solid States, H. V. Keer, Wiley Eastern*

Course Title: Chemistry of Natural Products

Course Code: MCH113

L	T	P	Credits
3	0	0	3

Total hours: 45

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 **14 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 **10 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 **11 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 **10 hours**

Antibiotics: Introduction, chemistry of pencillins, streptomycines, chloromphenicol, tetracyclins.

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.*

WEB SOURCES

- https://books.google.com/books/about/Chemistry_of_Natural_Products.html?hl=fr&id=C3l a6a_gnKUC#v=onepage&q&f=false
- https://chem.uCreditsedu/curricular-materials/textbook
- https://courses.lumenlearning.com/suny-potsdam-organicchemistry/

Course Title: Biology for Chemists

Course Code: MCH116

L	T	P	Credits
3	0	0	3

Total hours: 45

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 **11 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 **10 hours**

Carbohydrates

Mono saccharine, structure & functions Structural poly saccharine. Structural Polysaccharine- 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 **13 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 **11 hours**

Enzymes

1. Enzymes as biological catalyst and mode of their action.

2. 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 Rawnand KG Scrimgeour. pp 675. Neil Patterson Publishers, Prentice Hall Inc.*

SEMESTER-II

Course Title: Advanced Organic Synthesis

Course Code: MCH214

L	T	P	Credits
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 stereo chemical 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 cyclo addition reaction.

Small Ring Heterocycles

Three-membered and four-membered heterocyclic –synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes

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 dimethyl uprate, 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.*

WEB SOURCES

- https://chem.uCreditsedu/curricular-materials/textboo

Course Title: Spectroscopy: Techniques of Analysis

Course Code: MCH215

L	T	P	Credits
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 **11hours**

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 6th ed 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.*

WEB SOURCES

- *http://www.rnlkwc.ac.in/pdf/studymaterial/chemistry/Peter_Atkins Julio_de_Paula Physical_Chemistry 1_.pdf*
- *https://www.chemcome.com/wp-content/uploads/2020/11/Physical-chemistry-by-R.-L.-Madan-z- lib.org_.pdf*
- *https://chem.uCreditsedu/curricular-materials/textbook*

Course Title: Physical Chemistry

Course Code: MCH225

L	T	P	Credits
4	0	0	4

Total hours: 60

Learning Outcomes

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

1. Learn the thermodynamic description of exact, inexact differential and state function.
2. Analyze the qualitative properties of solution, the depression in freezing point.
3. Acquire purpose, scope and concepts of the statistical thermodynamics and various partition functions.
4. Evaluate conductivity measurements and titrations curve that are vital in electroanalytical activities.

Course Contents

UNIT I **12 hours**

Thermodynamics: Brief review of concepts involve in first and second law of thermodynamics, Entropy, free energy and chemical equilibrium. Thermodynamic equation of state, Maxwell relations

Non-ideal systems: Excess functions for non-ideal systems. Activity and activity coefficients and their determination, Concept of fugacity and its experimental determination, Partial molar properties and their determination

UNIT II **18 hours**

Statistical Thermodynamics: General introduction: Phase space, microstates, macro states, thermos dynamic probability. Brief introduction to different types of statistics. Ensemble concept. Canonical, grand canonical and micro canonical ensembles. Sterling approximation, Maxwell Boltzmann distribution law, introduction of partition functions.

UNIT III **13 hours**

Electrochemistry: Ion-solvent interactions: Born model of ion-solvent interactions; Structural models of ion- solvent interactions; Experimental determination of salt-solvent interactions; Relative heats of solvation of ions in the hydrogen scale

Ion-ion interactions: Debye-Hackle theory of ion-ion interactions. Verification of Debye Hackle limiting law; Activity coefficients at moderate concentrations and higher concentrations, Activity coefficients as a function of ion-ion and ion-solvent interactions; Mean activity coefficient and their experimental determination.

UNIT IV **17 hours**

Debye-Huckel-Onsager theory: Modification of Debye-Huckel-Onsager equation; Ionic conductances; Ion-association and ion-pair formation; Ion-triplets in electrolyte solutions; Ion-tripletsand conductance

Corrosion of Metals: Classification of corrosion processes, theories of corrosion process, passivation of metals; Corrosion monitoring and methods of corrosion prevention.

