



ಕ್ರಮಾಂಕ/No. : MU/ACC/CR.26/2025-26/A2

ಕುಲಸಚಿವರ ಕಛೇರಿ
ಮಂಗಳಗಂಗೋತ್ರಿ - 574 199
Office of the Registrar
Mangalagangothri - 574 199
ದಿನಾಂಕ/Date:14.07.2026

NOTIFICATION

Sub: Revised syllabus of M.Sc. in Industrial Chemistry Programme.

Ref: Academic Council approval vide agenda No.:ಎಸಿಸಿ:ಶೈ.ಮ.ಸಾ.ಸ.1:12
(2026-27) dtd 29.06.2026.

The revised syllabus of M.Sc. in Industrial Chemistry programme which has been approved by the Academic Council at its meeting held on 29.06.2026 is hereby notified for implementation with effect from the academic year 2026-27 and onwards.

Copy of the Syllabus shall be downloaded from the University Website (www.mangaloreuniversity.ac.in)


REGISTRAR

To,

1. The Registrar (Evaluation), Mangalore University.
2. The Chairman, PG Board of Studies in Industrial Chemistry, Dept. of Industrial Chemistry, Mangalore University.
3. The Chairman, Dept. of Industrial Chemistry, Mangalore University.
4. The Asst. Registrar (ACC), O/o the Registrar, Mangalore University.
5. The Director, DUIMS, Mangalore University – with a request to publish in the website.
6. Guard File.

MANGALORE UNIVERSITY



M.Sc. DEGREE PROGRAMME

IN INDUSTRIAL CHEMISTRY

(CHOICE BASED CREDIT SYSTEM-SEMESTER SCHEME)



DEPARTMENT OF INDUSTRIAL CHEMISTRY

MANGALGANGOTHRI-574199

MANGALORE UNIVERSITY

MANGALORE, STATE: KARNATAK,



Syllabus for M.Sc. Degree Programme in Industrial Chemistry
(With effective from the Academic Year 2026-27)

MANGALORE UNIVERSITY
DEPARTMENT OF INDUSTRIAL CHEMISTRY
M.Sc. DEGREE PROGRAMME IN INDUSTRIAL CHEMISTRY

(With effective from the Academic Year 2026-27)
Two years Master Degree programme (Four Semesters) M.Sc. Industrial
Chemistry (CBCS)

PREAMBLE

Updated syllabus for the two-year Master of Science in Industrial Chemistry program (Choice Based Credit System-Semester Scheme). In order to provide Hard Core, Soft Core, and Open Elective course with credits totaling 90 for the whole program. PG-BOS in Industrial Chemistry redesigned and approved the syllabus in Board of Studies meeting held on 5th May 2026 (Based on CBCS) for the PG course in Industrial Chemistry.

The curriculum, which includes 9 theoretical courses, is given as Hard Core courses, for a total 36 hard core credits is given for I, II, III semester, and I and one semester industrial project in IV semester as Hard Core courses with a total of 16 credits. In addition, students must study three soft-core courses each in I, II, and III semester with nine credits. Two credits are assigned as soft core for viva-voce examination in IV semester. Industrial Chemistry students now have the option of taking soft-core courses in the first, second, and third semester. All 9 practical courses will be taught as soft core with two credits each in the first and second semester, while the third semester practical course will get three credits. The total number of soft course credits is 33 and hard core credits totaling 52. The Board of studies in Industrial Chemistry has carefully selected two open elective courses for students from different disciplines, one each in the second and third semester, for six credits. As a result, the M.Sc course in Industrial Chemistry has total of 90 credits. A complete outline of the full curriculum is being prepared for the benefit of prospective postgraduates. Other crucial features, such as the University model question paper format, internal assessment exam, marks allocation, and estimated dates of internal examinations were tallied, and discussed in the Board of Studies meeting.

Program Objectives:

The M.Sc. Industrial chemistry course has an objective to impart knowledge of chemistry and hands-on experience to the students. The program includes an in-depth study on a number of areas in chemical sciences to which students are introduced at the core curriculum level, theoretical and experimental solutions to various problems and molding the students relevant to contemporary industries. The areas introduced by the department include agro-chemicals, pharmaceutical chemistry and petro-chemicals. Beside the theoretical and laboratory based curriculum, students complete an advanced project in the final semester of the program at an industry.

The degree provides a solid foundation in the discipline of core chemical sciences, critical thinking and problem solving skills. During the academic program students also develop an excellent written and oral communication skills, learn to work as a team and project management.

The objectives of this Postgraduate program include:

- To provide the highest level of education in chemical sciences and provide competent, creative and imaginative scholars
- To encourage free will and objective oriented enquiry for knowledge
- To make a significant contribution towards the development of skilled technical manpower. Thus cater to the need of growing demand of intellectual reservoir in the nation.
- The program is designed to achieve the objectives and to inculcate in the students concepts and intellectual skills, courage, integrity, awareness and sensitivity towards the needs and aspirations of the society
- The students can understand the role of chemistry in day-to-day life.
- To equip students with different types of problem solving related to academic and industrial domain

BASIS FOR INTERNAL ASSESSMENT

Internal evaluation grades in theoretical papers for the first, second, and third semester will be based on the average of two examinations, which will be scheduled on 10th and 14th weeks following the commencement of the semester

1. In the first semester, internal assessment will be awarded as follows: 20 marks for the Theory Test and 10 marks for the assignment written on specified related topics of units of the all-respective paper in hard-core and soft-core subjects
2. In the second semester, internal assessment will be awarded as follows: 20 marks for Theory Test and 10 marks for the seminar, or assignment /report written on the attendance of a national or international conference, workshop, training program or summary report of any research article for all papers in hard-core and soft-core subjects
3. In the third semester, internal assessment will be awarded as follows: 20 marks for Theory Test and 40 marks for the submission of industrial visit report, 40 marks out of which will be equally distributed between three hard core and one soft-core subject
4. The practical internal assessment marks for the first, second, and third semester will be calculated as follows: For the internal practical test (20 marks) + Lab record (5 marks) + Viva –Voce examination (5 marks). The practical test may be conducted toward the end of the semester.

THEORY QUESTION PAPER PATTERN FOR HARD CORE, SOFT CORE AND OPEN ELECTIVE COURSES

Question Papers in all the four semesters shall consist of Parts A and B.

- **Part A** shall contain Eight (8) very short answer type questions carrying 2 marks each drawn from all the four units of the syllabus (2 questions per unit). Five (5) questions are to be answered. There may be a maximum of two sub-divisions per question, carrying one (1) mark per sub-division.
- **Part B** shall contain Eight (8) brief and/or long answer questions carrying 12 marks each drawn from all the units of the syllabus (minimum 2 questions per unit). There may be a maximum of three sub-divisions per question, carrying 3 or more marks (4 or 5 or 6) per sub-division. Five (5) out of Eight (8) questions are to be answered from Part B. Overall 10 marks from Part A, & 60 marks from Part B. The total marks awarded to each course is 70

PRACTICALS EXAMINATION PATTERN

In all the semesters, 70 marks shall be awarded based on the experiment. All the three semesters I, II and III semesters, out of 70 marks, 20 marks are for the viva-voce to be conducted during practical and 50 marks for the experiment and the scheme of evaluation can be decided by the examiners during examination.

Candidates of IV semester shall undergo a compulsory project work in an industry for four months and prepare a project report (350 marks) on their work. Two examiners as in the case of theory papers shall evaluate the Project Report. Internal Assessment (150 marks) shall be allotted by project supervisors at the Industry. Internal guide from the department will evaluate the progress of the project work of a student time to time. Viva-Voce examination (100 marks) is to be conducted as per the University Regulations. The total marks awarded for the fourth semester course is 600 marks

**Two-Year Master's Degree Course
(Four Semesters) M.Sc. Industrial
Chemistry (CBCS)**

Semester	Hard core credits (T)	Soft core credits (T)	Open elective credits (OE)	No. of Practical Paper/ Project* credits	No. of Theory Paper	No. of Practical Paper	Total credits
I Semester	12	9	-	3(S)	3(H) + 1(S)	3(S)	21
II Semester	12	9	3	3(S)	3(H) + 1(S) 1(OE)	3(S)	24
III Semester	12	12	3	3(S)	3(H) + 1(S) 1(OE)	3(S)	27
IV Semester	16	02	--	Industrial Project 1(H)	1(H) + 1(S)		18
Total	52	32	6	9(S) + (1H)	10 (H) +4(S) +2(OE)	9 (S)	90

Core subjects	Total Credits	Percentage of Credits
Total Credits from all the Four Semesters:	90	100 %
Total Hard Core credits	52	57.77 %
Total Soft Core credits	32	35.55 %
Total Open Elective Credits	06 ((Not to considered for Calculating the CGPA)	6.66 %

H = Hard Core, S = Soft Core, P = Practical/Project Work, OE = Open Elective.

Details of the credit distribution of the program

Description of Course	Courses (Hard Core/Sof t-core)	Teaching Hrs./week	Credits	Hrs. of Exam	Max Marks: Exam+IA =Total
I -SEMESTER					
ICH 101:Inorganic Chemistry	H	4	4	3	70+30=100
ICH 102: Organic Chemistry-I	H	4	4	3	70+30=100
ICH 103:Physical Chemistry	H	4	4	3	70+30=100
ICS 104:Environment Health and Safety Measures	S	3	3	3	70+30=100
ICS 105:Paper and Textile Technology	S				
ICP 106:Inorganic Chemistry Practical -I	S	4	2	4	70+30=100
ICP 107:Organic Chemistry Practical-I	S	4	2	4	70+30=100
ICP 108:Physical Chemistry Practical-I	S	4	2	4	70+30=100
Total	3(H),4(S)	27	21		700
II-SEMESTER					
ICH 201:Analytical Chemistry	H	4	4	3	70+30=100
ICH 202:Advanced Organic Chemistry	H	4	4	3	70+30=100
ICH 203:Energy Systems, Colloids and Petrochemicals	H	4	4	3	70+30=100
ICS 204:Chemical Engineering Technology	S	3	3	3	70+30=100
ICS 205:Chemical Analysis in Agro and Food Industries	S				
ICP 206:Techniques in Quantitative Analysis	S	4	2	4	70+30=100
ICP 207:Estimations and Extractions in Organic Chemistry	S	4	2	4	70+30=100

ICP 208: Electro Analytical Techniques	S	4	2	4	70+30=100
ICE 209:Chemistry and Preparation of Household Chemicals and Cosmetics	OE	3	3	2	70+30=100
Total	3(H), 4(S), 1(OE)	30	24		800
III-SEMESTER					
ICH 301:Spectroscopic Techniques	H	4	4	3	70+30=100
ICH 302:Industrial Catalysis and Green Chemistry	H	4	4	3	70+30=100
ICH 303:Synthetic, Heterocyclic and Medicinal Chemistry	H	4	4	3	70+30=100
ICS 304:Computer Aided Drug Design	S	3	3	3	70+30=100
ICS 305:Polymers and Display Materials	S				
ICP 306:Synthesis of Complexes, Catalysts and Estimation of Alloys	S	6	3	5	70+30=100
ICP 307:Systematic Qualitative Analysis and Identification of Organic Compounds	S	6	3	5	70+30=100
ICP 308:Synthesis, Characterization and Applications of Polymers and Composites	S	6	3	5	70+30=100
ICE 309:Pesticides and their Environmental Impact Assessment	OE	33	3	2	70+30=100
Total	3(H), 4(S), 1(OE)		27		800
IVSEMESTER					
Project Work (4 Months)					350+150
ICH 401: Project Report	1(H) 1(S)	16 02	16 02		100
ICH 402: Viva-Voce Examination					Total= 600

Total	1(H), 1(S),	18	90		Grand Total=2900
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Programme Outcome for M.Sc. in Industrial Chemistry

SL. NO	Details
PO1	Analytical Skills: Graduates will gain the ability to collect, analyze, interpret, and apply data in a variety of contexts. They might also learn and understand to use specialized software or equipment
PO2	Problem-Solving Skills: Graduate will acquire the skills necessary to utilize their knowledge in order to identify, analyze, and address issues pertinent to their area of study
PO3	Disciplinary Knowledge: Graduates will gain an in-depth comprehension of their selected subject. Mastering both essential principles and theories, as well as advanced concepts. In addition to that, they will apply a strong theoretical and practical understanding developed through this specific program in their area of work
PO4	Ethics and Professionalism: Graduates may learn about the ethical and professional standards in their field, and how to apply them in real-world situations
PO5	Research Skills and Scientific temper: Depending on the field, graduates might learn how to design and conduct experiments or studies, analyze results, and draw conclusions in addition to that graduates might also learn how to review and understand Academic literature
PO6	Communication Skills : Graduates may learn to present complex information clearly and succinctly, write detailed reports, and collaborate with others
PO7	Self-directed and Lifelong Learning: The capacity to operate autonomously, recognize the necessary resources for a project, and oversee the project until its completion, while also being able to participate in independent and lifelong learning within the extensive framework of socio-technological transformations
PO8	Critical thinking: Graduate may be able to employ analytical thinking within a body of knowledge and also can assess and appraise evidence, claims and beliefs based on empirical data, recognize pertinent assumptions, and critically assess policies, theories by adhering to a scientific methodology for knowledge advancement

Programme Specific out comes for M.Sc. Industrial Chemistry

SL.NO.	Details
PSO1	The two years course of M.Sc. program helps the students to understand the essential concepts, principles, and theories associated with organic, inorganic, physical chemistry and its applications, also can demonstrate skill, hands on experience in conducting experiments within laboratory in chemical industries (PO3)
PSO2	The program helps the students to examine intricate issues, assess data, and implement theoretical principles in real-world contexts, recognize assumptions, and make judicious decisions and convey ideas proficiently (PO8)
PSO3	The program helps the students to utilize theoretical concepts and critical reasoning with technical skill to address the issues, and can gather data, investigate novel design opportunities (PO8)
PSO4	The program helps the students to devise research inquiries, perform literature reviews, organize and implement research studies in collaboration with chemical industries and academic research institutions (PO5)
PSO5	The program helps the students to cultivate diverse communication skill which include writing, listening, and speaking to facilitate the successful articulation of ideas and perspectives (PO6)
PSO6	The program helps the students to get jobs in chemistry field and its related area, additionally, students will also learn how to start their own business in chemistry field, so they can create their own jobs in the future (PO1)
PSO7	The program helps the students to develop analytical skill capacity to operate in research and development center in chemical industries as well as the ability to apply procedural knowledge to conduct scientific experiments with proficiency labs and research institute (PO2)
PSO8	The program helps the students will be well-versed in ethical issues in professional practice and research, as well as chemical safety procedures, additionally, students will be dedicated to sustainable and green chemistry techniques and aware about how chemical operations affect the environment (PO4)

I SEMESTER

I SEMESTER	
Course Name:	INORGANIC CHEMISTRY
Course Code:	ICH 101
Course Type:	Hard Core
Contact Hours/Week: 4L	Course Credit: 04

Course Objectives

- To understand the fundamental principles of coordination chemistry, including structure bonding, and reactivity of coordination compounds.
- To analyze various metallurgical processes and their industrial significance.
- To explore the chemistry and applications of organometallic compounds
- To apply symmetry concepts to predict molecular properties and understand electronic transitions.
- To correlate theoretical models (VBT, CFT, and MOT) with the properties of coordination complexes.

Course Content

UNIT-I: Coordination Chemistry

14hr.

Introduction and important terms pertaining to coordination compounds and naming of coordination compounds, Isomerism in coordination compounds (types of stereo isomerism and structural isomerism examples), theories of coordination chemistry: postulates and defects of Werner's theory, Sidgwick's electronic concept theory (Effective Atomic Number Rule), Valence bond theory, Crystal field theory (crystal field splitting in octahedral and tetrahedral coordination entities), Molecular orbital theory of coordination complexes, thermodynamic and kinetic stability, Ligand field effects on reaction rates. Magnetic properties, colors of coordination compounds, factors affecting the stability of coordination compounds, significance and applications.

UNIT-II: Organometallics

14hr.

Historical development, classification and nomenclature, stability, 16 and 18 electron rules, Transition metal alkyls and aryls-types, routes of synthesis, stability and decomposition pathways, Nucleophilic and electrophilic cleavage of metal-carbon sigma bonded compounds. Alkene activation. Transition metal to carbon multiple-bonded compounds-carbonyls, nitrosyls, metal-alkene, metal cyclopentadiene, metal-arene complexes.

UNIT-III: Bioinorganic Chemistry**14hr.**

Transport and storage of dioxygen- heme proteins, oxygen uptake, functions of hemoglobin, myoglobin, hemerythrin and hemocyanin's, synthetic oxygen carriers. Metal storage and transport –ferritin, transfer in and ceruloplasmin. Electron transfer proteins-cytochromes, iron-sulphur proteins. Metalloproteinase as enzymes– carboxy peptidase, carbonic anhydrase, alcohol dehydrogenase, catalyses, peroxides, cytochrome P450, superoxide dismutase, copper oxidases, vitamin B12 coenzyme.

UNIT-IV: Molecular Symmetry and Group Theory:**14hr.**

Symmetry elements and operations, Group theory- Concept of a group, definition of point group. Classification of molecules, Group multiplication tables. Matrix representations of symmetry operations, class similarity transformation, reducible and irreducible representations. The great orthogonality theorem. Character tables, relationship between representations and wave functions. Group theory and hybrid orbitals. Group theory and MO's. Molecular vibrations-Symmetry types of normal modes of vibrations. Selection rules for fundamental vibrational transitions, symmetry considerations to determine IR active and Raman active lines.

