गोंय विद्यापीठ
ताळगांव पठार,
गोंय – ४०३ २०६
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(Accredited by NAAC)

GU/Acad –PG/BoS -NEP/2024/487 Date: 03.09.2024

CIRCULAR

Ref: GU/Acad –PG/BoS -NEP/2023/543 dated 03.01.2023

In supersession to the above referred Circular, the Syllabus of Semester III to VIII of the **Bachelor of Science in Industrial Chemistry** Programme is enclosed. Further, the Syllabus of Semester I and II approved earlier is also attached.

The Dean/ Vice-Deans of the School of Chemical Sciences and Principals of the Affiliated Colleges offering the **Bachelor of Science in Industrial Chemistry** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2024.09.03 16:38:34 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

The Principals of Affiliated Colleges offering the Bachelor of Science in Industrial Chemistry Programme.

Copy to:

1. The Director, Directorate of Higher Education, Govt. of Goa
2. The Dean, School of Chemical Sciences, Goa University.
3. The Vice-Deans, School of Chemical Sciences, Goa University.
4. The Chairperson, BOS in Chemistry.
5. The Controller of Examinations, Goa University.
6. The Assistant Registrar, UG Examinations, Goa University.
7. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

Programme Structure for Semester I and II Under Graduate Programme- Industrial Chemistry Double Major										
Semester	**Major -Core**	**Minor**	**MC**	**AEC**	**SEC**	**I**	**D**	**VAC**	**Total Credits**	**Exit**
I	**CHC-100 Fundamentals of Chemistry (4)** **OR** **ICD-100 Fundamentals of Industrial Chemistry (4)**	**CHC-111 Basic Concepts in Chemistry (4)** **OR** **ICD-111 General Industrial Chemistry (4)**	**CHC-131 Introduction to Chemistry (3)**		**CHC-141 Water and Soil Analysis (1T+2P)** **OR** **CHC-142 Skills in Qualitative Organic Analysis (1T+2P)** **OR** **CHC-143 Chemistry of Cosmetics and Perfumes (1T+2P)** **OR** **ICD-141 Analysis of food products (1T+2P)**					
II										**CHE-161 Systematic Chemistry Laboratory Techniques [1+3]**

III	**ICD-200 The Role of Organic and Analytical Chemistry in Industries [3+1]**				**ICD-241 Empowering Skills in some small-scale units [1+2]**					
IV	**ICD-201 Unit operations in Industrial Chemistry [3+1] ICD-202 Inorganic Industrial Chemistry-I (3+1) ICD-203 Applied Physical Chemistry (2)**									
V	**ICD-300 Environmental chemistry and pollution control (3+1)**									

	ICD-301 Inorganic Industrial Chemistry-II (3+1)									
VI	**ICD – 302 Instrumentation in Industrial Chemical Analysis [2]** **ICD – 303 Industrial Pharmaceutical Chemistry [3 + 1]**									
VII	**ICD – 400 Advanced Industrial Inorganic Chemistry [3 + 1]** **ICD – 401 Advanced Industrial Organic Chemistry [2]**									

VIII	**ICD – 402** **Study of materials in Industrial Chemistry** **ICD – 403** **Selected topics in Industrial Chemistry [3+1]** **ICD-404** **Chemical Analysis in Industrial Applications (1+1)**								

Name of the Programme : **B.Sc. Industrial Chemistry**
Course Code : **CHC-100**
Title of the course : **Fundamentals of Chemistry**
Number of Credits : **3T+1P**
Effective from AY : **2023-24**

Pre-requisites for the Course	Nil	
Course Objectives:	• To study the postulates of kinetic theory of gases and understand the deviations of real gases from ideal behaviour. • To study the surface tension and viscosity of liquids. • To introduce the concepts of atomic structure. • To understand the basic concepts in organic chemistry. • To understand the preparation and reactivity of alkanes, alkenes and alkynes.	
Content		**No of hours**
	Fundamentals of Physical Chemistry **Gaseous state** Postulates of Kinetic Theory of gases and deviation from ideal behaviour, Vander Waal's equation of state. Critical phenomenon; PV isotherms of real gases, continuity of states, the isotherms of Vander Waal's equation relation between critical constants and Vander Waal's constants. Law of corresponding states, reduced equation of state. Molecular velocities: root mean square, average and most probable velocities, Qualitative discussion of Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Numerical problems. **Liquid State** Surface Tension, Units of Surface Tension, Determination of Surface Tension by Capillary Rise Method and stalagmometer method. Viscosity, Units of Viscosity, Poiseuille equation, Measurement of Viscosity by Ostwald Method, Effect of Temperature on Viscosity of a Liquid. Numerical problems.	**10** **05**
	Fundamentals of Inorganic Chemistry **Atomic Structure:** Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to atomic structure. Introduction to Schrodinger equation (**equation not to be derived**) and wave function. Radial and angular parts of the hydrogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Quantum numbers and their significance, Discovery of spin, spin	**15**