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

- *Bockris, J. O. M., Reddy, A. K., & Gamboa-Aldeco, M. (2019). Electrodynamics. Modern Electrochemistry 2A: Fundamentals of Electrodynamics.*
- *Bockris, J. O. M., & Khan, S. U. (2016). Quantum electrochemistry. Springer Science &Business Media.*
- *Glasstone, S. (2018). An introduction to electrochemistry. Read Books Ltd.*
- *Aston, J. G., Aston, J. G., & Fritz, J. J. (2015). Thermodynamics and statistical thermodynamics. Wiley*

WEB SOURCES

- *http://www.rnlkwc.ac.in/pdf/studymaterial/chemistry/Peter_Atkins Julio_ de_Paula Physical_Chemistry1_.pdf*
- *https://www.chemcome.com/wp-content/uploads/2020/11/Physical-chemistry-by-R.-L.-Madan-z-lib.org_.pdf*
- *https://onlinecourses.nptel.ac.in/noc22_cy14/preview*

Course Title: Physical Chemistry Lab

Course Code: MCH218

L	T	P	Credits
0	0	4	2

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: Organic Chemistry Lab

Course Code: MCH226

L	T	P	Credits
0	0	4	2

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) basis 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 : Dibenzalacetone/Cinnamic acid

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 The products may be characterized by spectral techniques.

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

SUGGESTED READINGS

- *Furniss, B. S. (1989). Vogel's textbook of practical organic chemistry. Pearson Eductaion India.*
- *Mann, F. G., & Saunders, B. C. (1975). Practical organic chemistry. Orient*

Blackswan.0.Khurana, J. M., & Sharma, P. (2004.

- *Chemo-selective reduction of a, ß- unsaturated aldehydes, ketones, carboxylic acids, and esters with nickel boride in methanol– water. Bulletin of the Chemical Society of Japan.*
- *Mann and Saunders. (2009). Practical organic chemistry, Pearson, 4th edition, UK.*
- *Silverstein, R. M. and Webster, F. X. (2014) Spectrometric identification of organic compounds, 8thEdn, Wiley.*
- *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.*
- *Vogel, A.I. (1996). Text book of quantitative Analysis, 4thedn.*

Course Title: Supramolecular Chemistry

Course Code: MCH216

L	T	P	Credits
3	0	0	3

Total hours: 45

Learning Outcomes

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

1. Recognize the fundamentals of supramolecular 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 **13 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 **09 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 **08 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 **15hours**

Supramolecular Devices

Supramolecular devices and sensors: various types of supramolecular devices, an overview, supramolecular photochemistry; molecular and supramolecular photonic devices: light conversion and energy transfer devices; molecular and supramolecular electronic devices; electronic conducting devices; molecular wires, 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, 1999.4*

Course Title: Surface and Polymer Chemistry

Course Code:MCH221

L	T	P	Credits
3	0	0	3

Total hours: 45

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 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.*
- *Polymerscience,V.R.Gowariker,N.V.ViswanathanandJ.Sreedhar,Wiley-Eastern.*
- *Seymour's Polymer chemistry, Marcel Dekker, Inc.*
- *G. Odian: Principles of Polymerization, John Wiley.*
- *F.W. Billmeyer: Text book of polymer science, John Wiley.*
- *P. Ghosh: Polymer science & technology, Tata Mcgraw-Hill.*
- *R.W. Lenz: Organic chemistry of synthetic high polymers.*

WEB SOURCES

- *http://www.rnlkwc.ac.in/pdf/study-material/chemistry/Peter_Atkins Julio_de_Paula Physical_Chemistry 1_.p*

Course Title: Green Chemistry

Course Code: MCH222

L	T	P	Credits
3	0	0	3

Total hours: 45

Learning Outcomes

After completion of the course, the learner will be 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 **06 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 **16 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 **15 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 **08 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 Based

Teaching, 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*

WEB SOURCESS

- *https://books.google.com/books/about/Textbook_of_Environmental_Chemistry.html?id=Y7GyU 5SVLkQC#v=onepage&q&f=false*
- *https://books.google.co.in/books/about/Textbook_of_Environmental_Chemistry. html?id=Y7GyU5SVLkQC&redir_esc=y#v=onepage&q&f=*