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Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Integrate theoretical knowledge to solve mechanistic and structural problems in coordination chemistry and apply this knowledge in research or industrial contexts-**Apply**

CO2: Analyze the electronic structures and reactivity patterns of organometallic complexes using MO theory and oxidation state consideration –**Analyze**

CO3: Evaluate the role of organometallic compounds in industrial and synthetic processes. **Evaluate**

CO4: Interpret the function and coordination chemistry of metal complexes in photosynthesis, respiration and electron transfer process –**Understand**

CO5: Discuss the application of bioinorganic principles in medicine-**Understand**

CO6: Apply concepts of point groups to classify the molecules–**Apply**

CO7: Utilize group theory to analyze molecular vibrations and predict IR and Raman activity. Analytical skill –**Apply**

Course Articulation Matrix: Mapping of Course outcome (COs) and (POs)

Course /Paper Title: ICH 101	Program Outcomes (POs)							
	1	2	3	4	5	6	7	8
CO1	V		V					
CO2								
CO3		V						
CO4					V			
CO5			V		V			V
CO6		V						V
CO7		V		V			V	

I SEMESTER	
Course Name:	ORGANIC CHEMISTRY-I
Course Code:	ICH-102
Course Type:	Hard Core
Contact Hours/Week: 4L	Course Credit: 04

Course Objectives

- To study and discuss the fundamentals concept of acid and bases used in organic synthesis
- To understand the characteristics of reaction intermediates and the influence of reaction conditions, including the type of solvent, isotopic effect, and the effect of salts
- To study the various types of reactions along with their kinetics, as well as the thermodynamic principles and the influence of thermodynamic parameters on reactions in relation to kinetic factors
- To comprehend the mechanisms of aliphatic and aromatic nucleophilic and electrophilic substitution reactions, along with the influence factors and associated with its various types of named reactions
- To comprehend and implement the diverse elements of stereochemistry and the applications of chirotechnology in asymmetric synthesis
- An exploration of aromaticity through various concepts, the assessment of aromaticity using different parameters, and a study of annulenes and the classification of aromaticity

Course Content

UNIT-I: Reaction Mechanism and its Intermediates

14hr.

Acids and Bases: Introduction to acids and bases, Bronsted-Lowry and acid-bases concept, organic acids and bases, Pearson's HSAB concept, pKa and pH, effect of solvent on acid and base strength, effect of structure of organic compound on acid and base strength. Reactivity in relation to molecular structure and conformation

Reaction intermediates: Generation, structure, stability, reactivity & detection of classical & non-classical carbocations, carbanions, free radicals, carbenes, nitrenes & arynes. N, S & P ylides & enamines.

Organic Reactions and Mechanism: Reaction mechanism & types of organic reactions, reaction profile diagrams, thermodynamic & kinetic control, leaving group and solvent. Methods of determining reaction mechanisms: Kinetic & non-kinetic methods-identification of products, detection of intermediates, isotopic labeling, stereochemical evidences, crossover experiments, kinetic evidences & kinetic isotopic effects. The Hammond postulate. Principle of microscopic

reversibility and Marcus theory. Steric effects. F strain, B-strain. Bond angle strain. The Hammett equation and its applications, ortho effect, Taft equation, linear free energy relationships

UNIT-II: Organic Reactions and Mechanism (Part-I)

14hr.

Aliphatic Nucleophilic Substitution reactions: Mechanisms Nucleophilic substitution: Substitution reactions of ambient nucleophiles, neighboring group participation of O, S, N, halogens, aryl groups, alkyl and cycloalkyl groups in nucleophilic substitution reactions. Sigma, Pi bond participation in acyclic and bicyclic systems (non-classic carbocations) Substitution at allylic, trigonal and Vinylic carbons, Meyer's synthesis of aldehydes, ketones and carboxylic acids, alkylation with trialkyl boranes.

Aliphatic Electrophilic substitutions: SE1, SE2 and SEi mechanisms hydrogen exchange, migration of double bonds, halogenations of aldehydes, ketones, acids, acyl halides sulphoxides and sulphones, aliphatic diazonium coupling, nitrosation at carbon and nitrogen diazo transfer reaction. Decarboxylation of aliphatic acids. Haloform reaction and Haller-Bauer reaction.

UNIT-III: Organic Reactions and Mechanism (Part-II)

14hr.

Aromatic nucleophilic substitution: A general introduction to different mechanisms of aromatic substitution S_NAr, A_N and Aryne, Von Richter rearrangement, Sommelet-Hauser rearrangement Smiles rearrangement. Radical substitution Mechanism: Reaction at Sp³ carbon: Reactivity in aliphatic substrates reactivity at bridged position, reactivity at Sp² carbon. Reactivity in aromatic substrates neighboring group assistance in free radical reactions, effect of reactivity in the attacking radical, effect of solvent on reactivity halogenations at an alkyl carbon and allylic carbon, hydroxylation at aromatic carbon by means of Fenton's reagent, oxidation of aldehydes to carboxylic acids, formation of cyclic ethers with Pb(OAc)₄ Reed reaction, Sandmeyer reaction, Kolbe reaction and Hunsdiecker reaction.

Addition Elimination Mechanisms: (a) Addition to carbon multiple bonds- Addition reactions involving electrophilic, nucleophiles and free radicals, cyclic mechanisms, orientation and stereochemistry, hydrogenation of double and triple bonds, Reformatsky reaction, Tollen's reaction, Wittig reaction, Prins reaction: (c) Elimination reactions: Stereochemistry of eliminations in acyclic and cyclic systems, orientation in eliminations - Cope and Hoffman elimination, pyrolytic elimination.

UNIT-IV: Stereochemistry

14hr.

Concept of chirality, optical isomerism, D, L-; R, S- designations, geometrical isomerism and E, Z designations, Stereoselective and stereospecific reactions, Racemization, mechanism of racemization, resolution of racemic mixtures, Atropisomerism Asymmetric synthesis-definition, importance, mechanism, energy consideration, advantages and limitations, methods of determination of

Enantiomeric excess. Enantio selective reactions,. Conformational isomerism and analysis in acyclic and simple cyclic systems - substituted ethanes, cyclopentane, cyclohexane and decalins,

Stereochemistry of non-carbon centers and stereochemistry of non-chiral compounds Cotton effect, CD and ORD. Aromaticity: Aromaticity and Huckel's rule, Aromaticity in benzenoid and non-benzenoid compounds, annulenes, and fullerenes. Alternant and non-alternant hydrocarbons, energy level of molecular orbitals, antiaromaticity, homoaromaticity, non-aromatic compounds.

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Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Evaluate the reactivity and strength of different acids and bases. **Analyze**

CO2: Utilize strategies and tactics to investigate organic reaction processes.

Apply

CO3: Put forward a reasonable mechanism for a given organic reaction.

Evaluate

CO4: Provide examples of the various types of reactions and rearrangement processes and mechanistic pathways. **Analyze**

CO5: Determine the process and end result of a certain addition, Elimination and nucleophilic substitution reaction. **Analyze**

CO6: Recognize the idea of organic compound configuration and conformation. **Understand**

CO7: Apply the concepts of stereochemistry and conformation of outcome of a reaction. **Apply**

CO8: To acquire knowledge on the generation of reactive intermediates, their mechanisms along with their applications in organic synthesis and industrial context. **Apply**

CO9: Describe strategies for the stereo specific/stereo selective organic transformations towards chiral target molecules. **Apply**

CO10: Identify chirality in molecular structures, and recognize the relationship. Between enantiomeric and diastereomeric structures **Analyze**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICH 102	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	✓	✓	✓					✓
CO2	✓	✓	✓					
CO3			✓		✓			
CO4			✓		✓			
CO5			✓					
CO6			✓					✓
CO7			✓		✓			
CO8	✓	✓	✓		✓			✓
CO9	✓	✓	✓		✓			✓
CO10	✓		✓		✓			

I SEMESTER	
Course Name:	PHYSICAL CHEMISTRY
Course Code:	ICH 103
Course Type:	Hard Core
Contact Hours/Week: 4L	Course Credit: 04

Course Objectives

- To provide a comprehensive understanding of the fundamental principle of quantum mechanics and thermodynamics as applied to chemical system.
- To develop the ability to analyze and interpret reaction kinetics, including the mechanisms and factors influencing chemical reactions
- To impart the knowledge on the causes, types and prevention methods of corrosion and the importance of corrosion control in industry.
- To know metal finishing processes, their technological aspects, and industrial applications.
- To introduce the application of electrochemistry in the color-alkali industry, electro synthesis, and electrochemical engineering, emphasizing modern technological developments.

Course Content

UNIT-I: Quantum Mechanics

14hr.

Quantum mechanics: Quantum theory and atomic spectra; the Bohr model, Photoelectric effect, De Broglie's hypothesis and wave-particle duality of material particles, Heisenberg's uncertainty principle, theory of wave motion, the wave function and its physical meaning, operators, Eigen values and Eigen functions, basic postulates of quantum mechanics, time independent, Schrodinger wave equation, Application of Schrodinger wave equation to particle in a 1D box.

UNIT-II: Thermodynamics and Chemical Kinetics

14hr.

Thermodynamics: Terminology, Laws of thermodynamics. Heat changes in chemical reaction-Born-Habercycle, bond energy, Kirchhoff's equation Entropy, flame and explosion temperature, calculation of heat of reaction. Free energy change and work function. Entropy-Evaluation, dependence on variables of a system, degradation of entropy. Entropy changes in chemical reaction. Thermodynamics of mixing. Theory and determination of Chemical Potential. Liquid mixtures. Excess functions for non-ideal solutions.

Chemical Kinetics: A brief review of basic concepts and terminologies in reaction kinetics. Rate law and factors effecting rate law. Steady state approximation. Complex reactions-reversible, parallel, consecutive and chain reactions, Explosive reaction (H_2-O_2) [qualitative aspects only].

UNIT-III: Corrosion

14hr.

Corrosion: Fundamentals of corrosion. Corrosion related damage, Types of corrosion (Galvanic, atmospheric, microbiological & stress). Methods of prevention and control (organic and inorganic coating, inhibitors, cathodic & anodic protection, material selection & design improvement). Corrosion problems in practice, passivity. Thermodynamics & kinetics of corrosion. Corrosion rate measurement (weight loss, Tafel extrapolation, polarization resistance) & monitoring. Concept & analysis of corrosion failure. Metal Finishing & Processing: Metal finishing and technological importance, Essentials of metal finishing, fundamentals of electrode position, effect of plating variables on the nature of electro deposit, electroplating process, electroplating of copper, nickel, chromium & gold. Principles & applications of electroless plating, electrochemical etching, electrophoretic painting & electroforming.

UNIT-IV: Chloro-Alkali Industry, Electro Synthesis, Electrochemical Engineering

14hr.

Chlor-alkali Industry: General concepts of brine electrolysis, modern technological developments, chlorine cell technologies, production of potassium hydroxide. **Electro synthesis:** Fundamentals of electro-organic & electro-inorganic synthesis, Kolbe's synthesis, electro reduction and oxidation of hydrocarbons, electro reduction of nitro compounds, synthesis of adiponitrile. Electro-inorganic synthesis of fluorine, chlorate and ozone. **Electrochemical Engineering:** Qualitative aspects of general considerations, costing of an Electrolytic process, performance and figures of merit, electrolysis parameters, principles of cell design, laboratory data and scale up.

REFERENCES:

1. Basic Quantum Chemistry, Harish Kumar Pandey Book womb Publisher 2018.
2. Quantum Chemistry, Ira N. Levine, 5th edn. Prentice Hall of India Pvt. Ltd., 2006.
3. Quantum Chemistry, R.K. Prasad, 4th revised edition, New Age International (P) Ltd., New Delhi.
4. Quantum Chemistry, Donald A. Mc Quarine, Viva Student Edition.
5. Principles of Quantum Chemistry, Ram Yatan Prasad & Pranitha, Cambridge University Press.
6. Thermodynamics for Chemists, S Glasstone, East-west Editon, New Delhi, 2003.
7. Chemical Thermodynamics-Basic Theory and Methods, 4th Edn., Klotz, Rosenbeg, Benjamin, 1986
8. Principles & Applications of Electrochemistry, DR Crow, third Edn. Chapman & Hall, 1987.
9. Chemical Kinetics, KJ Laidler, Harper & Raw.
10. Chemical Kinetics-Hareesh Mehra, Alfa publishing, New Delhi, 2006
11. Industrial electrochemistry by and Walsh, F.C. Iled, Chapman and Hall (1990)
12. Modern Electro chemistry, Vol I, IIA & IIB (1998) J.O.M. Bockries and A.K.N. Reddy Pentium. Press, New York (1970).

13. Engineering Chemistry by Jain and Jain 16th Ed, 2017.
14. Corrosion Engineering by Fontana, Mars G.,Mc Graw-Hill international 1978

Course Outcomes:

CO1: Apply mathematical tools like Schrodinger's equation to solve basic quantum mechanical problems- **Apply**

CO2: Understand the terminology, laws of thermodynamics and complex reaction mechanisms, including explosive reactions- **Understand**

CO3: Evaluate methods for prevention and control of corrosion, including inhibitors and passivation. – **Evaluate**

CO4: Analyse the industrial production and applications of various electrochemically synthesized compounds. –**Analyze**

CO5: Apply electrochemical principles to industrial processes, including electro synthesis and electroplating- **Apply**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICH 103	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	V	V	V					V
CO2	V		V		V	V		V
CO3		V			V			V
CO4	V	V	V					V
CO5			V		V			V

I SEMESTER	
Course Name:	ENVIRONMENT, HEALTH AND SAFETY MEASURES.
Course Code:	ICS-104
Course Type:	Soft Core
Contact Hours/Week: 3L	Course Credit: 03

Course Objectives

- To impart knowledge of environmental pollution and control measures
- To create awareness of occupational health hazards, risks, and personal protection methods
- To introduce waste management techniques, including hazardous waste and biomedical waste
- To educate students on laws and related to environment and occupational safety
- To develop skills in implementing safety audit, risk assessments

Course Content

UNIT-I: Air Pollution, Analysis and Control Methods: 10hr

Qualitative study of environmental segments, air pollutants, prevention and control, greenhouse gases & acid rain. Carbon monoxide, sources and control techniques. SO_x-sources, control techniques-scrubbing, limestone injection process. Ozone hole & CFCs. Photochemical smog & PAN. NO_x-Sources, NO_x, control technique use. Particulates: Size distribution, particulate collection-settling chambers, centrifugal separators, wet scrubbers, electrostatic precipitators and fabric filters. Analysis of air pollutants, Dispersion of air pollutants-weather, wind speed and acidity.

UNIT-II: Water, Waste Water Treatment and Analysis: 10hr.

Hydrologic cycle, sources, criteria & standards of water quality- safe drinking water, maximum contamination levels of inorganic and organic chemicals, radiological contaminants, and microbial contaminants. Public health significance and measurement of color, turbidity, total solids, acidity, fluoride, alkalinity, hardness, chloride, residual chlorine, sulphate, fluoride, phosphate and different forms of nitrogen in natural & polluted water.

UNIT-III: Quality Control and Quality Assurance

12hr.

Concepts of quality and quality control, the nature of variability's. Specification and tolerances, sampling inspection, cost reduction and quality improvement experiments. Optimization. Basic concepts of quality assurance, quality acceptance, sampling, reliability, cost aspects of quality decisions. Quality control in raw materials, production (in process) and finished product. Current trends in quality control, Laws related to quality control. Role Government standards like ISI, MINAS, Agmark, I.P., ASTM. ISO 9000 and ISO14000 series. ISO17025. Chemical warfare Convention: Definitions and schedules. Toxic chemicals tear gas, chemical weapons, ocean dumping of chemical weapons.

UNIT-IV: Good Laboratory Practices

10hr.

Safety equipment's, personal protective equipment's, compressed gas safety, 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. Emergency response- Chemical spills, radiation spills, biohazard spills, fires, medical emergency accident reporting, Safety rules of laboratory acquaintance of experimental set up and instruments, Intellectual property and intellectual property rights. Data management, importance of safety and security of data. Experimental process and risk assessment.

REFERENCES:

1. Environmental Chemistry, A.K.Dey, 7thed, New Age international Publishers, 2012.
2. Environmental Chemistry, S.K.Banerji, Prentice Hall India, 1993.
3. Environmental Chemistry, B. K. Sharma. 4th edition, GOEL Publishing House, New Delhi, 1998.
4. Chemistry of Water Treatment, S.D. Faust and O.M. Aly, and Butterworths, 1983.
5. Environmental chemistry, Ahluwalia V.K., Anne Books India, 2008.
6. Chemistry for Environmental Engineering, Sawyer and McCarty, McGraw Hill, 1978.
7. Environmental Chemistry, I. Williams, John Wiley, 2001
8. Statistical Quality Control, 2nd Edn. Manohar Mahajan Dampat Rai and Sons, 1995.
9. Quality management: a process improvement approach, Fryman Mark A, Cengage Learning, 2002.
10. Quality Control, Paranthaman D, Tata, McGraw Hill, 1987.
11. Gupta R.N. Chemical warfare and casualty management 2011
12. Vyas M.N. Safety and hazards management in chemical industries 2013. Atlantic publication.
13. Dikshith T.S.S Safety evaluation of environmental chemicals. New Age international, 1996.

