GURU KASHI UNIVERSITY

Master of Science in Chemistry

Session: 2023-24

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. Construct eco-friendly protocols and procedures for chemical processes in industry.
5. Programme targets the 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 techniques.

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
MCH103	Physical Chemistry	Core	4	0	0	4
MCH104	Analytical Chemistry	Core	4	0	0	4
MCH105	Inorganic Chemistry Lab	Technical Skill	0	0	2	1
MCH106	Organic Chemistry Lab	Technical Skill	0	0	2	1
MCH109	Organizational Management	Ability Enhancement	2	0	0	2
Discipline Elective –I (Any one of the following)						
MCH110	Organometallic Chemistry	Discipline Elective -I	3	0	0	3
MCH111	Chemistry of Materials					
MCH112	Bioinorganic Chemistry					
MCH113	Chemistry of Natural Products					
Total			**21**	**0**	**4**	**23**

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
MCH216	Supramolecular Chemistry	Core	4	0	0	4
MCH217	Chemical Dynamics and Electroanalytical Techniques	Core	4	0	0	4
MCH218	Physical Chemistry Lab	Technical Skill	0	0	2	1
MCH219	Advanced Chemistry Lab	Technical Skill	0	0	2	1
MCH220	Industrial Chemistry	Elective Foundation Course	1	0	2	2
MCH224	Human Values and Professional Ethics	Value Added Course	2	0	0	2
Discipline Elective –II (Any one of the following)						
MCH221	Surface and Polymer Chemistry	Discipline Elective -II	3	0	0	3
MCH222	Green Chemistry					
MCH223	Biophysical Chemistry					
MCH211	Chemistry of Cosmetics and Perfumes					
Total			**22**	**0**	**6**	**25**

Semester: III						
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**Credits**
MCH306	Basics of Research Methodology	Research Skill	4	0	0	4
MCH315	Research Proposal	Research Skill	2	0	4	4
MCH316	Ethics and IPR	Foundation/ Value Based	2	0	0	2
MCH317	Computer Lab	Skill Based	0	0	4	2
MCH318	Proficiency in Teaching	Ability Enhancement	2	0	0	2
MCH319	Service Learning	Community Linkage	0	0	4	2
MCH399	xxx	MOOC	-	-	-	4
Total			**10**	**0**	**12**	**20**

Semester: IV						
Course Code	**Course Name**	**Type of Course**	**L**	**T**	**P**	**Credits**
MCH402	Dissertation	Research Based Skill	-	-	-	20
Total						**20**
Grand Total			**53**	**0**	**22**	**88**

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 / Presentations: [05 Marks]

B. Attendance: [5 Marks]
C. Mid Semester Test: [30 Marks]
D. End- Semester 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 Afterrole 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 stereochemical aspects and modes of pericyclic, electrocyclic 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.

Reaction of Free Radicals : Polymerization, Halogenation: Chlorination, bromination, Bromination by NBS, Iodination, Fluorination, Polar effects in halogenation. Addition Reactions: Free radical addition of HBr, thiols and halogens; Auto-oxidation, Rearrangements.

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: E_2, $E_1$and E_1CB mechanism, Stereochemistry product ratio, Orientation of double bond, Hofman Rule, Saytzeff Rule; Factors Governing E_2 & E_1Mechanism; 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 ofImines 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 EducationIndia.*
- *Ingold, C. K. (1953). Structure and mechanism in organic chemistry.*
- *Pursell, D. P. (2009). Adapting to student learning styles: Engaging students with cell phonetechnology 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*

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Course Title: Physical Chemistry

Course Code: MCH103

L	T	P	Credits
4	0	0	4

Total hours: 60

Learning Outcomes

After completion of the course, the learner willbe 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 andtheir 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-triplets and conductance

Electrical double layer: Electrical field interfaces & their structure; Electro catalysis, Kinetics of electrode process/reactions

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). Electrodics. ModernElectrochemistry 2A: Fundamentals of Electrodics.*
- *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 statisticalthermodynamics. Wiley*

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*

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 willbe 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 Complexometric 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 colouring 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: Column ion-exchange chromatography etc.

Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible)

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*

Course Title: Inorganic Chemistry Lab

Course Code: MCH105

L	T	P	Credits
0	0	2	1

Learning Outcomes

After completion of the course, the learner willbe 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 presencein 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 $(NH_3)_2$Hg 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

9. Paper chromatography
10. Thin layer chromatography
11. Column chromatography

COMPLEXOMETRIC TITRATIONS

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

REDOX TITRATIONS

13. Determination of chlorate, preparation of 0.1M cerium (IV) sulphate solution.
14. Determination of hydrogen sulphide.
15. 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.*

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Course Title: Organic Chemistry Lab

Course Code: MCH106

L	T	P	Credits
0	0	2	1

Learning Outcomes

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

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

Course Contents

1. Qualitative Organic Analysis

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

2. Organic Synthesis

Benzoylation	: Hippuric acid
Oxidation	: Adipic acid/p-Nitrobenzoic acid
Aldol condensation	: 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, β-unsaturated aldehydes, ketones, carboxylic acids, and esters with nickel boride in methanol– water. Bulletin of the Chemical Society of Japan.*

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Course Title: Organizational Management

Course Code: MCH109

L	T	P	Credits
2	0	0	2

Total hours:30

Learning Outcomes

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

1. Develop confidence to face interviews and to groom them for workplace.
2. Enhance their individual abilities, thus strengthening their employability.
3. Equip them to get in to grips with its new realities.
4. Face a range of new challenges, all of which call for graduates to display accountability, professionalism and credibility.

Course Content

UNIT I **10 hours**

Speaking Activities- Group Discussion, Mock Interview, Extempore, Declamation, and Presentation.
Writing Skills Activity-Business letter, Cover Letter and Resume writing

UNIT II **06 hours**

Reading Activity- Reading comprehension exercises from competitive tests

Listening Skills Activity- Listening to comprehend

UNIT III **06 hours**

Personality Development Activity-SWOT Analysis, Grooming and Work Ethics

UNIT IV **08 hours**

Vocabulary Enhancement Activity- Exercises on Synonyms & Antonyms, One word substitution Grammar Activity- Exercises based on Narration, Change of voice and errors.

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

SUGGESTED READINGS:-

- *Sanjay Kumar & Pushp Lata, (2014) Communication skills, Oxford University Press.*
- *Barron's, (2013) Vocabulary Builder, Educational Series, Bright Publishers.*
- *Wren & Martin,(2009) High School Grammar, S. Chand & Company*
- *Dr. T. Kalyanan Chakravarthi & Dr. T. Latha Chakravarthi, (2012) Soft Skills for Managers, Bizant.*

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 willbe able to

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

Course Content

UNIT I **13 hours**

Organometallic Compounds

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

UNIT II **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 polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

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 inoctahedral 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: **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 willbe 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*

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-lib.org_.pdf*

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 willbe 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**

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

Biochemistry of Iron: Availability of iron, competition for iron, iron toxicity and nutrition. Enzymes and their functioning, Vitamin B_{12} coenzyme, its function

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

Nitrogenase: Biological N_2 fixation, molybdenum nitrogenase, spectroscopic and otherevidence, other nitrogenases 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 relatedcompounds, 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: 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 willbe 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=C3la6a_gnKUC#v=onepage&q&f=false
- https://chem.uCreditsedu/curricular-materials/textbook
- https://courses.lumenlearning.com/suny-potsdam-organicchemistry/

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 oxidationand reduction for solving the problems.
2. Explain about structure, reactivity and preparation of poly nuclear and macro ringcompounds.
3. Acqire the skills for correct stereochemical assignment and interpretation in rather simple organic molecules.
4. Predict the role of various reagents in organic synthesis.

Course Content

UNIT I **14 hours**

Rearrangements

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

UNIT II **16 hours**

Polynuclear Compounds & Macro-Ring Compounds

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

UNIT III **17 hours**

Heterocyclic Synthesis

Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition reaction

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 dimethylcuprate, lithium disopropylamide (LDA) dicyclohexylcarbodimide. 1, 3-Dithiane

(reactivity umpolung), trimethylsilyl iodide, tri-n-butyltin hybride, Woodward hydroxylation, osmium tetroxide, DDQ, selenium dioxide, phase transfer catalysts, crown ethers and Merrifield resin, Peterson's synthesis, Wilkinson's catalyst, Baker yeast.