	quantum number (s) and magnetic spin quantum number (ms). Shapes of s, p and d atomic orbitals, nodal planes. Rules for filling electrons in various orbitals, electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.	
	Fundamentals of Organic Chemistry **Basic Organic Chemistry** Curved arrow notation, drawing electron movement with arrows, half and double headed arrows, in organic reaction mechanisms. Physical Effects, Electronic Displacements: Inductive Effect, Mesomeric effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pKa values. Aromaticity: Benzenoids and Hückel's rule.	**08**
	Aliphatic Hydrocarbons: Functional group approach for the following reactions (Preparations & reactions) to be studied in context to their structure Alkanes: Preparation: Wurtz reaction, Kolbe's synthesis, Reactions: Free radical Substitution: Halogenation. Alkenes: Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides Reactions: Addition of HX (Markownikoff's and anti-Markownikoff's addition) Alkynes: Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of HX and bromine.	**07**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. A. Bahl and G. D Tuli Essentials of physical chemistry ,S. Chand Publications 2020 2. Puri, Sharma, Pathania Principles of Physical Chemistry ,Vishal publishing Co.2021 3. G. W. Castellan Physical Chemistry 4th Edition Addison-Wesley Publishing Co.2004 4. C. N. R. Rao University General Chemistry, Macmillan Publishers 1973 5. J. N. Gurtu Physical Chemistry Vol. I , Pragati Prakashan,10th Edition 2016 6. Gurtu and Gurtu Advanced Physical Chemistry, Pragati Prakashan 2019 7. J. D. Lee, *Concise Inorganic Chemistry, 5th Edn.*; Wiley India, (2003). 8. B. E. Douglas and D. H. McDaniel, *Concepts & Models of Inorganic Chemistry,* Oxford, 1970.	

	9. M. C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, ACS Publications, 1962. 10. B. R. Puri, L. R. Sharma and K. C. Kalia, *Principles of Inorganic Chemistry*, 33rd Edn, Vishal Publishing Co. 2020. 11. S. Prakash, G. D. Tuli, S. K. Basu and R D. Madan, *Advanced Inorganic Chemistry*, Vol 1, S. Chand & Company Pvt. Ltd. 2013. 12. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons, 2014. 13. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013. 14. Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi. 1988. 15. Finar, I. L. *Organic Chemistry* (Vol. I & II), E.L.B.S., 5th Edition. 2001. 16. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010. 17. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010. 18. Francis Carey, *Organic Chemistry*; 4th edition Edition, Tata McGraw Hill India. 2000 19. Paula Yurkanis Bruice, *Organic Chemistry*; 3rd Edition, Pearson Education Asia. 2018 20. Jerry March, *Advanced Organic Chemistry*; 4rd Edition, John Wiley, 2007
Course Outcome:	At the end of the course, students will be able to 1. Identify the properties of liquid and gases. 2. Explain the applications of liquid and gases. 3. Elucidate the atomic structure based on Quantum theory. 4. Identify the use of curved arrow notations in organic reaction mechanisms. 5. Understand various methods of preparation and reactions of alkanes, alkenes and alkynes.

Title of the course: Fundamentals of Chemistry
Number of Credits: 01 (Practicals)

Course Objectives:	• To translate certain theoretical concepts learnt earlier into experimental knowledge by providing hands on experience of basic laboratory techniques required for chemistry. • To introduce the fundamentals and basic techniques of volumetric and gravimetric estimations.	
Content		**No of hours**
	1. Determination of surface tension of two unknown liquids or dilute solutions by stalagmometer method.	**04**
	2. Determination of viscosity of two unknown liquids or dilute solutions by using Ostwald's viscometer.	**04**
	3. Study of the variation of viscosity of an aqueous solution with concentration of solute.	**02**
	4. Pre-Lab session (Laboratory safety, concept of normality and molarity and stoichiometric calculations)	**02**