Course Out comes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1:Explain different types of environmental pollution and evaluate pollution control techniques in Industry and laboratory setting. **Evaluate**

CO2:Identify occupational health hazards and implement appropriate personal protective equipment and safety measures. **Implementation**

CO3:Classify industrial, hazardous and implement appropriate personal protective equipment and safety measures. **Apply**

CO4:Classify industrial, hazardous and biomedical wastes and suggest suitable treatment and disposal methods. **Methodology**

CO5:Interpretnational and international EHS regulations and apply them in work place compliance strategies. **Apply**

CO6:Conduct safety audits and risk assessments, and develop emergency response protocol effectively. **Implementation**

Course Articulation Matrix: Mapping of Course out come (COs) and (POs)

Course/Paper Title: ICS 104	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1			✓	✓	✓		✓	
CO2		✓	✓	✓	✓	✓	✓	✓
CO3			✓	✓	✓		✓	✓
CO4	✓		✓	✓	✓		✓	✓
CO5	✓		✓	✓			✓	
CO6	✓		✓		✓		✓	

I SEMESTER	
Course Name:	PAPER AND TEXTILE TECHNOLOGY
Course Code:	ICS 105
Course Type:	Soft Core
Contact Hours/Week: 3L	Course Credit: 03

Course Objectives

- To explore different pulping methods; mechanical, chemical, and semi chemical
- To provide foundational understanding of natural and synthetic textile fibers
- To assess the sustainability and circular economy aspects in the industry
- To understand raw materials, chemistry and processes involved in pulp production

Course Content

UNIT-I: Pulp and Paper Science

12hr.

Raw materials for paper, Important fiber producing plants, woody & non woody fibers used in paper industry, physical and chemical characteristics. Structure of wood, structural elements of wood and bark, cell wall & fiber morphology, chemical components of wood; **Pulp Manufacture:** Mechanical pulping, Thermo mechanical and Refiner mechanical pulping, Semi chemical and chemical pulping. Kraft pulping. **Papermaking:** Beating and refining of pulp.

UNIT-II: Textile Technology

10hr.

Textile Technology: Brief history on origin of textiles. Introduction to textile fibers and basic requirements of textile fibers. Manufacture of eco-friendly regenerated fiber. Brief study of physical and chemical properties of cotton, wool, silk & bast fibers. Importance and need of ginning. Impurities in the cotton and remedies to minimize impurities in cotton.

UNIT-III: Introduction to Blending Techniques

10hr.

Introduction to blending techniques and its types. Blends of Polyester/cotton and polyester/viscose. Introduction to synthetic fibers. Raw materials for productions of PET, modified viscose rayon and their applications. Brief out line on production of acetate and cupramonium rayon and their applications.

UNIT-IV: Coating and Recycling of Paper and Textile

10hr.

Introduction to coating of Paper and metal foils. Fillers used in papermaking. Pressing: Objectives, types of presses, Drying: Theory and types, Finishing: Unwinding and rewinding. Evaluation of Paper: Physical, optical, electrical properties and Chemical properties of paper.

Objects of mixing and blending. Introduction to textile testing & quality control. Sampling techniques. Frictional, optical, electrical and thermal properties of textile. Recycling of paper and textile.

REFERENCES:

1. Bleaching of Pulp, R.P.Singh, TAPPI Pres Atlanta, 1979.
2. Joint Text Book Committee of the Paper Industry, Vol. I to X, Technical Editor Benjamin A. Thorp Series Editor Michael J. Kocurek, Published by the technical section Canadian Pulp and Paper Association 1962.
3. Hand Book for Pulping and Paper making, Christopher J. Biermann, Academic Press, Second Edition, 1996.
4. Hand Book for Pulp and Paper Technologists, Gary A.Smook, Formation of synthetic fibres, Walczalk.K. Gordon & Sci.London.
5. Manual of Cotton Spinning, Coulson. A.F.W. (Ed.), Vol. I toIV, Textile Institute Pub., Manchester, 1989.
6. Spun Yan Technology , Oste by, butter worthus, london,1987,physical testing of textiles b.p.Sovile, Wood Head, 1999, Principles of textiles, Testing, Booth, J.E Butterworth, Wedon III edition, 1968
7. Technology of Textile Processing, Technology of Dyeing, Shenai, V .A. 4th Edn., Sewak publications, Bombay,1988.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: To understand the raw materials, chemistry and processes involved in pulp production-
Understand

CO2: Evaluate pulp quality using appropriate analytical techniques. –**Evaluate**

CO3: Analyse the physical and chemical properties of common textile fibers.–**Analyse**

CO4: Apply principles of green chemistry to optimize coating and recycling processes. **Apply**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICS 105	Program Outcomes (POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1			✓	✓	✓		✓	
CO2		✓	✓	✓	✓	✓	✓	✓
CO3			✓	✓	✓		✓	✓
CO4	✓		✓	✓	✓		✓	✓

I SEMESTER	
Course Name:	Inorganic Chemistry Practical's-I
Course Code:	ICP 106
Course Type:	Soft core
Contact Hours/Week: 4L	Course Credit: 02

Course Objectives:

- To develop proficiency in classical quantitative analytical techniques
- To impart the basic analytical and technical skills to work effectively in different fields of chemistry
- To perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusion
- To gain hands on experience in volumetric and gravimetric analysis with statistical analysis of data

Course Content

Any Ten/ Twelve of the following experiments are to be carried out:

1. Analysis of Hematite-insoluble residue by gravimetric & Iron by volumetric method.
2. Analysis of Dolomite-insoluble residue by gravimetric & Ca, Mg by complexometric method.
3. Pyrolusite-Insoluble residue by gravimetric and Manganese content by oxalate method.
4. Determination of iron using potassium dichromate.
5. Preparation of pure sample of ferrous ammonium sulphate (Mohr's salt) $[\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}]$
6. Preparation of pure sample of potash alum (Fitkari) $[\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}]$
7. Complexometric determination of Mn, Cu, Ni and Fe-Cr mixture
8. Determination of Hardness of water.
9. Analysis of Halide Mixture-Iodide by KIO_3 and total halide by gravimetrically.
10. Colorimetric Determination of Iron by thiocyanate and Cu by aqueous ammonia.
11. Gravimetric Determinations of Mn, Ni, Mo, Pb/Cr, sulphide, thiocyanate.
12. Spot test for the detection of inorganic ions (any ten cations).
13. Statistical analysis of data.

REFERENCES:

1. G.H. Jeffrey, J.Bassette, J.Mendham and R.C.Denny, Vogel's Text Book of Quantitative Chemical Analysis, fifth Edition, Longman, 1999.
2. Vogel, "Text book of Qualitative Inorganic Analysis", third Edition, ELBS.1976.
3. D.A.Skoog and D.M.West, Fundamentals of Analytical Chemistry, IV Edition, Old Reinhold & Winston, Publication, 1982.
4. B.K.Sharma, Instrumental methods of Chemical analysis, Goel Publishing House, 24th Edition, 2005.
5. Gurdeep R. Chatwal, Sham K.Anand, Instrumental Methods of Chemical Analysis, Himalaya Publication, 1979.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1:Apply principles of colorimetric for the quantitative estimation of metalions **Apply**

CO2:Analyse coordination and solubility equilibrium involved in colorimetric and gravimetric estimations of transition metal ions.**Analyse**

CO3:Interpret experimental data draw conclusions about the chemical behavior and analytical properties of transition metal ions in aqueous solution. **Evaluate**

CO4:Use laboratory skill to determine medallion concentration in various samples, following safe laboratory practices.**Analyse**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICP 106	Program Outcomes(POs)							
	1	2	3	4	5	6	7	8
CO1	√	√	√	√	√		√	√
CO2	√	√	√		√		√	√
CO3	√	√	√	√	√		√	√
CO4	√	√	√	√	√	√		√

I SEMESTER	
Course Name:	ORGANIC CHEMISTRY PRACTICALS-I
Course Code:	ICP 107
Course Type:	Soft core
Contact Hours/Week: 4L	Course Credit: 02

Course Objectives

- To acquire knowledge of laboratory methodologies and safety protocols, as well as the necessary precautions for conducting reactions
- To receive instruction on the planning and implementation of both single and multistep synthesis of organic molecules
- To refine and characterize the products utilizing physical and chromatographic techniques
- To understand the mechanisms involved in the formation of the desired products
- To learn various types of named reactions and mechanisms
- To provide fundamental knowledge for conducting preparations, comprehend the nature of reactions and established reaction conditions along with their mechanisms
- To understand the calculations of mole and molar ratio for carry out the reaction
- To isolate the products from individual steps and purify them through the crystallization

Course Content :

Any Ten/ Twelve of the following experiments are to be carried out:

Single and two stage organic preparations, purification and characterization:

1. Preparation of 1,2,3,4- tetrahydron carbazole,
2. Preparation of 7-hydroxy -4-methyl-coumarin,
3. Preparation of Aspirin, Adipic acid para red and methyl red
4. Preparations of p-Bromo & p-Nitro aniline from acetanilide,
5. Preparation of Ethyl resorcinol from resorcinol,
6. Preparation of ϵ -caprolactum from cyclohexene,
7. Preparation of p-amino benzoic acid from p-nitro toluene,
8. Preparation of 5-tribromobenzene from aniline,
9. Preparation of benzyl acid from benzoic,
10. Preparation of p-chloro toluidine from toluidine,
11. Preparation of 2,4-Diphenyl hydrazine from chlorobenzene,
12. Preparation of o-Amino benzoic acid from phthalic anhydride

13. Preparation of Hydantoin from benzyl p-amino
14. Preparation of Azobenzene from aniline
15. Preparation of Thiazoles from acetophenones,
16. Preparation of Pyrimidines from aldehydes/ketones and
17. Preparation of Thiourea, from resorcinol & phthalic anhydride,
18. Preparation of Indigo from anthranilic acid,
19. Preparation of methyl orange from aniline,
20. Preparation of 5-hydroxy-1,3-benzothiazole from hydroquinone,
21. Preparation of benzimidazole from urea,
22. Preparation of Benzocaine from p-nitrotoluene,
23. Preparation of Dibenzyl from benzyl,
24. Preparation of Benzil from Benzoin,
25. Preparation of Benzal acetophenone dibromide from acetophenone.

REFERENCES:

1. Vogel's Text book of Practical Organic Chemistry including Qualitative Organic analysis-
B.S.Furnis et al., Longman ELBS, London 1989.
2. Experimental Organic Chemistry-Vol I & II P.R. Singh et al., TMH New Delhi-1981
3. Laboratory Manual inorganic Chemistry-Dey & Sitharaman Allied Publishers
New Delhi-1992
4. Organic Analytical Chemistry, Theory and Practice-Jagmohan, Nersa, 2003
5. Practical Organic Chemistry by F.G.Mann & B.C.Saunders, 4th Edition, Longman, 1970
6. Laboratory Manual of Organic Chemistry-Raj K Bansal 2nd edition Wiley 1990.
7. Systematic Lab Experiments in Organic Chemistry- by Arun Sethi, New Age International publishers, 2006,
8. Advanced Practical Organic Chemistry-by Jagmohan, Himalaya Publishing House, 1992

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Conduct reactions while adhering to appropriate safety protocols and to purify and characterize the products using physical and chromatographic techniques. **Apply**

CO2: Gain practical hands-on experience in executing the reaction and understanding the mechanism behind the formation of the products. **Understanding**

CO3: learn the skills about synthesis, purification, and analysis. **Apply**

CO4: Synthesis of organic compounds using various techniques such as reflux, crystallization, distillation, and understand the mechanisms involved in reactions like nitration, bromination reactions etc. **Understand**

CO5: Apply green chemistry principles in synthesis of assess the sustainability and

atom economy of organic reactions. **Apply**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course Articulation Matrix: Mapping of Course outcome (COs) and(POs)								
Course/Paper Title:ICS 107	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	√		√	√	√		√	√
CO2	√	√	√		√		√	√
CO3	√	√	√		√		√	
CO4	√		√	√	√		√	√
CO5	√	√	√		√	√		√

I SEMESTER	
Course Name:	PHYSICAL CHEMISTRY PRACTICALS-I
Course Code:	ICP 108
Course Type:	Soft core
Contact Hours/Week: 4L	Course Credit: 02

Course Objectives

- To develop an understanding of experimental methods in physical chemistry through hands on experience.
- To emphasize the importance of precision, accuracy, and safety in chemical experimentation.
- To cultivate analytical and data interpretation skills, including error analysis and graphical evaluation of experimental data.
- To determine physical constants using refractometry, adsorption experiment and viscometry.

Course Content

Any Ten/ Twelve of the following experiments are to be carried out:

1. Analysis of a binary mixture and determination of molar refraction of a solid and the composition of chloroform and acetone in its isotropic mixture by refractometry.
2. Analysis of a binary mixture of two miscible liquids by viscometry and the relation between viscosity of a solution and the electrical conductivity.
3. Study of variation of viscosity of a liquid with temperature.
4. Determination of parachor value for CH_2 group by S.T method, the composition of a solution by S.T measurement and the CMC of a soap solution by S.T measurement.
5. Surface tension-concentration correlation for solutions (Gibbs equation).
6. Verification of F and L adsorption isotherms for acetic & oxalic acids on activated charcoal.
7. Analysis of binary mixture by surface tension method.
8. Adsorption of iodine on charcoal from alcoholic solution.
9. Study of adsorption of picric-acid on charcoal using a calorimeter.
10. Acid catalyzed hydrolysis of methyl acetate and determination of catalytic strength of an acid.
11. Saponification of ethyl acetate by conductivity method.
12. Reaction between potassium persulphate and potassium iodide (including the study of salt effect and catalysis by Ag^+ , Fe^{2+} and Cu^{2+} ions).
13. Decomposition of diacetone alcohol by NaOH & Hydrolysis of t-Butyl chloride.
14. Reaction between hydrogen peroxide and HI .
15. Determination of solubility of lead iodide at different Temperature and hence molar heat of solution.
16. Determination of heat of solution of a sparingly soluble solute.

REFERENCES:

1. B. P. Levitt, Longman, Findlay's Practical Physical Chemistry, J Wiley, London, 1954.
2. Experimental Physical Chemistry, Das & Behera, Tata McGraw Hill, NewDelhi, 1983.
3. J.B. Yadav, 16th edition of Advanced Practical Physical Chemistry, Goelpublishers, 1989.
4. Experiments in Physical Chemistry, J.C.Ghosh, Bharathi Bhavan, 1974.
5. D.A.Skoog and D.M.West, Fundamentals of Analytical Chemistry, IV Edition, Old Reinhord & Winston, Publication, 1982.
6. B.K. Sharma, Instrumental methods of Chemical analysis, Goel Publishing

House, 24th Edition, 2005

7. Gurdeep R. Chatwal, Sham K. Anand, Instrumental Methods of Chemical Analysis, Himalaya Publication, 1979.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Understand the concept of surface tension and its dependence on intermolecular forces. **Understand**

CO2: Analyse the relationship between temperature, molecular size, and fluid flow behavior. **Analyse**

CO3: Present scientific and technical information resulting from laboratory experimentation in both written and oral format. **Understand**

CO4: Calculate the rate constant for the reaction and determine the catalytic strength of different acids based on reaction kinetics. **Calculate**

CO5: Interpret refractive index with molecular structure and composition. **Analyse**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICS 108	Program Outcomes(POs)							
	1	2	3	4	5	6	7	8
Course outcome								
CO1	√	√	√	√	√			√
CO2	√		√					√
CO3						√	√	
CO4	√	√	√					√
CO5		√						√

II SEMESTER

II SEMESTER	
Course Name:	ANALYTICAL CHEMISTRY
Course Code:	ICH 201
Course Type:	Hard Core
Contact Hours/Week: 4L	Course Credit: 04

Course Objectives:

- Understand the principles behind various type of titrations, indicators and error analysis
- Learn and apply chromatographic techniques for separation and analysis
- Acquire knowledge of electro analytical and spectroscopic techniques
- Explore the application of solvent extraction and chelometric titrations in complex sample analysis
- Understand the fundamentals and instrumentation of diffraction and molecular spectroscopy techniques.

Course Content

UNIT-I: Preparation and Analysis of Samples

14hr.

Preparation of samples for analysis, nature of errors, statistical treatment of errors, that- t-and f-tests, significant figures, rejection of data. Precipitation phenomena: Precipitation from homogeneous solutions, organic precipitants in inorganic analysis. Solvent extraction of metal ions, nature of extraction, distribution law, partition coefficients, types of extractions and applications. Theories of redox indicators, titration curves, feasibility of redox titrations. Chelometric titrations- titration curves with EDTA, feasibility of EDTA titrations, indicators for chelometric titrations, selective masking and demasking techniques, industrial applications of masking.

UNIT- II: Chromatographic Techniques:

14hr.

Principles, classifications and theory of chromatographic separations. Column chromatography: Principles, Differential migration, Separation of a mixture of o/p-nitro anilines **Gas Chromatography:** Principles, columns, detectors-TCD, FID, ECD and column efficiency, capacity factors, resolution. Practical aspects of GC-Hyphenated techniques. Liquid Chromatography HPLC: Principles, equipment,

columns, detectors, choice of column, materials GC, GC MS and LC-MS.

Ion exchange chromatography: Structures of resins, Types, Theory and apparatus, selectivity, Applications.

Thin layer chromatography: Principles, selection of stationary and mobile phases, Preparative TLC, Applications Paper chromatography: Theory and principle. Techniques: one, two-dimensional and circular paper chromatography. Mechanism of separation, structure of cellulose and types of paper. Methodology- Factors affecting Rf values. Advantages and applications.

UNIT-III : Electro Analytical Techniques

14hr.

Introduction, theory, principle, methodology, instrumentation and application of the following techniques: Conductometry, Potentiometry, Coulometry, Voltammetry.