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

SUGGESTED READINGS

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

WEB SOURCES

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

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 willbe 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 **14 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 **16 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 **15hours**

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 {^{57} Fe , 119 S N , ^{151} EU } compounds, to biological systems to surface study, I_2CI_6, IBr_2 CL_4, XeF_4 , $XeCI_4$.

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 ChemicalSociety 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: Supramolecular Chemistry

Course Code: MCH216

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

Course Contents

UNIT I **17 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 – crystal engineering of pharmaceutical phases.

UNIT II **13 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 – implications for drug design – crystal engineering of NLO materials, OLED.

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 **14 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.

Supramolecular chemistry in solution – cyclodextrin, micelles, dendrimers, gelators – classification and typical reactions – application

UNIT IV **16 hours**

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, tubular mesophases, molecularprotonics, 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, 1989.3.*

- *R. Desiraju, and T. Steiner, The Weak Hydrogen bond in structural chemistry and biology; Oxford University Press, Oxford, 1999.4.*

Course Title: Chemical Dynamics and Electro-analytical Techniques

Course Code: MCH217

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 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 **12 hours**

Chemical Dynamics-I

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

UNIT II **16 hours**

Chemical Dynamics-II

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.

Dynamic Chain (hydrogen bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), Photochemical reactions 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 **20 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, treatment of data, organic and inorganic polarographic analysis

UNIT IV **12 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 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-lib.org_.pdf*

Course Title:	Physical Chemistry Lab	L	T	P	Credits
Course Code:	MCH218	0	0	2	1

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, pHmetry, 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 alsofind 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 + K2S2O8) by colorimetric method and determine the rate constant of the reaction at room temperature.
11. Test the validity of Lambert-Beer's law for KMnO4 solution. Construct similarly the calibration curve for K2Cr2O7 solution and hence determine the concentration of an unknown K2Cr2O7 solution.

12. Study the kinetics of iodination of acetone in presence of acid. Hence find out the order withrespect 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 degreeof 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

- *James, A. M., & Prichard, F. E. (2014). Practical physical chemistry, New York: Longman.*
- *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.*
- *Berry, R.S. & Rice, S.A. (2009). J. Ross physical chemistry.*
- *Peter Atkins, P., & De Paula, J. (2014). Atkins' physical chemistry. OUP Oxford.*
- *Cengel, Y. A. (2015). Introduction to thermodynamics and heat transfer (Vol. 846). New York: McGraw-Hill.*
- *Glasstone, S. (2011). An introduction to electrochemistry. Read Books Ltd.*
- *Bockris, J. O. M., Reddy, A. K., & Gamboa-Adelco, M. E. (Eds.). (2006). Modern Electrochemistry1, 2A, and 2B. Springer US.*

Course Title:	**Advanced Chemistry Lab**
Course Code:	**MCH219**

L	T	P	Credits
0	0	2	1

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 Practicals

1. Selected organic chemistry experiments comprising 2-4 steps synthesis. Ex. Synthesis of Propanolol. 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 like 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. Introduction to explosive chemistry and exposure to explosive chemistry
7. Determination of cations by Atomic Absorption Spectroscopy
8. Determination of vanadium in lubricating oil by AAS
9. Determination of trace lead in a ferrous alloy by AAS
10. Isolation of carotene and its UV spectral confirmation
11. 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, 8hEdn, 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 PhysicalChemistry, (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:	**Industrial Chemistry**
Course Code:	**MCH220**

L	T	P	Credits
1	0	2	2

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

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the followinggases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, Sulphur dioxide and phosgene.
Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

UNIT II

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor Technology

UNIT III

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 SO_2, CO_2, CO, NO_x, H_2S and other foul smelling gases Methods of estimation of CO, NO_x, SO_x and control procedures removal of Sulphur from coal.Control of particulates

Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion/ Fission, Solar energy, Hydrogen,geothermal, Tidal and Hydel etc.
Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management
Biocatalysis

Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry

UNIT IV
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 treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial waterand 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 SOURCESS

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

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 willbe able to

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

Course Content

UNIT I **12 hours**

Adsorption

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

UNIT II **08 hours**

Micelles

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

UNIT III **14 hours**

Macromolecules

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

Classificationof 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 Appications of Polymers:

Crystalline melting point $\mathbf{T_m}$- 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_.pdf*
- *https://www.chemcome.com/wp-content/uploads/2020/11/Physical-chemistry-by-R.-L.-Madan-z-lib.org_.pdf*

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 willbe able to

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

Course Content

UNIT I **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 specialEmphasis Afterfollowing:

- 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 theGeneration 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 (UltrasonicAlternative 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

1. *Ahluwalia, V.K. & Kidwai, M.R. (2015). New trends in Green Chemistry, AnamalayaPublishers*
2. *Matlack, A.S. (2011) Introduction to green chemistry, Marcel Dekker.*
3. *Cann, M.C. & Connely, M.E. (2012). Real-World cases in green chemistry, AmericanChemical Society, Washington.*
4. *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=Y7GyU5SVLkQC#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=f*

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 willbe 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 nucleicacids, 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.*

Course Title: **Chemistry of Cosmetics & Perfumes**

Course Code: **MCH211**

L	T	P	Credits
3	0	0	3

Total hours: 45

Learning Outcomes

After completion of this course, the learner willbe able to

1. Prepare Cosmetic Products.
2. Identify artificial flavors.
3. Formulate cosmetic products of required choice.
4. Evaluate 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 their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oileucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone

UNIT IV **12 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.*

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 willbe able to

1. Assess handling of hazardous chemicals and methods of storage.
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 **12 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 **15 hours**

Data Collection and Analysis

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

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 III **13 hours**

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

UNIT IV **15 hours**

Chemical Safety and Ethical Handling of Chemicals:

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, Procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, Procedure for laboratory disposal of explosives, identification, verification and segregation of Laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

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: **MCH315**

L	T	P	Credits
2	0	4	4

LEARNING OUTCOMES

After completion of the course, the learner willbe able to

1. Get deep insights to collect, critique, and interpret peer reviewed research throughthe creation of a literature review.
2. Develop their knowledge through in-class discussions of research principles, terms, andmethodology.
3. Find the possible dissertation topics in thrust areas through the creation of a research proposal.
4. Summarize the findings using research design and appropriate research methods in writing the research proposal with the use of high level written and verbal communication skills.

Course Content

The research proposal is a document of outlining the research, students will undertake. Generally, a research proposal should contain all the key elements involved in the research process and include sufficient information for the readers to evaluate the proposed study. Regardless of the research area and the methodology students choose, all research proposals must address the following questions:

What students plan to accomplish, why they want to do it and how they are going to do it.

Introduction:

- Topic area
- Research question
- Significance to knowledge

Make sure the proposal starts on a general level with some type of introductory remarks before going into the details of the specific research question you are proposing. This can be accomplished by providing
a frame of reference, a definition, or a discussion of the significance of the topic in the field. Make sure the research question is fully stated in one place.

Literature Review:

- Previous research: others & yours
- Interlocking findings and unanswered questions
- Your preliminary work Aftertopic

 The remaining questions and inter-locking logic
 Reprise of your research question(s) in this context

The literature review demonstrates the applicant's knowledge of the main research achievements in the area of study. Pay attention to provide some of the key references in your area of research which requires doing extensive research on your part. Make sure whether you can easily determine how the proposal is building on earlier studies, as well as exploring a line of research that is new.

Methodology / Theoretical Framework:

 Approach
 Data needs
 Analytic techniques
 Plan for interpreting results
 Expected results

Provide a full description of your general research design, as well as the specific methods and procedures used in your research project. This section discusses what measures the researcher will take in order to
test the study's hypothesis.

i) Describe your theoretical approach or type of analysis, if applicable
ii) Explain the details of your methods

Objectives:

i) Give a concise and clear outline of what you intend to find out in your project and what objectives you want to achieve.
ii) Research questions may take the form of a hypothesis to be tested against a specific set of criteria or a more open-ended inquiry.
iii) Objectives should establish the relevance and value of the proposed research in the context of current academic thinking.
iv) Your proposal needs to show why the intended research is important and to justify the reason for doing the research.