	5. Calibration of Burette and Pipettes. 6. To prepare 100 mL of standard 0.1 M $K_2Cr_2O_7$ solution and carry out dilution to 0.05, 0.01, 0.005, and 0.001 M in 100 mL standard flasks 7. Volumetry: To prepare 100 ml of 0.1 N KHP solution and standardize the given approximate 0.1 N NaOH solution. 8. Gravimetric analysis: Determination of percentage composition of the given mixture ZnO + $ZnCO_3$ 9. Purification of organic compounds: (i) Recrystallization of Benzoic acid by using water as solvent and determination of melting point. (ii) Distillation of Acetone and determination of boiling point. (iii) Sublimation of Naphthalene and Determination of Melting point. 10. Determination of solubility and chemical nature of both solids and liquids. Water insoluble (Acid//phenol/ Base/Neutral) and water soluble (Acid/Neutral) of given compound. (8 compounds to be analysed)	**02** **02** **02** **02** **06** **04**
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment. Each of the experiments should be done individually by the students.	
References / Readings	1. S. W. Rajbhoj and T. K. Chondhekar, *Systematic Experimental Physical Chemistry*, Anjali Publication, Second Edition 2000. 2. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi . 2011 3. O. P. Pandey, D. N. Bajpai, S. Giri, *Practical Chemistry*, S. Chand Publication 2013. 4. Shikha Gulati, J. L. Sharma & Shagun Manocha, Practical *Inorganic Chemistry,* CBS Publishers, 2017. 5. G. H. Jeffery J. Bassett J. Mendham R C. Denney, *Vogel's Textbook of Quantitative Chemical Analysis*, 5th Edn., John Wiley, New York. 1989. 6. J. Mendham, R.C. Denney, J.D. Barnes, M. Thomas, *Vogel's Textbook of Quantitative Inorganic Analysis*, 6th Edn., Pearson Education Asia, 2000. 7. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012. 8. A.I. Vogel, A., R. Tatchell, B. S. Furniss, A.J. Hannaford, *Vogel's Textbook of Practical Organic Chemistry*, 5thEd., Prentice Hall; 2011. 9. D. Pasto, C. Johnson and M. Miller, *Experiments and Techniques in Organic Chemistry*, 1st Ed., Prentice Hall, 1991. 10. L.F. Fieser, K.L. Williamson, *Organic Experiments*, 7th edition D. C. Heath, 1992. 11. R.K. Bansal, *Laboratory Manual in Organic Chemistry*, New Age International, 5thEdition, 2016.	
Course outcomes	1. To acquire the knowledge and skill of basic volumetric and gravimetric estimations. 2. The students will be able to get hands on experience on the purification	

	techniques for organic compounds. 3. The students will be able to get hands on experience on the identification of chemical nature of organic compounds

Name of the Programme : **B.Sc. Industrial Chemistry**
Course Code : **ICD-100 Major**
Title of the course : **Fundamentals of Industrial chemistry**
Number of Credits : **3T+1P**
Effective from AY : **2023-24**

Pre-requisites for the Course	Nil	
Course Objectives:	• The aim of this course is to make students aware of organic and inorganic aspects of industrial chemistry. • To acquaint the students with the basic chemistry of different materials used in industry • To encourage the students to utilize this knowledge for any ancillary unit to the main industry.	
Content		**No of hours**
	Introduction to Industrial Chemistry and The Chemical Industry Introduction, The difference between Classical and Industrial Chemistry, Classification of Industries, The Chemical Industry, Basic requirements of Chemical Industries, Chemical production, Raw materials, Unit processes and unit operations. Quality control, Quality assurance, process control, research and development, pollution control, human resource, safety measures, economics of chemical process, selection of parameters of chemical industry, classification of chemical reactions, batch and continuous operations, industrial chemical reactions, intellectual property (IP).	**15**
	Industrial aspects of Organic Chemistry Raw material for organic compounds: Petroleum, natural gas, fractionation of crude oil, reforming, hydroforming, isomerisation. Fuel: Types of fuels – Advantages and Disadvantages. Classification of fuels, Calorific values, Determination of calorific value using Bomb's calorimeter & Boy's gas calorimeter.	**15**
	Industrial aspects of Inorganic Chemistry Inorganic materials of industrial importance: Alumina, silica, silicates, clay, mica, carbon, zeolites. Their availability, forms, structure and modifications. Basic Metallurgical operations: Pulverization, calcinations, roasting, refining of metals. Definition of the terms & illustration of the concept with suitable examples.	**15**
	Laboratory course: (30 Hrs) (01 credit) **1. Acquaintance with a safety measure in a laboratory.** (Demonstration and knowledge regarding handling chemicals, equipment and apparatus, flammable materials, storage and disposal of chemicals and solid wastes, guidelines in case of accident or injury) **2. To find out the melting points of organic compounds.** **3. To find out the boiling points of organic compounds.** **4. Simple laboratory techniques:**	**3** **3** **3**