Light-Scattering methods: Nephelometry & turbidimetry theory, effects of concentration, particle size & wavelength on scattering, instrumentation & application. **Fluorometry and Phosphorimetry:** Introduction, fluorescence and phosphorescence, factors affecting fluorescence and phosphorescence, internal conversion, intersystem crossing (radiation less processes) quenching. Theory, relationship between intensity of fluorescence and concentration, instrumentation—basic differences in the measurement of fluorescence and phosphorescence, spectrofluoro meters, advantages and disadvantages

UNIT-IV: Advanced Instrumental Techniques

14hr.

Spectrophotometry, Atomic spectroscopy, **Surface probe microscopy:** Atomic force microscopy, Scanning tunnelling microscopy, Field emission scanning electron microscopy, Transmission electron microscopy. **Thermal Analysis**-TGA, DTA and DSC-Principles, instrumentation and applications. **X-Ray diffraction techniques**-Powder and single crystal XRD, principle, techniques and applications.

REFERENCES:

1. Inorganic Chemistry, 3rd edn., G.L. Miessler and D.A. Tarr, Pearson Education Inc. 2014.
2. Inorganic Chemistry, 4th edn. J.E. Huheey, R.L. Keiter and A.L. Keiter, Addison Wesley, 1993.
3. G.D. Christian, Analytical Chemistry, John Wiley, 1986.
4. Analytical chemistry-problems and solutions by S.M. Khopkar, New Delhi: New Age International (P) Ltd., 2002.
5. Analytical chemistry by G.L. David Krupadanam, D. Vijay Prasad, K. Varaprasad Rao, K.L.N Reddy, C. Sudhakar, Universities Press India Ltd, 2002.
6. R.A. Day and A.L. Underwood: Quantitative Analysis, (Prentice Hall, India), 1998.
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9. Skoog, Holler and Nieman: Principles of Instrumental Analysis, Harcourt Acta, 2001.

10. Brown D R, Chromatography, Ivy Publishing House, 2001.
11. B.K.Sharma, Chromatography, Krishna Prakashanmedia, 1997.
12. Bier, Milan ED, Electrophoresis: Theory methods and applications, Academic1967.
13. AK Trainband Kutty, Crystallpgraphy, University Press, 2002.
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15. S.K.Chatterjee, X-Ray Diffraction theory and application, I STE, 2007.
16. S.M Cannon, Comprehensive Inorganic Chemistry,, Newyork, 1972.
17. J.H.Kennady, Analytical Chemistry: Principles, CengageLearningIndiaPvt.Ltd.
18. Dhanaraj, G., Byrappa, K., Prasad, V., Dudley, M. (Editors): Springer Handbook of Crystal Growth. ©2010.
19. A.G.Jackson: Handbook of Crystallography for Electron Microscopists and Others1991.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Explain the statistical treatment of analytical data and identify sources of error in qualitative analysis. **Knowledge**

CO2: Apply principles of redox precipitation and chemometric titrations including the use of appropriate indicators and masking agents. **Application**

CO3: Describe and implement various chromatographic techniques including column chromatography, GC and HPLC. **Understanding**

CO4: Analyze the instrumentation and working principles of gas and liquid - chromatography and understand the role of detectors such as TCD, FID and ECD. **Analyze**

CO5: Evaluate physical methods such as solvent extraction and discuss their applications in chemical analysis. **Evaluate**

CO6: Integrate spectroscopic and diffraction methods in the characterization and identification of chemical substances. **Analyze**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICH 201	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	V	V	V		V		V	V
CO2	V		V		V			V
CO3			V		V		V	V
CO4	V		V	V				
CO5		V	V					V
CO6	V	V	V					V

II SEMESTER	
Course Name:	ADVANCED ORGANIC CHEMISTRY
Course Code:	ICH 202
Course Type:	Hard Core
Contact Hours/Week: 4L	Course Credit: 04

Course Objectives

- To acquire knowledge and comprehension regarding the function of organic reagents in organic synthesis and their applications in elucidating reaction mechanisms
- To examine the categorization of natural products, their extraction, and their significance in biological contexts
- To acquire an understanding of the reaction mechanisms associated with different named reactions and their applications in organic synthesis
- To acquire essential knowledge regarding carbohydrates and their industrial and biological significance across various types

Course Content

UNIT-I: Reagents in Organic Synthesis

14hr.

Uses of one, 3-dithiane, Organoboranes, Trimethylsilyliodide, Tri-n-butyltin hydride, Selenium dioxide, Lead tetra acetate, Lithium aluminium hydride, Sodium borohydride, Organolithium, organo magnesium and Organo zinc compounds in organic synthesis and functional group transformations. Synthetic applications of, LDA, DCC, Gilman's reagent.

UNIT-II: Organic Named Reactions and Rearrangements

14hr

Reactions, mechanisms and synthetic uses of Mannich reaction, Barbier-Wieland degradation, Oppenauer oxidation, Birch reduction, Vilsmeier-Haack reaction, Suzuki coupling, Woodward-Prevost hydroxylation, Swern oxidation and Mitsunobu reaction. Classification and general mechanistic treatment of nucleophilic, electrophilic & free radical rearrangements, Intermolecular & intramolecular migration, nature of migration & migratory aptitudes, Mechanisms of Favorskii, Beckmann, Neber and **Claisen rearrangement**

UNIT-III: Natural Product Chemistry

14hr.

Introduction to primary and secondary metabolites in plants. Extraction methods of chemical constituents from plants, fractionation using solvents, specific extraction of alkaloids and supercritical fluid extraction. Characterizations of isolated compounds (terpenes, sterols, alkaloids, and flavonoids) by color reactions and spray reagents.

Determination of the carbon skeleton of alkaloids (Hofmann, Emde and Von Braun degradation methods) Classifications of Pigments. Structure elucidation and synthesis of Ocimene, structure elucidation of β -carotene. Biosynthesis of terpenes from mevalonic acid. Structure elucidation and synthesis of quercetin. Structural elucidation of testosterone, androsterone, and progesterone.

UNIT-IV: Carbohydrates

14hr.

Introduction, Ring size determination of Monosaccharides, conformational and configuration representations of monosaccharides, Mechanism of mutarotation, Base catalyzed isomerization of aldoses and ketoses, Epimerization, Anomeric effect, Glycosides, ether and ester derivatives of carbohydrate, Deoxy sugars, oxidation and reduction reaction of carbohydrate. Disaccharides: Lactose, Maltose, and sucrose. Polysaccharides: Structure and degradation of starch, cellulose and glycogen. Industrial importance and biological importance of cellulose, starch, glycogen, dextran, hemicelluloses, pectin, agar agar.

REFERENCES:

1. Organic Chemistry, Vol-II, I.L.Finar.3rd.ed., Longmans Green & Co.1964.
2. Schaum's outline of theory and problems of Organic Chemistry, Harbert Meislich, Howard Nechamkin and Jacob Sharefkin.2nded.,Tata McGraw-Hill New Delhi 2003.
3. Natural products: Their chemistry and biological significance, J. Mann, R.S. Davidson,J.B. Banthorpe and J. B. Harborne.Longman Scientific & Technical,1994.
4. A textbook of synthetic drugs, O. D. Tyagi and M. Yadav Modern Concepts of Advanced Organic Chemistry-R.P. Narein (Vikas, Delhi) 1997.
5. Name Reactions and Reagents in OrganicSynthesis, Second Edition Bradford P.Mundy, Michael G. Ellerd, Frank G. Favaloro Jr., First Ed, John Wiley & Sons, 2005.
6. Transition Metal Reagents and Catalysts: Innovations in Organic Synthesis JiroTsuji, Wiley-Blackwell; Revised ed. Edition,2002.
7. Carbohydrate Chemistry and applications of carbohydrates, K.M.Lokanatha Rai.
8. Carbohydrate Chemistry:Volume40,Editors:Amelia Pilar Rauter,ThisbeLindhorst,Yves Queneau RSC Publishing, 2014
9. A Textbook of Organic Chemistry-Tewari, Vishnoi and Mehrotra (Vikas, NewDelhi) 1998.
10. Textbook of Organic Chemistry-3rdEdn.-R.K.Bansal, (NewAge, NewDelhi) 1997.
11. Organic Chemistry-3rdEdn-F.A.Carey (Tata Mc Grew Hill, New Delhi) 1996.
12. T.Tsuji, Transition Metal Reagents and Catalysts: Innovations in Organic Synthesis, John Wiley & Sons, 2000.
13. S. D. Burke, R. L. Danheiser, Handbook of Reagents for Organic Synthesis, John Wiley & Sons, 1999.
14. L.Kuertiand B.Czako,Strategic Applications of named Reactions in Organic Synthesis, Elsevier Academic Press, 2005
15. N.R.Krishnaswamy, Chemistry of Natural Products; a Unified Approach, Universities Press, 1999.
16. Teachers. Hauptmann, the Chemistry of Heterocycles, 2nded.Wiley, 2003.
17. Heterocyclic chemistry Vol.1-3, R.R.Gupta, M.Kumarand V.Gupta, Springer Verlag.
18. An Introduction to the Heterocyclic Compounds, R.M.Acheson,John Wiley.
19. Principles of Modern Heterocyclic Chemistry, L.A.Paquett.
20. Chemistry of Natural Products P.S. Kalsi, Kalyani Publishers
21. Chemistry of Organic Natural Products, O.P. Agarwal, Vols., 1 & 2, GoelPub Natural Products Chemistry K.B.G. Torssell, John Wiley, 1983.

Course Outcomes:

Thinking and learning level of the student, upon successful completion of the course, the students will be able to

CO1:Acquire knowledge of different organic reactions and the reagents utilized as tools in the practice of organic synthesis –**Apply**

CO2:Examine the reagents and parameters required for the synthesis of designated target molecules-**Analyze**

CO3:Understand and implement a range of concepts related to various organic named reactions and rearrangements in the synthesis of desired molecules – **Understand**

CO4:Provide an examples of the various types of reactions and rearrangement processes' mechanistic pathways –**Analyze**

CO5:Understand the classification of natural products, its isolation and biological importance.-**Understand**

CO6: Understand the biological and industrial applications of carbohydrates

Understand Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/PaperTitle :ICH 202	Program Outcomes (POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	✓	✓	✓		✓		✓	✓
CO2	✓						✓	
CO3		✓	✓		✓		✓	
CO4		✓					✓	✓
CO5			✓	✓	✓	✓		
CO6	✓		✓	✓		✓	✓	✓

II SEMESTER	
Course Name:	ENERGY SYSTEMS, COLLOIDS, AND PETRO CHEMICALS.
Course Code:	ICH 203
Course Type:	Hard Core
Contact Hours/Week: 4L	Course Credit: 04

Course Objectives

- To introduce conventional energy sources and their mechanics
- To understand the role of non-conventional systems in sustainable development
- To analyze the stability, coagulation, and practical applications of colloidal system
- To understand the thermodynamics and efficiency of various energy systems
- To study the principle behind solar, wind, tidal, and geo thermal energy
- To understand the processes involved in the petrochemical industry

Course Content

UNIT-I: Energy Systems

14hr.

Chemical energy sources and their limitations (natural gas, coal, nuclear fusion, nuclear fission and Hydropower). Electrochemical energy systems-Introduction, classification, battery characteristics. Primary batteries- Alkaline MnO_2 batteries. Secondary batteries-Introduction, lead acid battery, Alkaline storage batteries. Lithium batteries-The primary & secondary lithium batteries. Lithium based conducting polymer battery. Fuel cells-Introduction, efficiency, classification and types, H_2 - O_2 fuel cell, methanol fuel cell, solid polymer electrolyte fuel cell, biofuel cell.

UNIT- II: Non-Conventional Energy Systems

14hr.

Solar energy cells-Introduction, semiconductor electrodes, semiconductor-electrolyte interface, parameter controlling efficiency, stability of semiconductor electrodes, **Photoelectron chemical and photo galvanic cells**. Production of Hydrogen, hydrogen energy. Hydrogen storage by metal and metal-alloys. Applications of photochemistry-photoelectron catalysis, photo reduction of CO_2 and photo electrochemical waste removal.

Formation of bio mass, photosynthesis; Biomass resources. Chemical constituents and physico chemical characteristics of biomass; Biomass conversion processes; Biofoul, Petrocrops. Wind energy-Atmospheric circulations, factors influencing wind and Betz limit. Ocean energy resources, Principles of ocean thermal energy conversion systems. Geothermal energy: Origin, types of geothermal energy sites.

UNIT- III: Colloidal Chemistry and Adsorption

14 hr

Colloidal Chemistry: Introduction, Method of determining particle size. Donnan membrane, equilibrium and potentials, Importance and applications of colloidal chemistry. Theory, properties and applications of gels and emulsion. Migration of an ion in an electric field, factors affecting electrophoretic mobility. Types of electrophoresis-free electrophoresis, zone electrophoresis-paper and cellulose acetate electrophoresis, gel electrophoresis.

Adsorption: Introduction, types, Adsorption isotherms-Langmuir and BET(no derivation), Gibbs adsorption isotherm, applications of adsorption- surface area determination. Kinetics of gaseous reaction on solid surface-uni and bimolecular surface reactions (qualitative study), Catalysis: Types and industrial applications.

UNIT- IV: Petroleum and Petrochemicals

14 hr

Petroleum and Petrochemicals: History of Petroleum-Origin, recovery and transportation, Composition of crude oils-Paraffins, Naphthenes, Aromatics, Sulphur compounds, Nitrogen compounds, Metallic constituents, Distillation-Pretreatment, atmospheric distillation, Vacuum distillation, Cracking-Thermal cracking, visbreaking, coking, catalytic cracking, hydrocracking, Reforming-Catalytic reforming.

Hydro treatment and Sulphur Recovery: Finishing processes-Caustic washing, Merox process, Hydrofining, methods for improving storage stability, filter, Molecular sieves Petroleum Products-LPG, LNG, Motor gasoline or Petrol, Diesel, Kerosene, Naphtha, Aviation turbine fuel, Heavy fuel oil, Bitumen, Lubricating oil, Greases, Petroleum waxes, Petroleum fractions for petrochemicals. Naphtha and Para xylene. General properties of petroleum products and alternative fuels.

REFERENCES:

1. Engineering chemistry, Gadag RV, I Kinternational, 2010.
2. Chemical and Electro chemical Energy Systems, Narayan R&B Viswanathan, University Press, 1998.
3. Modern Electrochemistry, Vol 2 A and B, JOM Bockris & A K N Reddy, Springer, NY, 1998.
4. Biochemical & Photosynthetic Aspects of Energy Production, Anthony San Pietro, Academic Press, N Y, 1980.
5. Bio Energy for Rural Energisation, R.C.Maheswari, Concepts Publication, 1997.
6. Modern Petroleum Refining Process, 2ndEdn. Rao, I B H.
7. Introduction to Petrochemicals, Maiti, I B H.
8. Textbook of Engineering Chemistry M Uppal, Khanna Publishers, 1986.
9. Modern Petroleum Chemistry-An overview, Kochu Baby, Manjaram & Kannatheri
10. Colloids Chemistry, A.K.Sharma, Goel publishing House, Meerut, 1991.
11. Sequeira, A. Jr. Petroleum Processing Handbook. J.J.McKetta (Editor) .Marcel Dekker Inc., New York. p. 634.1992.
12. Walmsley, A.G. In Modern Petroleum Technology. G.D.Hobson and W.Pohl (Editors). Applied Science Publishers Inc., Barking, Essex, England. Chapter 17. 1973.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1:Students can analyze the working of thermal power plants and internal combustion engines-**Analyze**

CO2:Students can explain the basic working principle of solar panels, wind turbines, and biogas systems- **Analyze**

CO3:Students will understand the significance of colloids in industrial and biological systems-**Understand**

CO4:Electrochemical energy systems pertaining to classical and modern batteries and fuel cells- **Apply**

CO5:Students will appreciate the importance of petroleum-based products in the chemical industry and evaluate their environmental concerns- **Evaluate**

CO6:Understand the synthesis and applications of primary petrochemicals like ethylene, propylene, benzene etc.-**Understand**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICH 203	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	V		V		V			V
CO2	V		V		V			
CO3	V		V		V			V
CO4	V		V			V		
CO5		V	V					V
CO6			V		V			V

II SEMESTER	
Course Name:	CHEMICAL ENGINEERING TECHNOLOGY
Course Code:	ICS 204
Course Type:	Soft Core
Contact Hours/Week: 3L	Course Credit: 3

Course Objectives:

- To outline the comprehensive framework of unit operations and unit processes employed in the chemical industries
- To understand the fundamental design and principles of operating instruments utilized in chemical industries
- To know the recent trends of unit operation and process involving flow chemistry technology
- To understand the manufacturing process of nitration, esterification, sulfonation, halogenation reactions used in the chemical industries

Course Content

UNIT-I: Unit Operations

10hr.

Evaporation: Types of evaporators, jacketed, horizontal and vertical tube evaporators, forced circulation evaporations, multiple effect evaporators.

Distillation: Boiling and distillation, vapor-liquid equilibrium, Raoult's law & Henry's law, relative volatility, azeotropic mixtures, flash distillation, steam distillation, vacuum distillation, fractional distillation.

UNIT-II: Crystallization and Flow chemistry

12hr.

Crystallization: Theory & mechanisms of growth of crystal, nucleation, super saturation ((Mier's theory), types of crystallization, classification of crystallizers (agitated tank, Swenson Walkers, (Krystal-Oslo), continuous vacuum crystallizers), caking of crystals, effect of impurities.

Gas absorption: Definition, examples, solution criteria for gas absorption, Characteristics, types, merits and demerits of plate and tower packing. Comparison of absorption and distillation,

Flow chemistry: Concepts and applications.

Flow chemistry: Introduction, Batch v/s Flow chemistry, General working principle, Types of reactors, Advantages and disadvantages, synthetic applications

UNIT-III: Unit Processes

10hr.