References:

Provide a list of all references that you have cited in the proposal.

Transaction Mode- Collaborative teaching, Group Discussion, E team Teaching, Activities Assessments, Collaborative teaching, Peer Teaching, Video Based Teaching, Quiz, Open talk, E team Teaching, Case analysis, Ted talks, 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 willbe 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.*

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Course Title: **Computer Lab**

Course Code: **MCH317**

L	T	P	Credits
0	0	4	2

LEARNING OUTCOMES

After completion of the course, the learner willbe 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 Contents
List of Practicals

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 physicalchemistry, (Pergamon Press)*
- *Levie, R. de, (2001) How to use excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press.*

Course Title: Proficiency in Teaching

Course Code: MCH318

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. Design and develop learner-centered instructional plans and learning outcomes.
2. Apply innovative teaching strategies and technologies to engage learners.
3. Explore different assessment methods to evaluate student learning and improve teaching practices.
4. Develop effective communication and classroom management skills.

Course Content

UNIT I **10 Hours**

Overview of the course and its objectives - Theories of learning and their implications 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 enquiry model

UNIT II **05 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 **07 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 **08 Hours**

The importance of reflective practice in teaching - Self-assessment and evaluation of teaching effectiveness – Need of 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, Teaching Demonstrations, Classroom Simulations, Reflective Journals/Blogs, Teaching Portfolios and Technology Integration

SUGGESTED READINGS

- *Das, R.C. (1993): Educational Technology – A Basic text, Sterling Publishers Pvt. Ltd.*
- *Evaut, M. The International encyclopaedia of educational technology.*
- *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.*
- *Kumar, K.L. (2008): Educational technology, New Age International Pvt. Ltd. Publishers, New Delhi (Second Revised Edition).*
- *Bruce R Joyce and Marsha Weil, Models of teaching, Prentice Hall of India Pvt Ltd, 1985.*
- *Siddiqui M S., and Khan M S., Models of teaching – Theory and Research, Manas Publication, New Delhi, 1991*

WEBLIOGRAPHY

- wiki.eveuniversity.org
- www.adprima.com
- www.apa.org
- www.crlt.umich.edu
- www.edutopia.org
- www.eveuniversity.org
- www.theteachersguide.com

Course Title: **Service Learning**

Course Code: **MCH319**

L	T	P	Credits
0	0	4	2

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

1. Explain the meaning of service learning , active learning, engaged teaching and engaged research
2. Develop networking skills. (The action or process of interacting with others to exchangeinformation and develop professional or social contacts.)
3. Explore the role and function of the civil society organizations in addressing the welfare needsof the deprived and disadvantaged sections of the society.
4. Recognize the socio-economic conditions of the poor and the commitment to a service-oriented career.

Course Content

Service learning: principles of service learning; classification of service learning models; difference between service learning and other community experiences; historical context of university community partnership; physics students and service learning. Service Learning for a postgraduate physics student and its scope in research.

Conceptualization of the idea of service learning through the following practical implementations:

(i) conducting awareness programmes on scientific temper for nearby communities,
(ii) organizing demonstrations of scientific experiments for school children to eradicate the fear of pursuing higher studies in science,
(iii) surveying the need of the communities and find out various possibilities of providing the solutions from physics point of view
(iv) providing consultancy to school students for various inter school science competitions.
(v) providing video lectures and/or demonstrations for school students.

TRANSACTION MODE

Discussions, Field Visits, Interactive Mode, Case Studies, Peer Teaching: Video Analysis, Role-Playing, Teaching Demonstrations, Classroom Simulations, Reflective Journals/Blogs, Team Teaching

SUGGESTED READINGS

- *Bedi Yashpal (2018) Handbook of preventive and community medicine Pragya SharmaEditor*
- *PatilRamagonda Asha (2022) Community organization and development, PHI Learning*

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.