Course Title: Chemistry of Cosmetics &Perfumes

Course Code: MCH211

L	T	P	Credits
3	0	0	3

Total hours:45

LEARNING OUTCOMES

On successful completion of this course, the students willbe 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 **10 hours**

Preparation and uses of the following:

Hair dye, hair spray, shampoo

UNIT II **10 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 **13 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 **11 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: Chemical Dynamics and Electro-analytical Techniques

Course Code: MCH217

L	T	P	Credits
3	0	0	3

Total hours: 45

Learning Outcomes

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 **12hours**

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 **11hours**

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*

WEB SOURCES

- *http://www.rnlkwc.ac.in/pdf/study-material/chemistry/Peter_Atkins Julio_de_Paula Physical_Chemistry 1_.pdf*
- *https://www.chemcome.com/wp-content/uploads/2020/11/Physical-chemistry-by-R.-L.-Madan-z- lsib.org_.pdf*

Course Title: Biophysical Chemistry

Course Code: MCH223

L	T	P	Credits
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**

BIOPOLYMER INTERACTIONS

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.*
- *Champe, P. C., Harvey, R. A., & Ferrier, D. R. (2005). Biochemistry.*

Semester: III

Course Title: Basics of Research Methodology

Course Code: MCH306

L	T	P	Credits
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**

Data Collection

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

- *Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2015)*
- *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: Research Proposal

Course Code: MCH398

L	T	P	Credits
0	0	8	4

Learning Outcomes

After completion of the course, the learner willbe able to

1. Get deep insights to collect, review and analyze the related literature.
2. To apply the knowledge to formulate hypothesis & design research process.
3. Find the research titles which are significant, applicable and researchable.
4. Interpret the findings to design statistical strategies & write references, bibliography and webliography.

Course Content

A research proposal contains all the key elements involved in the research process and proposes a detailed information to conduct the research.

The students are supposed to prepare the research proposal of any research area of their choice following these steps:

1. Selection of topic
2. Significance of the research area
3. Formulation of hypothesis/Research questions
4. Review of related literature
5. Method & Procedure (Includes sampling & design)
6. Data collection and proposed statistical analysis
7. Delimitations
8. Reference/Bibliography

Evaluation

The students will have to complete the writing process of each topic given above within one week, which will be evaluated at the end of every week. It will consist of 8 marks each. The final proposal shall be of 15 marks, Viva 16 marks and attendance 5 marks.

Transaction Mode

Collaborative learning, Group Discussion, E team Teaching, Activities, Assessments, Collaborative teaching, Peer Teaching, Video Based Teaching, Quiz, Open talk, E team Teaching, Case analysis, Flipped Teaching.

Course Title: **Ethics and IPR**

Course Code: **MCH316**

L	T	P	Credits
2	0	0	2

Total hours: 30

LEARNING OUTCOMES

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

1. Develop sensitivity and awareness; leading to commitment and courage to act on their own belief.
2. Recognize the basic concepts of Intellectual Property Rights.
3. Examine the statutory provisions of different forms of IPRs in simple forms
4. Explain the role of IPRs in professional life.

Course Content

UNIT I **08 hours**

Ethics: Definition, moral philosophy, nature of moral judgments and reactions, scope, Ethics with respect to science and research, Intellectual honesty and research integrity

Professional Ethics: Values in Work Life; Professional Ethics and Ethos; Codes of Conduct, Whistle-Blowing, Case Studies on Ethics in Science

UNIT II **06 hours**

Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP) Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data, Publication ethics: definition, introduction and importance

UNIT III **09 hours**

Introduction to Intellectual Property rights: Concept & theories, Kinds of intellectual Property Rights, Advantages and Disadvantages of IPR, Development of IPR in India, Role and Liabilities of IPRs in India.

UNIT IV **07 hours**

Rights of Trademark-Kind of signs used as trademark-types, purpose and functions of a trademark, trademark protection, trademark registration, selecting and evaluating trade mark, trade mark registration process.

Trade Secrets: Meaning, Types of Trade Secrets, Statutory Position of Trade Secrets in India, Proofs Required in Trade Secret Litigation Case.