Unit process and flow sheet. **Nitration:** Nitrating agents, kinetics and mechanism of nitration of aromatic compounds, nitration of paraffinic hydrocarbons, nitrate esters, N-nitro compounds, and typical industrial manufacturing process.

Sulfonation: Sulfonating agents, kinetics and mechanism, desulfonation, work-up procedures. Industrial equipment and technique, Batch and continuous processes, manufacturing processes for detergents, dye intermediates, Turkey red oil.

Alkylation and Acylation: Alkylation and acylation at Carbon, Oxygen and Nitrogen, Friedel-Craft reaction, applications of active methylene compounds like diethyl malonate and ethyl acetoacetate. Industrial processes

UNIT-IV: Catalytic Hydrogenation and Hydrogenolysis:

10hr.

Catalytic hydrogenation and hydrogenolysis: Different types of catalysts, Industrial hydrogenation processes. **Halogenation:** Kinetics & mechanism of halogenation reaction, survey methods, catalytic chlorination, manufacturing processes for chlorobenzene, BHC, chlorinated methanes, vinyl chloride. **Oxidation:** Oxidizing agents with typical applications of each, liquid phase oxidation with oxidizing compounds. **Esterification:** Kinetics and mechanism, esterification of carboxylic acid derivatives, esters by addition to unsaturated systems, industrial **esterification**, ethylacetate, methylmethacrylate, cellulose acetate and nitroglycerin.

REFERENCES:

1. F a Henglein, Chemical Technology, Fieser English edition, Pergamon, 1969.
2. J M Coulson, Chemical Engineering, Vol.I, II&III, Pergamon, 1964.
3. R N Shreve, the Chemical Process Industries, Mc GrawHill, Professional, 1984.
4. W L Badger T Band hero, Introduction to Chemical Engineering, McGraw Hill Professional, 1955.
5. A Hougen, K M Watson, R A Ragatz, Chemical Process Principles, Vol I & II, John Wiley and sons, 1959.
6. John J McKetta Jr, Unit operations hand books, Volume1, CRC Press, 1992.
7. Warren L. McCabe, Julian C. Smith, Peter Harriott, Unit operations of chemical engineering, McGraw Hill Professional, 1956.
8. P H Groggins, Unit Processes in Organic Synthesis, Mc GrawHill Professional, 5th Edition, 1995.
9. Engineering chemistry, Gadag RV, I K international, 2010.
10. Comprehensive industrial chemistry, More Prakash G, Pragathi Prakashan, 2010.

Course Outcomes:

Thinking and learning level of the student, upon successful completion of the course, the students will be able to

CO1:Acquire knowledge regarding unit process and unit operations related to evaporation, distillation, and crystallization methods employed in the chemical industries. **Understanding**

CO2:Have the opportunity to understand the design of instruments at the plant level to produce the necessary products, as well as to learn about the implementation of safety precautions in the chemical industry. **Apply**

CO3:Have the opportunity handling of hazardous reactions such as nitration, sulfonation, and halogenations reaction sat big scale at plant level in the chemical industries. **Apply**

CO4:Acquire knowledge of principle, working and applications of flow chemistry

Knowledge Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICS 204	Program Outcomes (POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓			
CO3					✓		✓	✓
CO4	✓	✓				✓		✓

II SEMESTER	
Course Name:	CHEMICAL ANALYSIS IN AGRO AND FOOD INDUSTRIES
Course Code:	ICS 205
Course Type:	Soft Core
Contact Hours/Week: 3L	Course Credit: 03

Course Objectives:

- To study the analysis of fuel and soil
- To learn different types of fertilizers
- To study different types of insecticides, herbicides, fungicides, repellents
- To learn the adulterants of food and its purification

Course Content

UNIT-I: Analysis of Soil and Fuel,

10hr

Analysis of soil: Moisture, pH, total nitrogen, phosphorous, silica, lime, Magnesia, Manganese, sulfur and alkali salts. **Fuel analysis:** Solid, liquid and Gas, ultimate and proximate analysis heating values, grading of coal, liquid fuels, flash points, aniline point, octane number and carbon residue, gaseous fuels—producer gas and water gas – calorific value.

UNIT-II : Fertilizers

12hr.

Fertilizers: Introduction, Essential plant Nutrients, Classification of Essential Nutrients, Primary Nutrients, Secondary Nutrients, Micronutrients, Macronutrients, Classification of Fertilizers-Straight Fertilizers, Compound/Complex Fertilizers, Fertilizer Mixtures, Feed Stock/ Raw materials-Nitrogenous Fertilizers, Phosphate Fertilizers, Potassium Fertilizers, Manufacture and general properties of Fertilizer products- Intermediates-Ammonia, Nitric Acid, Sulphuric Acid, Phosphoric Acid, Nitrogenous Fertilizers-Ammonium Sulphate, Ammonium Nitrate, Calcium Ammonium Nitrate, Calcium Nitrate, Ammonium Chloride, Urea, Phosphatic Fertilizers, Ground Rock Phosphate, Single Superphosphate, Triple Superphosphate, Potassium Fertilizers- Potassium Chloride (Muriate of Potash), Potassium Sulphate (Sulphate of Potash), Potassium Nitrate, Complex Fertilizers-Ammonium Phosphate Sulphate, Ammonium Phosphates, Mono Ammonium Phosphate (MAP), Di-Ammonium Phosphate (DAP), Nitro phosphates, Urea Ammonium Phosphates, NPK Complex Fertilizers.

UNIT-III: Insecticides, Repellents, and Fungicides

10hr

Insecticides: Introduction, classification, Organo chlorine insecticides-BHC, DDT, endosulfan, sevin, Insect pheromones, general introduction and applications in integrated pest management. **Repellents:** Survey & synthesis of the repellents-N,N-diethyltoluamide, 2-ethyl-1,3- hexanediol, **Fungicides:** Introduction, Inorganic & organic fungicides, Systemic **Fungicides-** types & examples. **Herbicides:** Introduction, study of sulfonyl urea's, Mechanism of action and toxicities of insecticides, fungicides and herbicides.

Unit-IV: Food analysis

10hr

Food analysis: Moisture, ash, crude protein, fat, crude fiber, carbohydrate, calcium, potassium, sodium, and phosphates, food adulteration – common adulteration in food, contamination of food stuffs, microscopic examination of foods for adulterants, Pesticide analysis in food products-Extraction and purification of sample, thin layer chromatography detection for organo phosphorous insecticide residues, thin layer chromatography for identification of Organo-chlorine pesticides in food products

REFERENCE:

1. Food contaminants-Origin, propagation and analysis by S.N.Mahindru,2004
2. Food chemistry by Alex V Ramani,Tamil Nadu,2009
3. Methods on Physico-chemical analysis of fruits by Dr.B.C.Mazumdar and Dr .K. Mazum der , 2003
4. A text book of Fertilizers by Ranjan Kumar Basak,2007
5. Chemistry of Herbicides by Sree Ramulu,US,1982

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1:To study the analysis of fuel and soil-**Analyse**

CO2:To analyze food samples to determine nutritional content, food additives, contaminants, and preservatives using classical and instrumental methods - **Analyze**

CO3:To understand different types of insecticides, herbicides, fungicides, repellents – **Understand**

CO 4:To evaluate the adulterants of food and its purification- **Evaluate**

CO5:Students gain knowledge about the analysis of soil and food, determination calorific values of fuels, food analysis and clinical chemistry. Students learn about different types of fertilizers, insecticides, fungicides, herbicides – **Knowledge**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICS 205	Program Outcomes (POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1			V	V	V		V	
CO2			V		V	V	V	
CO3	V				V		V	
CO4		V	V	V	V		V	
CO5			V		V	V	V	

II SEMESTER	
Course Name:	Techniques in Quantitative analysis
Course Code:	ICP 206
Course Type:	Soft core
Contact Hours/Week: 4L	Course Credit: 02

Course Objectives:

- To develop proficiency in classical quantitative analytical techniques
- To impart the basic analytical and technical skills to work effectively in different fields of chemistry
- To perform accurate quantitative measurements with an understanding of the theory and use of contemporary chemical instrumentation, interpret experimental results, perform calculations on these results and draw reasonable, accurate conclusion
- To gain hands on experience in volumetric and gravimetric analysis with statistical analysis of data

Course Content

Any Ten/ Twelve of the following experiments are to be carried out:

1. Colorimetric determination of Ti (IV) and Zr(IV)
2. Simultaneous colorimetric determination of two metal ions – Mn and Cr.
3. Flame photometric determination of Na,K,Li and Ca individually and in mixtures.
4. Solvent extraction of Ni(II)
5. Estimation of iron in cement by colorimetric method
6. Determination of composition of complexes: a) Job's method: Fe-1, 10-Phenanthroline complex) Mole ratio method: Zr-Alizarin redS complex) Slope ratio method: Cu ethylenediamine complex, d) Limiting logarithmic method: Uranyl sulphosalicyclic acid complex.
7. Determination of stability constants-Turner Anderson method:Fe-Tironsystem,
8. Cement analysis: i) SiO₂-Gravimetrically ii) Calcium, Volumetrically iii) Iron , Volumetrically IV) Magnesium, Complexometrically iv) Aluminium, Gravimetrically.
9. Determination of available chlorine in bleaching powder and residual chlorine in water samples.
10. Determination of Iron present insulpha-drugs; colorimetrically.
11. Analysis of chalcopyrites, magnetite and ilmenite.
12. Ion-exchange chromatography: Separation & determination of Mg²⁺/Zn²⁺,Zn²⁺/Cd²⁺ & Cl⁻/Br⁻
13. Determination of COD of a water sample and dissolved oxygen (DO) by Winkler's method
14. Determination of nitrate & nitrite in water samples and seawater.
15. Analysis of heavy metals in wastewater, seawater (Pb, Hgetc.byspectrophotometry).
16. Determination of available NPK in soil and fertilizer.
17. Nephelometric determination of sulphate/phosphate.
18. Determination of alkalinity of water samples.
19. Determination of fluoride in drinking water by spectrophotometer and ion selective electrode.
20. Determination of phosphates in detergents

REFERENCES:

1. Vogel's Text Book of Quantitative Chemical Analysis (5th Ed), G.H.Jeffrey, J.Bassette, J. Mendham and R.C.Denny, Longman, 1999.
2. Sarvesh Kumar Dubey Asha Arora: A Practical Book on Soil Plant Water and Fertilizer Analysis, S.R. Scientific Publication.2010
3. Gupta PK, Soil, Plant, Water And Fertilizer Analysis (2nd Ed.), 2017

Course Outcomes:

CO1:Apply principles of flame photometry and spectrophotometry to quantitatively determine metal ions (e.g., Na⁺, K⁺, and Ca²⁺) and colored species in given samples with precision and accuracy **Apply**

CO2:Demonstrate proficiency in the operation of analytical instruments, including flame photometers and UV-Vis spectrophotometers, and interpret corresponding spectra/data. **Analyze**

CO3:Analyze the chemical composition of bleaching powder through classical and instrumental methods, identifying available chlorine and other active components. **Analyze**

CO4:Correlate theoretical concepts with experimental observations, reinforcing understanding of atomic emission and molecular absorption phenomena in inorganic chemical analysis. **Understanding**

CO5:Develop technical reporting and data interpretation skills, including calibration curve generation, sample preparation, and error analysis-**Analyze**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICS 206	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	v	v	v					
CO2			v	v	v			
CO3	v	v	v	v	v			v
CO4								
CO5	v	v		v	v	v		v

II SEMESTER	
Course Name:	ESTIMATIONS AND EXTRACTIONS IN ORGANIC CHEMISTRY
Course Code:	ICP 207
Course Type:	Soft core
Contact Hours/Week: 4L	Course Credit: 02

Course Objectives

- To equip students with knowledge and skills for the quantitative determination of various organic compounds, including sugars, amino acids, phenols, carboxylic acids, amides, esters, aldehydes, ketones, and urea using classical and instrumental techniques.
- To teach methods to determine components of binary mixtures, particularly combinations of acids with esters or amides.
- To enable identification and estimation of functional groups such as hydroxyl, vicinal diols, enols, amino, amide, nitro, and unsaturation using suitable qualitative and quantitative methods.
- To provide hands-on experience in the extraction of natural products like caffeine, piperine, nicotine, and hesperidin using conventional and Soxhlet extraction techniques.
- To encourage careful observation, proper documentation, critical analysis of data, and safe laboratory practices.

Course Content

Estimations

Any Ten/ Twelve of the following experiments are to be carried out:

1. Estimation of Glucose by Titration with Fehling's Reagent
2. Estimation of Amino acid by Sorensen's formol titration method
3. Estimation of Phenol by Bromination method.
4. Estimation of Amine by Bromination method.
5. Estimation of Acid and Ester by titration method
6. Estimation of Acid and Amide by titration method
7. Estimation of the number of double bonds by the Bromination method
8. Estimation of Esters by hydrolysis
9. Estimation of Nitro group by Stannous chloride method
10. Isolation of Casein from Milk
11. Isolation of Lactose from Milk

12. Isolation of Piperine from black pepper
13. Isolation of Nicotine from Tobacco•
14. Isolation of Hesperidin from Orange Peel Using Soxhlet Extractor
15. Isolation of Caffeine from Tea powder

REFERENCES:

1. Elementary Practical Organic Chemistry, Vol. II, Quantitative Organic Analysis-A.I.Vogel
2. Experimental Organic Chemistry, Vol. I &II, P.R.Singh, Tata McGraw-Hill,1981.
3. Practical Organic Chemistry- IV Ed- Dey &.Sitaraman, Allied, New Delhi,1992.
4. Laboratory Experiments in Organic Chemistry-Adam, Johnson &Wicon, McMillan,1979.
5. Experimental Organic Chemistry,.H.D.Durst&G.E.Goke, McGraw-Hill,1980
6. More Spectroscopic Problems in Organic Chemistry-A.J. Baker et al.,Heyden,1975.
7. Spectral Problems in Organic Chemistry,Davis& Wells, Chapman &Hall,1984.
8. Elementary Practical organic chemistry, Part 2: Quantitative organic analysis by Arthur I. Vogel, 2nd Edition, CBS Publishers and distributors,1987.
9. Organic analytical chemistry, Theory and Practice-Jag Mohan, Narosa,2003.
10. Laboratory Manual of Organic Chemistry - Raj K Bansal, 2nd Edition, Wiley,1990.
11. Systematic Lab Experiments in Organic Chemistry-Arun Sethi, New age International, 2006.

Course Outcomes:

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

CO1:Quantitatively analyze organic compounds including sugars, amino acids, phenols, carboxylic acids, and nitrogen-containing compounds using appropriate titrimetric and colorimetric methods. **Analyze**

CO2:Accurately determine combinations in organic mixtures, such as acid-ester and acid-amide systems, by applying selective chemical separation and estimation techniques.**Understanding**

CO3:Identify and estimate the presence of key functional groups (hydroxyl, vic-hydroxyl, enol, amino, nitro, etc.) using classical qualitative methods supported by confirmatory tests. **Analyze**

CO4:Perform extractions of natural products like caffeine (from milk or tea), piperine, nicotine, and hesperidin using both solvent extraction and Soxhlet apparatus with a strong understanding of the underlying principles.**Determination**

CO5:Apply laboratory best practices, maintain detailed records, and interpret experimental data with scientific reasoning and awareness of safety protocols.

CO6: Integrate theoretical concepts with practical application, preparing them for advanced work in organic chemistry, natural product chemistry, and analytical chemistry. **Understanding**

Course Articulation Matrix: Mapping of Course Outcome (Cos) and (POs)

Course/Paper Title: ICP 457	Program Outcomes (POs)							
Course outcome		2	3	4	5	6	7	8
CO1		✓	✓					
CO2	✓	✓	✓					
CO3		✓	✓	✓	✓			
CO4	✓	✓	✓	✓	✓	✓	✓	
CO5		✓	✓	✓				✓
CO6		✓	✓	✓				✓

II SEMESTER	
Course Name:	ELECTROANALYTICAL TECHNIQUES
Course Code:	ICP 208
Course Type:	Soft core
Contact Hours/Week: 4L	Course Credit: 02

Course Objectives

- To introduce the theoretical foundations of electrochemical processes, including electrode potentials, redox reactions, and mass transport.
- To provide comprehensive knowledge of key electroanalytical techniques such as potentiometry, conductometry, coulometry, and voltammetry.
- To develop students' abilities to operate electroanalytical instruments, interpret data, and troubleshoot experiments
- To illustrate the use of electroanalytical methods for the quantitative and qualitative analysis of chemical species in various matrices.
- To encourage analytical thinking in experimental design and interpretation of electrochemical measurements.

Course Content

Electrochemistry:

A. Conductometry (At least 5 experiments to be carried out)

1. Determination of hydrolysis constants (aniline hydrochloride etc.).
2. Titration of a mixture of acetic acid, monochloro and trichloroacetic acids with NaOH.
3. Determination of concentrations/amounts of sulphuric acid, acetic acid and copper sulphate using sodium hydroxide.
4. Measurements of the conductance of a weak acid, HOAc and of the strong electrolytes NaOAc, HCl and NaCl and to calculate the ionization constant of the acid.
5. Analysis of the mixture of HCl and NH_4Cl .
6. Determination of activity coefficient of Zinc ions in 0.002M ZnSO_4 .
7. Determination of equivalent conductance's and dissociation constants of weak acids.