	5. 1. Crystallization from water (Demonstrations and experiments): i) Sodium Chloride ii) Copper Sulphate 2. Crystallization from C_2H_5OH (Demonstrations and experiments): i) Benzoic acid ii) Acetanilide 3. Distillation of: i) Water ii) Acetone 4. Fractional distillation of: i) Acetone and water	**6** **6** **6** **3**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings **References for practicals**	1. A textbook of Industrial Chemistry by Pol, Date, Adhav & Shinde (Manali Prakashan, Pune). 2021 2. Industrial Chemistry by Dr. Helen Njeri Njenga, African Virtual University, Linkread:https://www.academia.edu/42781438/Prepared_by_Helen_Njeri_NJENGA 3. UGC course material as prescribed by UGC 4. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley. 1995 5. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi. 1997. 6. The Chemical Process Industries, by R. Norris Shreve McGRAW-HILL BOOK COMPANY, INC. 1945. 7. Industrial Chemistry by B. K. Sharma, Krishan Prakashan, 2014 8. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company. 2015 1. College Industrial chemistry practicals by Patel, Turakhia and Puniyani 2. UGC practical manual for experimental analysis 3. Sunita Rattan, Experiments in Applied Chemistry, S.K. Kataria & Sons, Second edition, 2008	
Course Outcome:	At the end of the course, students will be able to 1. Learn difference between classical and industrial chemistry 2. Understand basic requirements of chemical industries and knowledge regarding basic terms involved in industrial chemistry 3. Describe different raw materials like petroleum, natural gas for synthesizing organic compounds. 4. To study techniques like fractionation of crude oil, reforming, hydroforming, isomerization carried out in petroleum refineries and to understand the availability, forms, structure and modifications of various inorganic materials of industrial importance. 5. To understand concepts in adsorption, to learn about colloids, emulsions, micro emulsions, micelles & aerosols.	

Name of the Programme : **B.Sc. Industrial Chemistry**
Course Code : **CHC-111**
Title of the course : **Basic Concepts in Chemistry**
Number of Credits : **4+0**
Effective from AY : **2023-24**

Pre-requisites for the Course	Nil	
Course Objectives:	• To define the terms and state laws involved in thermodynamics and chemical equilibrium. • To solve numerical based on chemical energetics and chemical equilibrium. • To understand the development of periodic table and periodic trends. • To explain the theories of acids and bases. • To understand IUPAC nomenclature of organic compounds. • To understand the types of organic reactions, reactive intermediates and importance of selected organic compounds.	
Content		**No of hours**
	Thermodynamics I Thermodynamics I: Definition of thermodynamic terms, system, surroundings etc. Types of thermodynamic systems and thermodynamic processes. Intensive and extensive properties. Concept of heat and work, first law of thermodynamics, definition of internal energy and enthalpy. Heat capacity – heat capacities at constant volume and at constant pressure and their relationship, calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and reversible conditions. Numerical problems are expected	**08**
	Solutions Solutions of liquids in liquids, Raoult's law and deviation from Raoult's Law (Ways of expressing concentration: Molarity, Normality, Molality Mole fraction, parts per million) Solutions of gases in Liquids: Factors influencing the solubility of gases. Henry's law. Numerical problems	**05**
	Chemical Equilibrium Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Definition of ΔG and ΔG^{o}, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.	**07**
	Introduction to the periodic table Development of the periodic table- Dobereiner's Triads, Newland's Law of Octaves, Mendeleev's periodic table and Modern periodic table (Theories and limitations), Classification of the elements into s,p,d and f -block elements on the basis of electronic configuration, Trends in the periodic table (atomic and ionic size)	**12**
	Acid- Base Theories	**08**