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

- *Narayanan, P., (2007) Intellectual property law, Eastern Law House 3rd ed.*
- *Tripathi A.N., (2008) Human values, New Age International (P) Ltd.*
- *Robbins, S.P., (2007) Organizational behavior, Prentice Hall of India 8th ed.*
- *Journal of Intellectual Property Rights, published by National Institute of Science. Communication, CSIR.*

Course Title: Computer Lab

Course Code: MCH317

L	T	P	Credits
0	0	2	1

LEARNING OUTCOMES

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

1. Gain an insight of various computer software used in chemistry.
2. Develop skills to make use of various tools for structural elucidation.
3. Draw various structures with the help of object drawing tools.
4. Evaluate the role of computer software in solving chemistry problems.

Course Content

List of Practical's

1. Role of computer software & programme in solving chemistry problems
2. Handling numeric data: Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs, Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet
3. Introduction to different structure, object drawing & solving software's, structural elucidation using analytical & different mathematical tools
4. Incorporating chemical structures, chemical equations, and expressions from chemistry into word processing documents.

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

- *A. Findary, T. A. Kitchner , Practical physical chemistry, (Longmans, Green and Co.)*
- *J. M. Wilson, K. J. Newcombe, A. R. Denko, R. M. W. Richett, Experiments in physical chemistry, (Pergamon Press)*
- *Levie, R. de, (2001) How to use excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press.*

Course Title: PROFICENCY IN TEACHING

Course Code: MCH397

L	T	P	Credits
2	0	0	2

Total Hours: 30

Learning Outcomes

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

1. Design the learner-centered instructional plans and learning outcomes.
2. Apply innovative teaching strategies and technologies to engage learners.
3. Analyze the different assessment methods to evaluate student learning.
4. Reflect on teaching experiences and continuously improve teaching practices.
5. Develop effective communication and classroom management skills.

Course content

UNIT I **10 Hours**

Overview of the course and its objectives – Specify 1-2 theories or give overview of theories of learning for teaching - Understanding the role of the teacher and student in the learning process - Writing clear and measurable learning outcomes -

Meaning Nature, definition, scope, and importance Pedagogy, Andragogy, and Heutagogy – Skills-based approach to teaching (Teaching skills), Micro-teaching, Macro teaching. Methods and approaches of teaching - CAM, Structure-function approach, Synthetic and Analytic approach, Jurisprudential inquiry model

UNIT II **6 Hours**

Understanding the diverse needs and backgrounds of learners - Creating an inclusive and supportive learning environment - Facilitating active learning and student engagement strategies

Lectures, discussions, and demonstrations - Group work, collaborative learning, and cooperative learning - Problem-based learning, case studies, and simulations

UNIT III **7 Hours**

Integrating technology tools into instruction – Online, blended learning, flipped learning, and M-learning approaches - Using educational software and platforms effectively

Formative and summative assessment methods – Difference between Assessment, Evaluation and Measurement, E-assessment tools,

UNIT IV **7 Hours**

The importance of reflective practice in teaching - Self-assessment and evaluation of teaching effectiveness –Need for Professional development -

Teaching in multicultural and international classrooms - Culturally responsive teaching practices

Meaning, Definition of teaching model - Assumptions, Importance, Role, and type of teaching models. Historical teaching model, Philosophical model of teaching

Transaction Mode

Discussions, Case Studies, Microteaching, Classroom Observations, Peer Teaching: Video Analysis, Role-Playing, Lecture-cum-demonstration, Classroom Simulations, Reflective Journals/Blogs, Teaching Portfolios and Technology Integration, Flipped Teaching