B. Potentiometry (At least 7 experiments are to be carried out)

8. Determination of pK_a values of phosphoric acid by potentiometric titration with sodium hydroxide using glass electrode.
9. Determination of acidic & basic dissociation constants and isoelectric point of an amino acid.
10. Determination of the potential of an electrochemical cell and mean ionic activity coefficient.
11. Determination of activity coefficient of an electrolyte at different molalities.
12. Determination of pH of buffer solutions with a pH meter & evaluation of pK_a of acids
13. Determination of thermodynamics of a cell reaction
14. Determination of pK_a values of mono, di and tri-acidbase.
15. Determination of solubility of insoluble silver halide and the standard electrode potential using quinhydrone electrode
16. Determination of degree of hydrolysis of CH_3COONa and NH_4Cl .
17. Determination of hydrolysis constant of aniline hydrochloride.
18. Verification of Nernst equation for Ag^+ , Cu^{2+} and Zn^{2+} species.
19. Determination of transport number of ions by emf method (Ag^+ , Cd^{2+} , NO_3^- , SO_4^{2-})
20. pH titration of (a) HCl versus NaOH, (b) CuSO_4 versus NaOH and (c) HOAc versus NaOH and (d) lead nitrate versus potassium chromate.
21. Potentiometric titration of halides in mixtures (Cl^- , Br^- and I^-) with silver nitrate.
22. Potentiometric determination of dissociation constants of weak acids.

REFERENCES:

1. B. P. Levitt, Longman, Findlay's Practical Physical Chemistry, J Wiley, London, 1954.
2. Experimental Physical Chemistry, Das & Behera, Tata McGraw Hill, New Delhi, 1983.
3. J.B. Yadav, 16th edition of Advanced Practical Physical Chemistry, Goel publishers, 1989.
4. Experiments in Physical Chemistry, J.C. Ghosh, Bharathi Bhavan, 1974.
5. D.A. Skoog and D.M. West, Fundamentals of Analytical Chemistry, IV Edition, Old Reinhold & Winston, Publication, 1982.

6. B.K. Sharma, Instrumental methods of Chemical analysis, Goel Publishing House, 24th Edition, 2005
7. Gurdeep R. Chatwal, Sham K. Anand, Instrumental Methods of Chemical Analysis, Himalaya Publication, 1979.
8. Experimental Physical Chemistry, V.D, Athawale, Parul Mathur, New Age International Pvt.Ltd. 2001.

Course Outcomes:

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

- **CO1:** Explain the principles of electrochemical cells, electrode potentials, and redox reactions involved in electroanalytical methods. **Analyze**
- **CO2:** Apply potentiometric methods using ion-selective electrodes and reference electrodes for accurate determination of ionic species. **Apply**
- **CO3:** Utilize conductometric techniques for analysis of electrolytic solutions and titrations involving ionic reactions. **Application**
- **CO4:** Perform coulometric experiments to determine analyte concentrations based on charge passed during electrolysis. **Understanding**
- **CO5:** Analyze complex mixtures using voltammetric techniques (e.g., cyclic, differential pulse, and stripping voltammetry), understanding current-potential relationships. **Analyze**
- **CO6:** Operate and calibrate electroanalytical instruments, record data accurately, and interpret results for both academic and industrial applications. **Analyze**
- **CO7:** Design and optimize electroanalytical procedures for specific chemical and biochemical applications. **Analyze**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICP 208	Program Outcomes (POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	✓	✓	✓					
CO2			✓	✓	✓			
CO3	✓	✓		✓	✓			✓
CO4			✓					✓
CO5	✓	✓		✓	✓	✓		✓
CO6	✓	✓		✓	✓	✓		✓
CO7	✓	✓		✓	✓	✓		✓

II SEMESTER	
Course Name:	Chemistry of Household Chemicals and Cosmetics
Course Code:	ICE 209
Course Type:	Open Elective
Contact Hours/Week: 3L	Course Credit: 03

Course Objectives:

- To introduce the chemical nature, formulation, and functional principles of common household chemicals and personal care products
- To understand the physicochemical properties, mode of action, and safety profiles of ingredients used in cosmetics and household products
- To familiarize students with labeling, regulatory standards, and quality control practices in the chemical formulation industry
- To develop awareness about the environmental and health impacts of synthetic chemicals in daily-use products
- To encourage exploration of greener, safer, and bio-based alternatives in consumer chemical products

Course Content

UNIT-I: Household chemicals:

15Hr.

History of household Industry, Basic Theory of Household Chemicals, and Raw material required for household product, Product manufacture in household industry. Role of household product in day-to-day life. Cleaning agents: Introduction, synthesis and applications of Natural cleaning agents, cleaning action, Floor cleaner, Toilet Cleaner, Bathroom Cleaner, and Kitchen Cleaner.

UNIT-II: Soap Technology

15hr.

Technology of Soap: Chemistry of soap; Raw material for soap industry and their selection; hard fats yield inland oil yielding soaps; Chemical reactions of soaps; Hard and Soft soaps; Plant and process employed in soap manufacture; Liquid handwash and liquid dish wash. Preparation of sanitary acid, Preparation of liquid soap, Preparation of white phenyl, Solid soap manufacture Detergents and surfactants Washing action of detergents; Types of detergents; Introduction of surfactants; Types of surfactants.

UNIT-III: Cosmetics Technology

15hr.

Introduction, history, classifications and sources of cosmetics and perfume. Psychological benefits, fragrance and mood, aromatic substances, types of aromatic substances, chemical constituents of aromatic substances, odors of substances from vegetable, animal and artificial origin. Additives (thickeners, foam stabilizers, pearlescent agents, conditioning agents, etc.) Oil components; Waxes, Silicone Chemistry oils; Cream bases; Emulsifiers; Humectants; Aerosol Propellants. Production of essential oils with special reference to the following, Eugenol, Geraniol, Jasmones, Civetone. Preparation of herbal face creams using natural resources.

REFERENCES:

1. Majur Chandrasekhar Shetty, Small-scale industries and house hold industries in developing economy. Asia Publishing House, 1963.
2. Prasad Giri Raj: Modern Technology of Perfumes, Flavors and Essential Oils (2nd Edition), NIIR Board, 2004.
3. B.K.Sharma: Industrial chemistry by GOEL Publishing House, 2000
4. Poucher's Perfumes, Cosmetics and Soaps, Publisher: Springer Netherlands Ed by H. Butler 2000.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Identify and describe the key chemical components in household cleaners, detergents, and personal care products-**Understand**

CO2: Explain the chemical principles behind cleansing, emulsification, disinfection, preservation, and fragrance release in household and cosmetic products-**Understand**

CO3: Analyze formulation strategies used in detergents, shampoos, toothpastes, deodorants, and skincare products-**Analyze**

CO4: Evaluate the toxicity, skin compatibility, and environmental persistence of common synthetic and natural cosmetic ingredients –**Evaluate**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICE 209	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	√	√	√		√	√		
CO2	√	√	√		√	√		√
CO3	√	√	√					√
CO4	√	√	√		√		√	√

III SEMESTER

III SEMESTER	
Course Name:	SPECTROSCOPIC TECHNIQUES
Course Code:	ICH 301
Course Type:	Hard Core
Contact Hours/Week: 4L	Course Credit: 04

Course Objectives:

- An exploration of molecular spectroscopy methods ,specifically vibration and Raman spectroscopy
- To understand the principles and applications of UV, IR, ^1H and ^{13}C NMR, and mass spectroscopy in the structure analysis of organic molecules
- To acquire knowledge in structure elucidation through the resolution of composite spectral challenges

Course Content

UNIT- I: Introduction to spectroscopic techniques 14hr

Introduction to spectroscopic techniques, intensity of spectral lines, natural line width and line broadening. Rotational, vibrational and electronic energy levels and selection rules.

Microwave Spectroscopy: The rotation and classification of molecules, rotation spectra of diatomic and polyatomic molecules. Rigid and non-rigid rotator models. Determination of bond lengths, isotope effect on rotation spectra. Stark effect, nuclear and electron spin interaction. Microwave Spectrometer.

Vibrational Spectroscopy: Vibration spectra of diatomic molecules - linear harmonic oscillator, vibrational energies, zero point energy, force constants and bond strengths; Harmonicity of molecular vibrations- Morse PE diagram, selection rules, fundamental, overtones and hot bands. Vibrations of polyatomic molecules- normal modes of vibrations& nature of molecular vibrations (Eg.CO₂ and H₂O).**Vibration-rotation spectra** of diatomic and polyatomic molecules, selection rules, PQR branches.

Raman spectroscopy: Introduction, theory and applications of Raman spectra, mutual exclusion principles and its applications.

UNIT-II: Application of Infrared and UV spectroscopy

14hr

Application of infrared spectroscopy in the structural study-identity by fingerprinting and identification of functional groups. Characteristic vibrational frequencies of common functional groups (alkanes, alkenes alkynes, aromatic compounds, alcohols, ethers, phenols and amines). Study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides and acids). Factors affecting band positions and intensities-hydrogen bonding, phase and solvent.

UV/Electronic Spectroscopy: Basic principles, Beer-Lambert law, molar absorptive, energy levels, types of electronic transitions. Franck - Condon principles, ground and excited electronic states of diatomic molecules. Chromophores, auxochromes, electronic spectra of polyatomic molecules. Emission spectra, Spectra of transition metal complexes, charge transfer spectra. Instrumentation and application. Factors affecting the positions of UV bands. Electronic transitions and empirical correlations of predicting λ_{max} of organic compounds. Woodward-Fieser rules. UV absorption of aromatic compounds - effect of substituents and solvent effects. Empirical rules to calculate λ_{max} . Application of UV spectroscopy in the structural study of organic molecules.

UNIT-III: Nuclear Magnetic Resonance Spectroscopy

14hr.

Nuclear Magnetic Resonance Spectroscopy: Magnetic properties of nuclei, theory and measurement techniques, chemical shift and its measurements, factors affecting chemical shift. Integration of NMR signals, spin-spin coupling, coupling constant. Shielding and deshielding. Chemical shift assignment of major functional groups, Classification (AX, AMX, ABX), spin decoupling; effects of chemical exchange, fluxional molecules, Hindered rotation through NMR spectrum, Karplus relationships (Karplus curve), double resonance techniques, solvent effects and Nuclear Overhauser Effect, lanthanide shift reagents. **NMR of nuclei other than proton:** ^{13}C NMR chemical shift & factors affecting it, coupling constants. Decoupling-Noise decoupling& broadband decoupling. Off-resonance proton decoupling-some representative examples. 2D NMR techniques. ^{19}F NMR spectroscopy

UNIT-IV: Mass Spectrometry

14hr.

Mass Spectrometry: Basic principles, interpretation of mass spectra, molecular ions, meta-stable ions and isotope ions, ion abundance. Fragmentation processes-representation of fragmentation, basic fragmentation type and rules. McLafferty rearrangement. Fragmentations (fragmentation of organic compounds with respect to their structure determination) associated with functional groups-alkanes, alkenes, cycloalkanes, aromatic hydrocarbons, halides, alcohols, phenols, ethers, aldehydes, ketones, carboxylic acids, esters, amides, acid chlorides, nitro compounds and amines, retro Diels-Alder fragmentation and nitrogen rule.

Composite Problems involving the applications of UV,IR,¹H and ¹³C NMR and mass spectroscopic techniques.

REFERENCES:

1. Organic spectroscopy, William Kemp, 3rdEdn.Palgrave, 1991.
2. Organic spectroscopy: Principles and applications, Jagmohan, 2ndEdn.Narosa, 2007.
3. I.L.Finar Organic Chemistry VolII 6th edition ELBS Longman1973
4. Fundamentals of Molecular Spectroscopy IVed. C.N.Banwell & E.M.Mc Cash Tata McGraw-Hill Publishing CompanyLtd.,1994.
5. Organic Analytical Chemistry Theory and Practice, Jag Mohan, Narosa Publishing House, 2003.
6. Spectrophotometric Identification of Organic Compounds, R.M. Silverstein, F.X.Webster, sixth Ed., John Wiley & Sons, Inc, Network, 2004.
7. N.J.Turro, Modern Molecular Photochemistry, University Science Books, 1996.
8. N. J. Turro, J. C. Scaiano, V. Ramamurthy, Modern Molecular Photochemistry try of Organic Molecules, 1st ed., University Science Books, 2010.
9. T.W. Greene, P. G. M. Wuts, Protecting Groups in Organic Synthesis, 2nd ed., John Wiley, 1991.
10. Atta-Ur-Raman, M.I.Choudhary, Solving Problems with NMR Specroscopy, Academic Press, New York, 1996.
11. D.F.Taber, Organic Spectroscopic Structure Determination, A Problem Based Learning Approach, Oxford University Press, 2009.
12. D.H.Williams, I.Fleming, Spectroscopic Methods in Organic Chemistry, Tata Mc Graw Hill, 988.
13. E.B.Wilson, Jr., J.C.Decius, P.C.Cross, Molecular Vibrations: TheTheory of Infrared and Raman Spectra, Dover Publications, 1980.
14. H.Gunther, NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, 3rd ed., Wiley- VCH, 2013.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1:Acquire knowledge in basic understanding of interaction of energy with matter and its resulting consequences –**Understanding**

CO2:The course will equip with comprehensive understanding of molecular spectroscopy techniques, specifically vibrational and Raman spectroscopy –**Analyze**

CO3:Identify structures of unknown organic compounds based on the data from UV-Vis, IR, Mass Spectrometry ¹HNMR and ¹³CNMR spectroscopy- **Apply**

CO4:Utilize hyphenated techniques and spectral library matching to identify the structures of unidentified organic compounds - **Apply**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICP 301	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	✓	✓	✓		✓	✓		
CO2	✓	✓	✓		✓		✓	✓
CO3		✓	✓	✓	✓		✓	
CO4	✓	✓	✓	✓	✓		✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓
CO6	✓	✓	✓		✓		✓	
CO7	✓	✓	✓	✓	✓	✓	✓	✓

III SEMESTER	
Course Name:	INDUSTRIAL CATALYSIS AND GREEN CHEMISTRY
Course Code:	ICH 302
Course Type:	Hard Core
Contact Hours/Week: 4L	Course Credit: 04

Course Objectives

- To study in detail about the types and applications of catalysts
- To learn about the applications of solid catalyst in industry
- Understanding the role of organometallic compounds as catalysts
- To learn about nano catalysts and their applications
- To study photo catalyst and their applications
- To understand green chemistry techniques

Course Content

UNIT-I: Industrial catalysis

14hr.

Heterogeneous catalysis: Preparation of solid catalyst-Precipitation method, Impregnation, Physical mixing, Evaluation-test reactions and characterization (physical and chemical analysis) of prepared catalyst, Performance criteria of catalysts-Activity,selectivity,temperature response,catalystsize and shape, pretreatment, catalyst life, criteria for selection of catalyst.

Catalytic promoters, stabilizers, catalytic supporter- role of supporter, preparation and structure of supports-Silica,alumina,Zeolite,supported catalyst, Deactivation of catalyst-sintering, poisoning-selective poisoning and non-selective poisoning fouling, effect of coke formation on catalyst. Electro catalyst- Features and applications, Industrial applications of catalysis, Surface active agents, classification of surface active agents, micellization, hydrophobic interactions, critical micellar concentration (CMC), factors affecting the CMC of surfactants.

UNIT- II: Catalysis by Organometallic Compounds

14 hr.

Transition metal hydrides: Synthetic routes, structure and reactivity, synthetic applications. (Pd, Ni, Fe,Co,Ticomplex);Coordinative unsaturation,oxidative addition and reductive elimination and insertion reactions, olefin hydrogenation , Wilkinson's Catalyst,Wacker process,Zeigler-Natta process, olefin meta thesis, Monsanto process for the synthesis of aceticacid,heterogenization of homogeneous catalysts using polymer supports.

UNIT-III: Catalysis by Nano Catalysts

14hr.

Synthesis of Nanoporous Catalysts Microporous materials: Zeolites- Zeotypes – Overall steps in zeolite crystallization,Zeolite synthesis via dry gel route, ZeoliteY-determination of surface acidity-shape-selectivity;Mesoporous aluminosilicates: Synthesis of Mesoporous Silica-MCM-41,SBA-15;Alumino phosphates; Mesoporous Carbon- Sulfated Zirconia- Ag/SiO₂ composite nano catalysts. Nanophotocatalysis and Catalysis of Gold nanocrystals Introduction to photo catalysis: Principle- Band energy engineering- Degradation of dye, Hydrogen generation- Organic synthesis.

UNIT-IV: Green Chemistry

14hr.

Planning a green synthesis in a chemical laboratory, green preparation-Aqueous phase reactions, solid state (solvent less) reactions, photochemical reactions, Phase transfer catalyst-catalyzed reactions, enzymatic transformations and reactions in ionic liquids. Synthesis using scavenger resins, catalysis and biocatalysts.

Sonochemistry: Introduction, instrumentation, the phenomenon of cavitation, types of Sonochemical reaction, Sono chemical esterification, substitution, addition, oxidation, and reduction and coupling reactions. Microwave induced organic synthesis: Introduction, reaction vessel and reaction medium, concept, specific effect, atom efficiency, % atom utilization, advantages and limitations, alkylation of active ethylene compounds, N-alkylation, condensation of active ethylene

compounds with aldehydes, Diels-Alder reaction, Leuckardt reductive amination of ketones, and synthesis of enamino ketones.