	Arrhenius Concept, Bronsted Theory, The Lux – Flood Solvent Systems, Solvent System theory and Lewis Concept of Acids and Bases. (Theories and limitations)	
	Carbon, IUPAC nomenclature of organic compounds, and aromaticity. Valency of carbon-structure of methane, sp^3 hybridisation. Selected functional group of organic compounds with IUPAC nomenclature (alkanes, alkenes, alkynes, alcohols, ethers, carboxylic acids, esters, thiol, amine, amides, halides, nitriles, nitro compounds aldehydes and ketones). Concept of aromaticity, Huckel's Rule, nomenclature of benzenoids (halo, nitro, alkyl), naphthalene and anthracene compounds.	**10**
	Types of organic reactions and structure, properties and uses of selected organic compounds Types of organic reactions with two examples of each: addition, elimination, substitution, oxidation, reduction and rearrangement. Structure and stability of intermediates carbocation, carbanion, free radical. Structure, properties and uses of the following selected organic compounds. Ethanol, acetone, ethyl acetate, formaldehyde, acetylene, benzoic acid, n-butane, chloroform, diethyl ether, cresol, benzaldehyde, aniline, urea, glucose, lauric acid. Preparation of ethanol, benzoic acid, acetone, acetylene, ethyl acetate, diethyl ether.	**10**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. A. Bahl, B.S Bahl and G.D. Tuli, *Essentials of Physical Chemistry,* S. Chand Publication. 2009 2. Puri, Sharma and Pathania, *Principles of Physical Chemistry*. 47th edition. 2020 3. Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa. 2004. 4. C. N. R. Rao., University General Chemistry,Macmillan Publishers 1973 5. J.N.Gurtu Physical Chemistry Vol.I ,Pragati Prakashan,10th Edition 2016 6. Gurtu and Gurtu Advanced Physical Chemistry,Pragati Prakashan 2019 7. Samuel Glasstone Textbook of Physical chemistry Macmillan Publications 2nd Edition 1953 8. R.L.Madan Chemistry for degree students S.Chand Publications 2nd revised edition 2014 9. J. D. Lee, *Concise Inorganic* Chemistry, 5th Edn. Wiley India. 2003. 10. P. W. Atkins, T. L. Overton, J. P. Rourke, M. T. Weller & F. A. Armstrong, *Shriver & Atkins' Inorganic Chemistry*, 5th Edn.; Oxford University Press (2010). 11. N. N. Greenwood & A. Earnshaw, *Chemistry of the Elements*, 2nd Edn., Pergamon Press, Exeter. 1984. 12. F. A. Cottton, G. Wilkinson and P. L. Gaus, *Basic Inorganic Chemistry.* 3rd Edn. Wiley India. 2007	

	13. B. R. Puri, L. R. Sharma and K. C. Kalia, *Principles of Inorganic Chemistry,* 33rd Edn, Vishal Publishing Co. 2020. 14. S. Prakash, G. D. Tuli, S. K. Basu and R D. Madan, Advanced Inorganic Chemistry, Vol 1, S. Chand &Company Pvt. Ltd. 2013. 15. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons. 2014. 16. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013. 17. Sykes, P. A *Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi. 1988. 18. Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S., 5th Edition. 2001. 19. Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010. 20. Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010. 21. Francis Carey, *Organic Chemistry*; 3rd Edition, Tata McGraw Hill India. 2000. 22. Paula Yurkanis Bruice, *Organic Chemistry*; 3rd Edition, Pearson Education Asia. 2018 23. Jerry March, *Advanced Organic Chemistry*; 4rd Edition, John Wiley. 2007. 24. https://www.jagranjosh.com/general-knowledge/list-of-important-organic-compounds-1456306311-1
Course Outcome:	At the end of the course, students will be able to 1. Explain the terms involved in chemical thermodynamics and equilibrium. 2. Evaluate different thermodynamic parameters. 3. Discuss the development of Modern Periodic table and periodic trends 4. Classify the acids and bases using the various theories. 5. Write the names and structures of the organic compounds using IUPAC nomenclature. 6. Understand the importance of selected organic compounds.

Name of the Programme : **B.Sc. Industrial Chemistry**
Course Code : **ICD -111**
Title of the course : **General Industrial Chemistry**
Number of Credits : **4+0**
Effective from AY : **2023-24**

Pre-requisites for the Course	Nil	
Course Objectives:	• To make students to understand basics in industrial chemistry. • The important operations like distillation, evaporation, mixing and crystallization will prove their indispensability in chemical industry. • To make students aware about basic instrumental techniques used in industry.	
Content		**No of hours**
	Nomenclature: Generic names, Trade names and nomenclature of some industrially important chemicals	**5**
	Dimensions and Units: Basic chemical calculations – atomic weight, molecular weight, equivalent weight, Mole concept, Avogadro's number, composition of liquid and gaseous mixtures.	**5**
	Renewable Natural Resources: Cellulose & Starch. Their properties & modifications. Important industrial chemicals derived from cellulose & starch. Alcohols, ethanol (industrial solvent) and alcohol-based chemicals, including oxalic acid & furfural.	**15**
	Unit operations: **Distillation:** Introduction- Single and fractional distillation, Batch and continuous distillation. Azeotropic and extractive distillation **Evaporation:** Introduction- Equipments- short tube (standard) evaporator, forced circulation evaporators, falling film evaporators, climbing film (outward flow) evaporators & wiped film (agitated) evaporators.	**15**
	Mixing: Concept of Mixing, Types of Mixers	**10**
	Crystallization: Crystal geometry, principles of crystallization, nucleation, crystal growth, vacuum crystallizer **Industrial pollution:** Pollutants and their statutory limits, pollution evaluation methods. Solid waste management & Industrial safety. **Basic analytical equipment:** Principles, working & applications of pH meter, conductivity meter, potentiometer, colorimeter.	**10**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. A textbook of Industrial Chemistry by Pol, Date, Adhav & Shinde (Manali Prakashan, Pune). 2021 2. UGC course material as prescribed by UGC 3. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi. 1997. 4. The Chemical Process Industries, by R. Norris Shreve McGRAW-HILL	