Suggested Readings

- *Ali, L. (2012). Teacher education. New Delhi: APH Publishing Corporation.*
- *Anandan, K. (2010). Instructional technology in teacher education. New Delhi: APH Publishing Corporation.*
- *Bruce R Joyce and Marsha Weil, Models of Teaching, Prentice Hall of India Pvt Ltd, 1985.*
- *Chalan, K. S. (2007). Introduction to educational planning and management. New Delhi: Anmol Publications Pvt. Ltd.*
- *Chand, T. (2008). Principles of teaching. New Delhi: Anmol Publications Pvt. Ltd.*
- *Chiniwar, P. S. (2014). The technology of teaching. New Delhi: Anmol Publications Pvt. Ltd.*
- *Curzon, L. B., & Tummons, J. (2004). Teaching in future education. U.S.A: Bloomsbury Academic Publications.*
- *Das, R.C. (1993): Educational Technology – A Basic Text, Sterling Publishers Pvt. Ltd.*
- *Evaut, M. The International Encyclopedia of Educational Technology.*
- *Gage N L, Handbook of Research on Teaching, Rand Mc Nally and Co., Chicago, 1968.*
- *Graeme, K. (1969): Blackboard to Computers: A Guide to Educational Aids, London, Ward Lock.*
- *Haas, K.B. and Packer, H.Q. (1990): Preparation and Use of Audio Visual Aids, 3rd Edition, Prentice Hall, Inc.*
- *Haseen Taj (2006):modern Educational Technology, Agra: H.P Bhargava Book House.*
- *Jarvis, M. (2015). Brilliant ideas for ICT in the classroom. New York: Routledge Publications.*

Course Title: Service Learning

Course Code: MCH396

L	T	P	Cr.
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: Industrial Chemistry

Course Code: MCH320

L	T	P	Credits
2	0	0	2

Total Hours: 30

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 **09 hours**

Industrial Gases and Inorganic Chemicals

Industrial Gases: Uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, Sulphur dioxide.

Inorganic Chemicals: Application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, bleaching powder, sodium thiosulphate, hydrogen peroxide.

UNIT-II **05 hours**

Industrial Metallurgy

Processes involved in extraction of metals (ferrous and nonferrous) and ultrapure metals for semiconductor Technology

Biocatalysis

Introduction to biocatalysis: Importance in Chemical Industry

UNIT III **10 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

UNITIV **15 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.

Industrial waste management, incineration of waste. Water quality parameters for waste water, industrial water and domestic water.

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.*
- *S. M. Khopkar, Environmental pollution analysis: Wiley Eastern Ltd, New Delhi.*
- *S.E. Manahan, Environmental chemistry, CRC Press (2015).*

WEB SOURCES

- https://books.google.co.in/books/about/Textbook_of_Environmental_Chem ist ry.html?id=Y7GyU5SVLkQC&redir_esc=y#v=onepage&q&f=false.

Course Title: Advanced Chemistry Lab	L	T	P	Credits
Course Code: MCH321	0	0	4	2

Learning Outcomes

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

1.Apply extraction method required for identification and preparation of derivatives.

2.Determine the concentration of unknown compounds through established experiments.

3.Recognize the appropriate safety measures to deal with explosive chemistry and its exposure.

4.Ascertain established facts on working through advance instruments and spectroscopic analysis.

Course Content

List of Practical's

1. Selected organic chemistry experiments comprising 2-4 steps synthesis. Synthesis of Propranolol. The products are to be separated either by column chromatography or by recrystallization
2. The products are to be characterized by melting point and spectroscopic technique
3. Inorganic chemistry experiments - preparation of metal complexes and characterization.
4. Spectrophotometric estimation of Tin with toluene 3, 4-dithiol (dithiol)
5. Simultaneous spectrophotometric determination (chromium and manganese)
6. Determination of cations by Atomic Absorption Spectroscopy
7. Determination of vanadium in lubricating oil by AAS
8. Determination of trace lead in a ferrous alloy by AAS
9. Isolation of carotene and its UV spectral confirmation
10. Structure interpretation from Spectra

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.*
- *Silverstein, R. M. and Webster, F. X. (2014) Spectrometric identification of organic compounds, 8thEdn, Wiley.*
- *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.*
- *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).*
- *Vogel, A.I. (1996). Text book of quantitative Analysis, 4thedn.*
- *Pavia, Lampman and Kriz, Introduction to spectroscopy, 3rd Edn., Brooks/Cole.*

Course Title: Fuel Chemistry

Course Code: MCH322

L	T	P	Credits
2	0	0	2

Total Hours: 30

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 **07 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 **08 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 **07 hours**

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

UNIT IV **08 hours**

Lubricants*:* Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and 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).*

SEMESTER-IV

Course Title: Dissertation

Course Code: MCH402

L	T	P	Credits
-	-	-	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.

1. 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.

2. 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.

3. Dissertation will be evaluated internally by the supervisor allotted to the student during the semester.

4. 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.

5. 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.