REFERENCES:

1. Heterogeneous Catalysis, D.K.Chakrabarty and B.Viswanathan ,New Age International (P) Limited, 2008
2. Nano porous Materials: Synthesis and Applications, Edited by Qiang Xu, CRC Press, 2013
3. Catalysis: Principles and Applications, Edited by B.Viswanathan, S. Sivasanker,A.V. Ramaswamy, Narosa Publishing House, 2011
4. Introduction to catalysis and Industrial catalytic process by Robert J.Farruto, 2016.
5. Photo catalysis, Edited by Masao Kaneko, Ichiro Okura, Springer, 2003.
6. New and Future Developments in Catalysis, Edited by StevenL.Suib, Elsevier, 2013.
7. Catalysis by Gold, Geoffrey C.Bond, Catherine Louis, David T. Thompson, Imperial College Press, 2006.
8. Green Chemistry edited by Bela Torok Timothy Dransfield, Elsevieer, 2017.
9. New Trends in Green Chemistry, V.K.Ahluvalia, 1sted, Springer Nature, 2019.
- 10.Green Chemistry, Theory and Practice, PaulT. Anastas and John C. Warner, Oxford University Press, 1998, New York, USA.

Course outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1:Explain the principles and mechanisms of heterogeneous catalysis and its industrial and environmental applications- **Understand**

CO2:Evaluate green chemistry principles and apply them to design environmentally friendly and sustainable chemical processes- **Evaluate**

CO3:Analyze the role of organometallic compounds in homogeneous and heterogeneous catalysis, including reaction mechanisms and selectivity- **Analyze**

CO4:Demonstrate the application of sonochemistryincatalysis, synthesis, and energy-efficient processes. **Apply**

CO5:Interpret the role of nanomaterials in catalysis and assess their advantages over conventional catalysts in terms of surface area, selectivity, and reusability-**Analyze**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICH 302	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	✓		✓		✓			
CO2	✓	✓	✓					✓
CO3	✓	✓	✓		✓			✓
CO4			✓				✓	✓
CO5	✓	✓	✓	✓	✓			

III SEMESTER	
Course Name:	SYNTHETIC, HETEROCYCLIC AND MEDICINAL CHEMISTRY
Course Code:	ICH 303
Course Type:	Hard Core
Contact Hours/Week: 4L	Course Credit: 04

Course Objectives:

- This course will provide students with an in-depth understanding of the retrosynthetic analysis technique for designing synthetic pathways, particularly for intricate organic compounds
- This course aims to assist students in comprehending the fundamental concepts and applications of pericyclic reactions
- To study the synthesis, reactivity, and industrial applications of heterocyclic compounds
- To study the principles of drug design, the mechanisms by which various drugs operate, and their significance in biological contexts

Course Content

UNIT- I: Planning and Execution of Multistep Synthesis

14hr

Basic principles and technologies used in disconnection approach, synthons and synthetic equivalents, Inter conversion of functional groups, one group C-X and two group C-X disconnections. Protecting groups-Principles of protection of hydroxyl, amino, carboxylic and carbonyl groups. Use of C-C one group and C-C two group disconnections in the synthesis of 1,2;1,3;1,4;1,5 and 1,6-difunctionalised compounds. Retro synthetic analysis of alcohols, carbonyl compounds, cyclic and acyclic alkanes, benzocaine, p-methoxyacetophenone, acetocyanohydrin, 2-methyl-6-methoxy-indole-3-acetic acid, 6-methylquinoline and. Illustrative synthesis of Juvabione, Longifolene, Prelog-Djerassi-Lactone, Solid phase synthesis of polypeptides.

UNIT-II: Pericyclic chemistry

14hr.

Pericyclic Reactions: Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl systems. Classifications of Pericyclic reactions. Woodward-Hoffmann correlation diagram and FMO approach.

Electro cyclic Reactions: Introduction, Con-rotatory and dis-rotatory Process, $4n$ and $4n+2$ systems. Reactions of cations and anions.

Cyclo addition reaction: Suprafacial and Antarafacial addition, $2+2$ and $4+2$ systems, 1,3-dipolar cycloaddition reactions and their applications in the synthesis of five membered heterocycles.

Sigmatropic reactions: Suprafacial and Antarafacial shift of H, $[1, 3]$ and $[3, 3]$ -sigmatropic shifts. Cope, Oxy-Cope and Aza-Cope rearrangements.

UNIT-III: Heterocyclic Compounds

14hr.

Hantzsch-Widman system for naming monocyclic fused and bridged heterocycles. Chemistry of derivatives of pyrazole, imidazole, oxazole, thiazole, benzofuran, indole, benzothiophene, pyridine, quinoline. Inter conversion of coumarin to benzofuran, pyrrole to pyridine, Pyrimidine to pyrazole, indole/isatin to quinoline, furans to pyrrole. Uses of furan, pyrrole, and thiophene in the synthesis of non-heterocycles.

UNIT-IV: Medicinal Chemistry

14hr.

Concept of lead compounds, analogues and prodrug, Factors governing drug design ADME, drug design through molecular disjunction and conjunction. Drug receptor interactions-Forces involved in drug receptor interactions. Theories of drug action-occupancy, rate, and induced fit theory. Concept of fragment-based drug discovery. Structurally specific and non-specific drugs, Classification, synthesis and mode of action of following classes of drugs-Antipyretic analgesics (Cinchophen), General anaesthetics (Thiopental sodium), Local anaesthetics (benzocaine), cardiovascular

drugs (diazoxide), antimalarials (chloroquinephosphate), antineoplastic agents (methotrexate and fluorouracil), antiviral drugs (methisazone).

REFERENCES:

1. Organic Synthesis-Special Techniques, V.K. Ahluwalia and R. Aggarwal, Narosa, New Delhi, 2001.
2. Organic Synthesis, R.E.Ireland, PrenticeHall India, 1969.
3. Advanced Organic Chemistry, IVEdn. PartA&B, F.J.Carrey&R.J.Sundberg, Kluwer, 2001.
4. Organic Synthesis-A Disconnection Approach, Stuart
5. Artin Organic Synthesis, an and, Bindra&Ranganath, Wiley, NewDelhi, 1970.
6. ModernMethodsofOrganicSynthesis, N.Carruthers, CambridgeUniversity, 1996.
7. Organic Reaction Mechanisms, V.K.Ahluwalia & R.K.Parashar, Narosa, 2006
8. Heterocyclic Chemistry, J.Joule&G.Smith, Van-Nostrand, ELBS, 1978.
9. ComprehensiveHeterocyclicChemistry, Vol.I-VIEdn., Katritzky&Rees, Pergamon, 1984.
10. Heterocyclic Chemistry, RajK. Bansal, New AgeInternational, 1999.
11. Medicinal Chemistry, Ashuthosh Kar, Fourth edition, NewAge International Pvt Ltd.
12. Pericyclic reactions, S.M.Mukherji (TheMcMillanBangalore), 1979.
13. V.K.Ahluwalia and Mahu Chopra, Medicinal Chemistry.
14. GrahamLPatrick, An introduction to medicinalchemistry, Oxford.
15. Ashutosh Kar, MedicinalChemistry.
16. Frank Jensen, Introduction to Computational Chemistry, Wiley Publisher, Second Edition, 2006.
17. Pericyclic Reactions, S.M.Mukherji, Macmillan, I ndia.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1:Develop a synthetic route for transforming simple organic molecules into more complex structures using a retro synthetic strategy **Apply**

CO2:The student will gain an understanding of the essential principles and applications of pericyclic reactions **Understanding**

CO3:The student will gain an understanding of the synthesis, chemical reactivity, and biological significance of different heterocyclic compounds **Understanding**

CO4:To examine the fundamentals of drug design, the mechanisms through which different drugs function, and their importance in biological settings. **Apply**

CO5:Recognize pericyclic reactions, including an understanding of thermal and photochemical processes **Analyze**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICH 303	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	v		v		v			
CO2	v	v	v					v
CO3	v	v	v		v			v
CO4			v				v	v
CO5	v	v	v	v	v			

III SEMESTER	
Course Name:	COMPUTER AIDED DRUG DESIGN
Course Code:	ICS 304
Course Type:	Soft Core
Contact Hours/Week: 3L	Course Credit: 03

Course Objectives:

- The subjects designed to impart knowledge on the current state of the art techniques involved in computer assisted drug design
- Upon completion of this course the student should be able to Role of CADD in drug discovery
- Different CADD techniques and their applications Various strategies to design and develop new drug like molecules Working with molecular modeling software's to design new drug molecules. The *in silico* virtual screening protocols

Course Content

UNIT-I: Computer Based Drug Design

12hr.

Introduction to Computer Aided Drug Design (CADD) History, different techniques and applications Quantitative Structure Activity Relationships: Basics History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (logP, pi-substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters Quantitative Structure Activity Relationships Deriving 2D-QSAR equations 3D-QSAR approaches and contour map analysis Statistical methods used in QSAR analysis and importance of statistical parameters

UNIT-II: Molecular Modelling and Docking

12hr.

Molecular Modeling and Docking: A) Molecular and Quantum Mechanics in drug design) Energy Minimization Methods: comparison between global minimum conformation and bioactive conformation, C) Molecular docking and drug receptor interactions: Rigid docking, flexible docking and extra-precision docking. Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AChE and BChE) Molecular Properties and Drug Design: a) Prediction and analysis of ADMET properties of new molecules and its importance in drug design, b) Novel drug design: Receptor/enzyme-interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design) Homology modeling and generation of 3D-structure of protein

UNIT-III: Pharmacophore Mapping and Virtual Screening

10hr

Pharmacophore Mapping and Virtual Screening Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophore modeling; Conformational search used in pharmacophore mapping In Silico Drug Design and Virtual Screening Techniques Similarity based methods and Pharmacophore based screening, structure based In-silico virtual screening protocols 12

REFERENCES:

1. Computational and structural approaches to drug discovery, Robert M. Stroud and Janet F. Moore, RCS Publishers.
2. Introduction to Quantitative Drug Design by Y. C. Martin, CRC Press, Taylor & Francis group.
3. Drug Design by Ariens Volume 1 to 10, Academic Press, 1975, Elsevier Publishers.
4. Principles of Drug Design by Smith and Williams, CRC Press, Taylor & Francis.
5. The Organic Chemistry of the Drug Design and Drug action by Richard B.

Silverman, Elsevier Publishers.

6. Medicinal Chemistry by Burger, Wiley Publishing Co

7. An Introduction to Medicinal Chemistry–Graham L. Patrick, Oxford University Press.

8. Wilson and Griswold's Text book of Organic Medicinal and Pharmaceutical Chemistry,

9. Lippincott Williams & Wilkins. Comprehensive Medicinal Chemistry–

10. Corwin and Hansch, Pergamon Publishers. Computational and structure approaches to drug design edited by Robert M Stroud and Janet F Moore

11. Rajarshi Guha (Editor), Andreas Bender (Editor), Computational Approaches in Cheminformatics and Bioinformatics Wiley-Blackwell, 2012.

12. Fan Li, Developing Chemical Information Systems: An Object-Oriented Approach Using enterprise JAVA, John Wiley & Sons, 2006, ISBN: 0470068787, 978047006878.

13. Johann Gasteiger (Editor), Thomas Engel (Editor), Chemo informatics: Textbook, Wiley Publisher ISBN: 978-3-527-30681-7, 2003.

Course Outcomes:

CO1: Apply molecular modeling software to design and optimize potential drug molecules-**Apply**

CO2: Analyze drug-target interactions using molecular docking, scoring functions, and visualization tools-**Analyze**

CO3: Evaluate pharmacy kinetic properties (ADMET) and drug-likeness using cheminformatics tools and Lipinski's rule-**Evaluate**

CO4: Integrate computational techniques and data bases (e.g., Pub Chem, PDB, DrugBank) in the drug discovery pipeline-**Apply**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICS 304	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	✓		✓		✓			
CO2	✓	✓	✓					✓
CO3	✓	✓	✓		✓			✓
CO4			✓				✓	✓
CO5	✓	✓	✓	✓	✓			

III SEMESTER	
Course Name:	Polymers and Display Materials
Course Code:	ICS 305
Course Type:	Soft Core
Contact Hours/Week: 3L	Course Credit: 03

Course Objectives:

- To learn polymer chemistry and properties and synthetic methods
- To know the versatility of polymer materials in their applications
- To study some polymer used in industry
- To provide the knowledge of basic concepts of liquid crystals and its applications in display technology
- To learn OLED phenomenon and applications
- To learn the aspects thin film preparations

Course Content

UNIT-I: Polymers

15hr.

Polymers: Introduction-Basic concepts and classification of polymers, Molecular weight and its distribution, Polymerization techniques- bulk, solution, suspension, emulsion, poly-condensation, solid and gas phase polymerization. Determination of molecular weight: Osmometry, viscometry. Viscosity vs. molecular weight and mechanical property vs. molecular weight relationships, Chain structure and configuration, Synthesis, properties, structural features and applications of some important commercial polymers (PS, PVC, PMMA, PET, Nylon-6, Nylon-6,6), Engineering polymers (Kevlar, Nomex, ABS, PC, Teflon). Polymer processing techniques, additives for improvement of polymer properties, spinning of industrial polymers, wet, dry melt spinning and electrospinning.

UNIT-II: Polymer blend and composites

15hr.

Polymer blend and composites-preparation and uses. Characterization techniques of polymer blend and composite using FT-IR, PXRD, TGA, DSC, FE-SEM, EDX, XPS polymers as separation devices-principles and applications of reverse osmosis, ultra and nano filtration and electro dialysis, Uses in food industry and biotechnology. Medical applications of polymers: Introduction to nano composites Concepts and design of oral, transdermal and targeted drug delivery systems-micro, macro and nano sized systems. Biodegradable polymers-Sources of plastic waste, waste management techniques.

UNIT- III: Liquid crystals and thin films

15hr.

Liquid Crystals: Definition, Liquid crystal phases, Thermotropic liquid crystals, Nematic phase, Smectic phases, Chiral phases, Cholesterics, Lyotropic liquid crystals –Hexagonal columnar phase, Micellar cubic phase. Theoretical treatment of liquid crystals- Parameter to describe a liquid crystal, optical properties of liquid crystals, LCD.

Organic LED materials: Introduction, phenomena, fabrication and applications. PLED and QLED.

Fabrication of Thin Films: Thin Films and Langmuir-Blodgett Films, Preparation techniques, vaporization /sputtering, chemical process, MOCVD, sol-gel etc growth technique, photolithography, properties and applications of thin and L-B films.

REFERENCES:

1. Material science and Engineering D Callister, Wiley 7th ed. 2007.
2. Liquid Crystals, Second Ed., John Wiley & Sons, Inc., 2007.
3. Solid State Chemistry, AR West, Wiley 1987.
4. Modern aspect of Solid-State Chemistry, CNR Rao, 1st ed. 1970.
5. Principles of Polymer Science, Bahadur Pand N.V Shastri, Narosa, New Delhi, 2000.
6. Polymer Science and Engineering, D.J. Williams, Prentice Hall Inc, New Jersey, 1971.
7. Theory and Basics of Polymer Science, F.W. Billmeyer, John Wiley Sons, NY, 1984
8. Engineering Polymer Source book, Seymour RB, McGraw Hill,
9. Introduction to Physical Polymer Science L.H. Sperling, Wiley-Interscience

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Understanding the versatility of polymers their uses in diverse fields and understands the chemistry of polymers- **Understand**

CO2: Determine a structure and composition of polymer composites- **Apply**

CO3: Students learn about fundamental of liquid crystal and their application in LCD technology- **Apply**

CO4: Learn about thin films processes and applications- **Apply**

Course Articulation Matrix: Mapping of Course Outcome(COs) and (POs)

V

Course/Paper Title: ICS 305	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	V		V	V	V		V	V
CO2	V	V	V	V	V	V		V
CO3	V	V	V		V			V
CO4		V	V	V		V	V	V

III SEMESTER	
Course Name:	SYNTHESIS OF COMPLEXES, CATALYSTS AND ESTIMATION OF ALLOYS
Course Code:	ICP 306
Course Type:	Soft Core
Contact Hours/Week: 6L	Course Credit: 03

Course Objectives

- To gain the basic analytical and technical skills to work effectively in different fields of chemistry
- To demonstrate the ability to synthesize and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation
- To learn advance techniques in gravimetric and volumetric analysis
- To synthesize complexes and nanocatalysts

Course Content

Any Ten/ Twelve of the following experiments are to be carried out:

1. Analysis of Brass–Cu gravimetrically using α -Benzoinoxime and Zn complexometrically.
2. Analysis Cu and Ni alloy.
3. Analysis of Stainless Steel-Insoluble residue by gravimetry, and Nickel by gravimetrically using DMG complex, and Fe volumetrically using Ce (IV) and Cr (III) volumetrically by persulphate oxidation.
4. Flame photometric determination of Na, K mixtures.
5. Chemical Separation Techniques
6. Cu (II) +Fe (II)-Cu gravimetrically as CuSCN and Fe using Ce (IV).
7. Cu (II) +Ni (II)-Cu gravimetrically as CuSCN and Ni using EDTA.
8. Fe (III)+Ca(II)-Fe gravimetrically as Fe_2O_3 and Ca using EDTA.
9. Cr (III) +Fe (III)-Using EDTA by Kinetic masking method.
10. Synthesis and characterization of potassium trioxalatochromate (III) trihydrate
11. The Solid- phase synthesis of trans- bis (glycinato) copper(II)
12. Preparation of Tris (acetyl-acetoacetanato) iron (II) complexes
13. Preparation of bis-dichlorotriphenylphosphine nickel(II)
14. Synthesis of hexamminecobalt (III) chloride
15. Preparation of Silver nanoparticles
16. Preparation of ZnO nanoparticles

REFERENCES:

1. G. H. Jeffrey, J.Bassette, J.Mendham and R.C.Denny, Vogel's Text Book of Quantitative Chemical Analysis, fifth Edition, Longman, 1999.
2. Vogel, "Text book of Qualitative Inorganic Analysis", third Edition, ELBS.1976.
3. D.A.Skoogand D.M.West, Fundamentals of Analytical Chemistry,IVth Edition, Old Reinhold and Winston, Publication, 1982.
4. B.K.Sharma,Instrumental methods of Chemical analysis,Goel Publishing House,24 th Edition, 2005
5. Gurdeep R.Chatwal, Sham K.Anand, Instrumental Methods of Chemical Analysis, Himalaya Publication, 1979.
6. Industrial Applications of Homogeneous Catalysis, Editors: Mortreux, A.,Petit,F. (Eds.) Springer, 1988
7. Louis S.Hegedus,Björn C.G.Söderberg,Transition Metals in the Synthesis of Complex Organic Molecules, Björn C. G. Söderberg, Springer1994.
8. Nikolay Gerasimchuk, SergiyTyukhtenko, Inorganic Synthesis: A Manual for Laboratory Experiments Cambridge Scholars Publishing, 2021.
9. Colquhoun, H M, Holton, J, Thompson, D J, and Twigg, M V. New pathways for organic synthesis. Practical applications of transition metals. United States: N. p., 1984.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Understanding the versatility of polymers their uses in diverse fields and understands the chemistry of polymers- **Understand**

CO2: Determine a structure and composition of polymer composites-**Apply**

CO3: Students learn about fundamental of liquid crystal and their application in LCD technology-**Apply**

CO4: learn about thin film processes and applications-**Apply**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title:ICP 306	Program Outcomes (POs)							
	1	2	3	4	5	6	7	8
CO1	✓		✓	✓	✓		✓	✓
CO2	✓	✓	✓	✓	✓	✓		✓
CO3	✓	✓	✓		✓			✓
CO4		✓	✓	✓		✓	✓	✓

III SEMESTER	
Course Name:	SYSTEMATIC QUALITATIVE ANALYSIS AND IDENTIFICATION OF ORGANIC COMPOUND
Course Code:	ICP 307
Course Type:	Soft Core
Contact Hours/Week: 6L	Course Credit: 03

Course Objectives

- To provide fundamental understanding regarding the separation of organic binary mixtures
- To classify the nature of the mixture such as solid-solid, solid-liquid, liquid-liquid etc
- To educate various purification methods including distillation
- To identify components along with their functional group test and melting/boiling points
- To verify the structure while preparing the corresponding derivative
- To gain practical experience in identifying functional groups and preparing its derivatives
- To gain knowledge regarding the separation methods for acids, bases, phenols, and neutral compounds
- To comprehend the identification of organic compounds through the spectroscopic techniques such as FT-IR, Mass, ^1H NMR, ^{13}C NMR

Course Content

1. Systematic qualitative analysis of an organic mixture containing two compounds (Identification, method of separation, detection of elements, and the functional group(s) present in each of them and preparation of one solid derivative for the conformation of each of the functional group (s).
2. Structural elucidation of organic compounds by spectroscopic techniques.

REFERENCES:

1. Comprehensive practical organic chemistry : Qualitative analysis by V K Ahluwalia, Sunita Dhingra
2. More Spectroscopic Problems in Organic Chemistry-A.J.Baker et al., Hayden, 1975.
3. Spectral Problems in Organic Chemistry, Davis & Wells, Chapman and Hall, 1984.
4. Elementary Practical organic chemistry, Part 2: Quantitative organic analysis by
5. Arthur I. Vogel, 2nd Edition, CBS Publishers and distributors, 1987.
6. Practical organic chemistry, Mann and Saunders
7. A hand book of qualitative and quantitative analysis by H.T. Clarke

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1:Acquire knowledge reading the separation and estimation of binary mixtures-**Apply**

CO2:Additionally, they are capable of identifying functional groups and determining the structures of organic compounds through spectroscopic techniques.
–**Understand**

CO3:Understand basics of separation of organic tertiary mixtures-**Understand**

CO4:Identify and chemical nature of mixture, and Separate of each component from mixture-**Analyze**

CO5:Identify each component through their functional group EST, elemental analysis and M.P/BP.-**Analyze**

CO6:Purify the compounds using different technique including distillation, crystallization etc, and record physical constants for individual compounds-**Analyze**

CO7: To learn and appreciate good laboratory practices- **Apply**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICP 307	Program Outcomes (POs)							
	1	2	3	4	5	6	7	8
CO1	✓		✓	✓	✓		✓	✓
CO2	✓	✓	✓	✓	✓	✓		✓
CO3	✓	✓	✓		✓			✓
CO4		✓	✓	✓		✓	✓	✓
CO5		✓	✓	✓		✓	✓	✓
CO6		✓	✓	✓		✓	✓	✓
CO7		✓	✓	✓		✓	✓	✓

III SEMESTER	
Course Name:	SYNTHESIS, CHARACTERIZATION AND APPLICATIONS OF POLYMERS AND COMPOSITES
Course Code:	ICP 308
Course Type:	Soft Core
Contact Hours/Week: 6L	Course Credit: 03

Course Objective

- Develop understanding of **thermodynamic principles** such as partial molar properties, heat changes, and phase equilibria.
- Study **phase behaviour** in binary and ternary systems and interpret phase diagrams.
- Analyse **molecular interactions and association phenomena** in solutions.
- Apply **calorimetric, conductometric, and spectrophotometric techniques** for quantitative analysis.
- Understand **electrochemical processes** including EMF measurements, corrosion, and electroplating.
- Investigate **reaction kinetics** and physicochemical properties such as viscosity and conductivity.
- Gain knowledge of **polymer chemistry**, including synthesis, characterization, and thermal properties.
- Explore **nanomaterials and surface chemistry concepts** such as micelle formation and detergency.
- Develop skills in **experimental design, data analysis, and error evaluation**.
- Enhance laboratory competence, safety awareness, and scientific reporting.

Course Content

Any Ten/ Twelve of the following experiments are to be carried out:

1. Determination of partial molar volumes of a) Salts – water and b) alcohol – water (methanol & ethanol) systems by density method.
2. Study of phase diagram of a ternary aqueous system of potassium chloride and water.
3. Study of phase diagram of a ternary system of ethanol – Toluene – water or DMSO- water – benzene or ethanol – benzene – water etc.
4. Study of association of benzoic acid in benzene.
5. Determination of heat of solution of KNO_3 in water, integral heat of dilution of H_2SO_4 and heat of ionization of acetic acid and ammonium hydroxide calorimetrically.
6. Determination of conc. of KMnO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ by spectrophotometer.

7. **Determination of rate of corrosion by weight loss method.**
8. **Determination of specific heat of liquids and solutions by calorimetry.**
9. **Determination of thermodynamic parameters of a cell reaction by EMF method.**
10. **Electroplating of i) Nickel, ii) Chromium, iii) Aluminium and iv) copper on a copper plate.**
11. **Study of potential-pH diagrams.**
12. **Saponification of ethyl acetate by conductivity method**
13. **Conductometric determination of critical micelle concentration.**
14. **Cleansing power of Detergents**
15. **Preparation and characterization of phenol-formaldehyde resin**
16. Preparation of polysaccharide stabilized silver nanoparticles and their characterization
17. Estimation of viscosity average molecular weight of polymers
18. Determination of glass transition temperature of a polymer by dilatometry
19. Determination of molecular weight of polymer by end group analysis

REFERENCES:

1. Advanced Practical Physical Chemistry by J. B. Yadav, 5th edition, 1989.
2. Practical physical chemistry by V. D. Atwale, 5th edition.
3. Experimental Methods in Polymer Science by Toyochi Tanaka, 2000, Elsevier.
4. Polymer Synthesis and Characterization: A Laboratory Manual by S. R. Sandler, W. Karo, J. Bonesteel, and E. M. Pierce, Academic Press, New York, 1998.
5. Polymer Chemistry by S. Koltzenburg, M. Maskos and O. Nuyken, Springer, 2017.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: To determine partial molar volume of salt and water **Analyze**

CO2: To determine of specific heat of liquids and solutions by calorimetry. **Analyze**

CO3: Analyze dye adsorption on hydrogels for water purification-**Analyze**

CO4: Apply concept of thermodynamics and kinetic parameters of chemical reactions for adsorption and drug delivery- **Apply**

CO5: Students are able to estimate the viscosity of average molecular weight of the polymer **Apply**

CO6: Students are able to determine glass transition temperature of polymer **Apply**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICP 308	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	✓	✓	✓	✓	✓	✓		
CO2	✓	✓	✓		✓		✓	✓
CO3	✓	✓	✓	✓	✓		✓	✓
CO4	✓	✓	✓	✓	✓		✓	✓

III SEMESTER	
Course Name:	PESTICIDES AND THEIR ENVIRONMENTAL IMPACT ASSESSMENT
Course Code:	ICE 309
Course Type:	Open Elective
Contact Hours/Week: 3L	Course Credit: 03

Course Objectives

- To introduce the types, structures, and chemical nature of common pesticides and their modes of action
- To understand the synthesis, application, and degradation pathways of pesticides in the environment
- To evaluate the impact of pesticides on soil, water, air, and non-target organisms
- To familiarize students with national and international regulations regarding pesticide usage
- To train students in techniques of Environmental Impact Assessment (EIA) specific to agro chemicals.
- To encourage the adoption of greener, sustainable pest management strategies

Course content

UNIT-I: Pesticides, Repellents, Insecticides, Fungicides, and Herbicides:

15hr.

Pesticides: Introduction and classification. **Insecticides:** Introduction, classification, Organo chlorine insecticides-BHC, DDT, sevin, endosulfan, Insect pheromones, general introduction and applications in integrated pest management. **Repellents:** Survey and synthesis of the repellents-N, N-diethyltoluamide, 2-ethyl-1, 3-hexanediol. **Fungicides:** Introduction, Inorganic and organic fungicides, Systemic fungicides-types and examples. **Herbicides:** Introduction, study of sulfonyl ureas, Mechanism of action and toxicities of insecticides, fungicides and herbicides.

UNIT-II; Residues of Agrochemicals

15hr.

Residues of Agrochemicals: a) Pesticides Residues in the Atmosphere: Pesticides into the atmosphere, their fate and transport of vapors, precipitation, and effect of residues on human life) Pesticides residues in Water system: Nature and origin of pollution of aquatic systems, Point and Non-Point pollution. Dynamics of pesticides in aquatic environment.

UNIT-III: Residues in the Soil

15hr.

Pesticides residues in the Soil: Absorption, Retention, Transport and Degradation of pesticides in the soil, Effect on microorganisms and Consequent effect on the soil condition, Fertility, Interaction in the soil, Effect of pesticide residues on the quality of human life. Model ecosystem, in general and consequent effect on human life. The Cases of & affected societies (endosulfan tragedy) and starving populations facing problems of health and nutrition, Traditional wisdom and Food security.

REFERENCES:

1. Dikshith T.S.S. Safety evaluation of environmental chemicals. New Age International, 1996.
2. Chemical Safety Matters-IUPAC-IPCS, Cambridge Univ. Press, 1992.
3. Environmental Chemistry, A.K. Dey, Wiley Eastern.
4. Environmental Chemistry, S.K. Banerji, Prentice Hall India, 1993.
5. Chemistry of Water Treatment, S.D. Faust and O.M. Aly, Butterworths, 1983.
6. Environmental chemistry, Ahluwalia VK, Anne Books India, 2008.
7. Chemistry for Environmental Engineering, Sawyer and McCarty, McGraw Hill, 1978.
8. Environmental Chemistry, I. Williams, John Wiley, 2001
9. Engineering Chemistry by Jain and Jain.
10. Pesticide Synthesis Handbook: Thomas A. Unger, Prochrom Industries Quimicas S/A Elsevier, 1996.
11. Metabolic pathways of agro chemicals. Part 1 [Herbicides and plant growth

- regulators] : Edin-chief T Roberts, Royal Society of Chemistry, Cambridge, 1998.
12. Metabolic pathway of Agro chemicals. Part-2 [Insecticides and Fungicides]: Terry. R. Roberts and David H. Hutson, 1999. Chemistry of Insecticides and Fungicides: U.S. Shree Ramulu Oxford & IBH Pub., 2nd, 1995.
 13. Principles of Pesticide Chemistry: S. K. Handa, Ed. By Agro bios (India), 2008.
 14. Handbook of Systemic Fungicides Vol-I: S.C. Vyas, Published by McGraw Hill, 1993.
 15. Analytical Methods for Pesticides, Plant growth regulators & food additives: Vol. I-XVII Ed. By Gunter Zweig.
 16. The Agrochemical Handbook: Royal Society, England, Hartley, D., Kidd, H., 1984.
 17. Pesticide Science and Biotechnology: R. Greenhalgh and T.R. Roberts International Union of Pure and Applied Chemistry, Blackwell Scientific Publication, 1987.
 18. The Chemical Process Industries: D.N. Shreve
 19. Pesticides in India-Recent facts and figure: R&D section, Yawalkar Pesticides, Nagpur (Agri-Horticulture, Nagpur).
 20. Pesticide Chemistry: G. Matolcsy, M. Nádas, V. Andriska, Elsevier Science Publishing, USA, 1988.
 21. Pesticides: preparation and mode of action: Crymlyn, R. 1978.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Classify and describe different types of pesticides (organophosphates, carbamates, organochlorines, etc.) based on their chemical structure and function- **Understand**

CO2: Analyze the adverse effects of pesticide residues on ecosystems, human health, and biodiversity- **Analyze**

CO3: Apply principles of environmental chemistry to evaluate pesticide pollution through laboratory and field data- **Apply**

CO4: Assess pesticide-related case studies using Environmental Impact Assessment (EIA) protocols and identify risk mitigation strategies- **Evaluate**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title:ICE 309	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1		v	v	v			v	v
CO2	v	v	v		v			v
CO3		v	v		v		v	v
CO4		v				v		
CO5	v		v		v	v		v

IV SEMESTER

IV SEMESTER	
Course Name:	Project Report
Course Code:	ICH 401
Course Type:	M.Sc. Project Dissertation
Contact Hours/Week: 40L	Course Credit: 16

Course Objectives

- To acquire practical experience in executing various types of reactions within the chemical industry
- To acquire experience in the operation of various analytical instruments, including HPLC, GC-MS, ^1H NMR, ^{13}C NMR and UV-visible spectrophotometry, utilized in the chemical industry
- To acquire knowledge on the development of analytical methods for the analysis of pharmaceuticals and their intermediates
- To acquire knowledge on the management of diverse hazardous reactions and reagents.
- To acquire knowledge on the implementation of environmental health and safety rules and the safe handling of chemicals, as well as to adhere to various types of standard operating procedures.
- To seek jobs in chemical industries.
- To learn research methodology and to form a project report on the work carried out at the Industry during IV semester

Course Content

Students will undertake project work at several chemical firms in India for four months, supervised by an internal guide as one of the teachers from the Department of Industrial Chemistry and an external scientist or research executive, group leader of the respective chemical industries. The student has to prepare a dissertation

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Students are capable of managing many sorts of reactions and reagents in the chemical industry- **Analyze**

CO2: Students will understand information about handling of instruments such as HPLC-GC-MS, ^1H -NMR, and UV-Visible spectrophotometers employed in the chemical industry- **Understand**

CO3: Students will devise diverse methodologies appropriate for the analysis of medicines and their intermediates-**Analyze**

CO4: Students will become acquainted with the application of safety and health management systems utilized in chemical industries- **Understand**

CO5: Student undergoes training at chemical industries or 4 months internship and prepare dissertation on the work carried out-**understand**

CO6: The students will understand research methodology and how to document results and derive conclusions- **Understand**

CO7: Students will secure placements in the chemical industry **Job opportunity**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICH 401	Program Outcomes (POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	✓	✓	✓	✓			✓	✓
CO2	✓	✓	✓		✓			✓
CO3		✓	✓		✓		✓	✓
CO4				✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	✓	✓
CO7	✓	✓	✓	✓	✓	✓	✓	✓

IV SEMESTER	
Course Name:	Viva-Voce Examination
Course Code:	ICH 402
Course Type:	Evaluation of Project work
Contact Hours/Week: NA	Course Credit: 02

Course Objectives:

- To evaluate the project work to be carried out in chemical industries both by internal and external supervisor
- To present the abstract of the project work carried out during IV semester for evaluation by the examiners

Course Content

A student needs to work in various types of chemical industries for the period of 4 months and after completion of the project work, a student needs to present his/ her project report in front of the internal and external guide for *prima face viva voce* examination.

Course Outcomes:

Thinking and learning level of the student upon successful completion of the course, the students will be able to

CO1: Apply theoretical knowledge to get Jobs in Industries and chemical engineering principles to identify and solve real-world industrial problems- **Apply**

CO2: Demonstrate the ability to design and execute a project plan, including literature review, process development, data collection, and analysis within the context of a chemical industry setting-**Create**

CO3: Evaluate chemical manufacturing processes with regard to efficiency, safety, environmental impact, and regulatory compliance-**Evaluate**

CO4: Communicate technical findings effectively through written reports, presentations, and discussions, adhering to industrial documentation standards-**Apply**

CO5: Work effectively as part of a team and demonstrate professionalism, ethical practices, and project management skills in an industrial or industrial-simulated environment- **Apply**

CO6: Develop insights into modern chemical industry operations, including process scale-up, instrumentation, and quality control protocols-**Understand**

Course Articulation Matrix: Mapping of Course Outcome (COs) and (POs)

Course/Paper Title: ICH 402	Program Outcomes(POs)							
Course outcome	1	2	3	4	5	6	7	8
CO1	√	√	√	√			√	√
CO2	√	√	√		√			√
CO3		√	√		√		√	√
CO4						√		
CO5	√	√	√	√	√	√	√	√
CO6	√	√	√	√	√	√	√	√