	BOOK COMPANY, INC. 1945. 5. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company. 2015 6. Unit Operations in Chemical Engineering, Warren McCabe, Julian Smith, Peter Harriott 7. Unit Operations – I, K A Gavhane, 25th Edition, Nirali Prakashan. 2015. 8. Instrumental methods of Chemical Analysis by B K Sharma, Krishna Prakashan, 2014. 9. Analytical Chemistry by Gary Christian, Kevin A. Schug, & Purnendu Dasgupta, 7th Edition, John Wiley & Sons. 2013.
Course Outcome:	At the end of the course, students will be able to 1. Study nomenclature and learn generic names, trade names & proper names of different industrially important compounds 2. Understand basic unit operations carried out in industries such as distillation, evaporation, mixing and crystallization and understand the instrumentation. 3. Understand about statutory limits of pollutants, the solid waste management and Industrial safety with respect to chemical hazards. 4. Understand principles, working and applications of basic analytical instruments

Name of the Programme : B.Sc. Industrial Chemistry
Course Code : CHC-131
Title of the Course : Introduction to Chemistry
Number of Credits : 3
Effective from AY : 2023-2024

Pre-requisites for the Course:	Nil	
Couse Objectives:	• To introduce chemistry as a scientific discipline • To describe the development of chemistry • To describe the utility of chemistry in medical and industrial fields. • To explain the underlying chemical aspects of chemistry in environment and pollution. • To introduce important Indian scientists and discuss their valuable contributions.	
Content:		**No of hours**
	1. Importance of science in life Towards scientific approach, involvement of science in daily life, different branches of science: significance and applications (viz: chemistry, physics, biology, microbiology, medical science etc.)	**04**
	2. History and development of Chemistry History of Chemistry, Different branches of chemistry (Organic, Physical, Inorganic, Analytical, Pharmaceutical, Green chemistry): their evolution and progress. Wöhler's synthesis of urea, Relations of heat to chemical phenomena, Antoine Lavoisier-Mercury Calx, M. Tswett's invention of Chromatography, P. Anastas's principles of Green Chemistry, Important Discoveries in chemistry: Hydrogen, Oxygen, Concept of Atom, X-ray, Rubber, Penicillin, Nuclear reactor, Plastic.	**08**
	3. Chemistry in medical sciences Classification of Drugs, names and uses of the following drugs with one example each: Antibiotics, Analgesics, Antihistamines, Anticonvulsant, Hypnotics and Sedatives.	**04**
	4. Medicinal plants Introduction: Importance of plant kingdom in general and medicinal plants in particular. Viz. Tulsi, Aloe vera, Turmeric, Vinca rosea, Cinchona, Datura etc. Compounds obtained from them, their uses and applications.	**05**
	5. Chemistry & Industry Minerals and ores: general awareness, chemical plants: cost, environmental impact and recycling.	**04**
	6. Chemistry of Environment & Pollution Introduction to segments of Environment (Atmosphere, Hydrosphere, Lithosphere) Definition of pollutant, pollution. Air Pollution: Composition of Air, Acid rain, Greenhouse effect and Global warming, ozone layer depletion.	**08**

	Water Pollution: Water cycle, Hardness of water, Factors deteriorating the water quality, Eutrophication, Fluoride in drinking water Soil Pollution: Chemical composition of Soil, Soil pollutants, Effects of soil pollution, Control of soil pollution. **7. Indian Scientists and their contributions to nation** 1. Jagdish Chandra Bose – Physicist (1858-1937). 2. Anandibai Joshi – Physician (1865 - 1887). 3. Sir C. V. Raman – Nobel laureate & Physicist (1888-1970). 4. Janaki Ammal – Botanist (1897 - 1984). 5. Kamala Sohonie – Bio-chemist (1912 – 1998). 6. Asmita Chatterjee – Chemist (1917 – 2006) 7. Anna Mani – Physicist and meteorologist (1918- 2001). 8. Rajeshwari Chatterjee – Scientist (1922-2010). 9. A.P. J. Abdul Kalam – Scientist (1931-2015) 10. Darshan Ranganathan – Chemist (1941 – 2001). 11. Prof. C.N.R Rao- Chemist (1934) 12. S. Nambi Narayanan- Aerospace Scientist (1941) 13. Raghunath Mashelkar- Chemical Engineer (1943)	**12**
Pedagogy:	Mainly lectures and tutorials with assignments	
References/Readings:	1. A History of Chemistry by Sir Edward Thorpe, The Rationalist Press Association, Ltd., 1909, Vol I. 2. Chemistry by Richard Harwood, Cambridge University press. published 1998. 3. Organic Chemistry. Morrison, Boyd, Bhattacharjee. Pearson. 2010 4. Fundamentals of Chemistry, Vol. 1. A History of Chemistry. Fabrizio Tuifivo and Ferruccio Trifivo from UNESCO - Encyclopedia Life Support Systems 5. Food Science, Nutrition and Safety, Sukhneet Suri and Anita Malhotra, Pearsons. 2013 6. Medicinal Chemistry by A. Kar. New Age International Pvt. Ltd Publishers, 2007 7. Jagdish Chandra Bose by Sanjay Goyal. Prabhat Prakashan. 2015. 8. First lady doctor of India. The Telegraph. Retrieved 2016-05-01. 9. Lilavati's Daughter's-The Women Scientists of India by Indian Academy of Sciences (Bangalore) 2008.* 10. Prof. C. V. Raman: A biography by Uma Parameswaran., Penguin, Ed. 2011 11. https://ethw.org/Rajeshwari_Chatterjee 12. https://www.sanskritimagazine.com/rajeswari-chatterjee-first-woman-scientist/ 13. https://www.indiatimes.com/technology/news/rajeshwari-chatterjee-karnataka-women-engineer-518515.html 14. Wings of fire: An Autobiography by A. P. J. Abdul Kalam. Universities Press. 2009 15. https://medium.com/sci-illustrate-stories/darshan-ranganathan-84c88a96d3a	

	16. https://feminisminindia.com/2019/03/19/darshan-ranganathan-organic-chemistry/ 17. https://www.jncasr.ac.in/sites/default/files/2022-04/CV-PROF%20CNR%20RAO.pdf 18. https://journalsofindia.com/c-n-r-rao-and-his-contributions/ 19. https://en.wikipedia.org/wiki/Nambi_Narayanan 20. https://www.outlookindia.com/magazine/story/a-gladiator-in-the-space-ring/299101 21. https://www.beaninspirer.com/raghunath-anant-mashelkar-story-indomitable-will-great-scholar-indian-chemical-engineer/ 22. Durdamya Aashawadi Dr Raghunath Mashelkar, Dr. Sagar Deshpande, Sahyadri Prakashan. [A Marathi Book] 23. S. M. Khopkar, Environmental Pollution Analysis, New Age International Limited, Publishers, New Delhi. 2020 24. A.V. Salker, Environmental Chemistry: Pollution and Remedial Perspective, Narosa Publishing House, Navi Mumbai. 2017 [* *Contains Anandibai Joshi, Janaki Ammal, Kamala Sohonie, Asmia Chatterjee, Anna Mani, Darshan Ranganathan*]
Course Outcomes:	Students will be able to: 1. Describe the chemistry as a scientific discipline. 2. Describe the development and branches of Chemistry 3. Appreciate the utility of chemistry in day-to-day life. 4. Explain the preliminary chemical aspects of environment and pollution. 5. Describe and appreciate the contributions of important Indian scientists.

Name of the Programme : B.Sc. Industrial Chemistry
Course Code : CHC-141
Title of the course : Water and Soil Analysis
Number of Credits : 1T+2P
Effective from AY : 2023-24

Pre-requisites for the Course	Nil	
Course Objective:	• To define the various terms encountered in sampling and study the techniques involved. • To study methods that can be employed for the determination of the various physico-chemical parameters of water and soil.	
Content		**No of hours**
	1. Sampling Techniques: Terms encountered in sampling: the population or the universe, Sample, Sampling unit, increment, the gross sample, the sub sample, Analysis sample, Bulk ratio, Size to weight ratio, Random sampling, Systematic sampling, Multistage sampling, Sequential sampling. Sampling of Liquids and Solids. Preservation, storage and preparation of sample solution.	**05**
	2. Analysis of soil: Composition of soil, Concept of pH and pH measurement, chelation, chelating agents, use of indicators. Bulk density, Specific gravity, moisture content, water holding capacity, pH, electrical conductivity, alkalinity, calcium, magnesium and organic matter.	**05**
	3. Analysis of water: Definition of pure water, sources responsible for contaminating water, water purification methods (For domestic and industrial waters). Water analysis: Dissolved oxygen, free carbon dioxide, B.O.D., C.O.D. and total carbohydrates	**05**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers / assignments / presentations / industry visits / mini projects / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. A.K. De, *Environmental Chemistry*. New age international Publishers, 4th Edition. 2007 2. B. K. Sharma, *Environmental Chemistry*. Krishna Prakashan Media (P) Ltd. 2014. 3. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012. 4. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009. 5. Dr Sunita Rattan *Experiments in Applied chemistry* ,3rd Edition 2011-S. K. Kataria and Sons 6. Pandey O.P./Bajpai D.N. and Giri S. *Practical Chemistry,* S Chand Publications	
Course Outcome:	At the end of the course students will be able to 1. Understand the fundamentals and techniques of water and soil	

	sampling. 2. To describe the methods for the determination of various physico-chemical parameters of soil and water

Title of the course: Water and Soil Analysis
Number of Credits: 02 (Practicals)

Course Objectives:	• To help in better understanding of the techniques of sampling soil and water studied in theory, through demonstration. • To apply the knowledge studied in theory for the determination of various physico-chemical parameters of soil and water and thereby develop related skills.	
Content		No of hours
	1. Techniques of soil sampling (Demonstration) 2. Determination of pH of soil sample 3. Determination of Bulk density of soil sample 4. Determination of Moisture content of soil sample 5. Determination of conductivity of soil sample 6. Determination of organic content in soil sample 7. Techniques of water sampling (Demonstration) 8. Determination of pH and conductivity of a water sample 9. Determination of dissolved oxygen (DO) in a given water sample 10. Determination of magnesium content 11. Determination of total hardness in the water sample 12. Determination of acidity of a water sample 13. Determination of alkalinity in a given water sample 14. Measurement of dissolved CO_2 15. Determination of total solids in water.	**15 x 4 = 60**
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment. Minimum two samples each to be analysed for every experiment involving soil and water analysis (4 hours each practical session).	
References / Readings	1. A. K. De, *Environmental Chemistry*. New age international Publishers, 4th Edition. 2007 2. B. K. Sharma, *Environmental Chemistry*. Krishna Prakashan Media (P) Ltd. 2014. 3. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012. 4. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009. 5. Dr Sunita Rattan *Experiments in Applied chemistry* ,3rd Edition 2011-S. K. Kataria and Sons 6. Pandey O.P./Bajpai D.N. and Giri S. *Practical Chemistry,* S Chand Publications	
Course outcomes	At the end of the course students will be able to: 1. Observe and understand the techniques employed for soil and water sampling.	

	2. Develop skill for the determination of the various physico-chemical parameters of soil and water.

Name of the Programme : **B.Sc. Industrial Chemistry**
Course Code : **CHC-142**
Title of the course : **Skills in Qualitative Organic Analysis**
Number of Credits : **1+2**
Effective from AY : **2023-24**

Pre-requisites for the Course	Nil	
Course Objective:	• To understand the theoretical aspects of qualitative organic analysis • To explain mechanistically the chemical tests in qualitative organic analysis.	
Content		**No of hours**
	1. Chemical nature of organic compounds Nature of organic compounds based on physical state of the following compounds: benzoic acid, m-nitroaniline, β-naphthol, acetone, aniline, naphthalene, benzophenone, m-dinitrobenzene (to be shown with structure); presence of saturated and unsaturated compounds using bromine water, potassium permanganate solution; water solubility of organic compounds (any two water soluble and water insoluble compounds); chemical nature of organic compounds (to be explained with reactions)- water insoluble acid/phenol/base/neutral, water soluble acid/phenol/neutral.	**07**
	2. Analysis of hetero elements and functional groups Detection and presence of hetero elements - N/S/X (to be explained with reactions); Detection and presence of functional groups – CH(O) acid- salicylic acid, CH(O) phenol- β-naphthol, CH(O) neutral- acetone, benzaldehyde, ethyl acetate and ethanol, CH(O)N acid p-nitrobenzoic acid, CH(O)N phenol -nitrophenol, CH(O)N base - nitroaniline , CH(O)N neutral- urea, CH(O)N,S neutral- thiourea, CH(O)Cl neutral- chlorobenzene (to be explained with reactions).	**06**
	3. Purification Techniques Recrystallisation, distillation, sublimation. Determination of physical constants of organic compounds- melting point, boiling point.	**02**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / mini projects / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996. 2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960. 3. Pandey, O.P., Bajpai D. N. & Giri S. *Practical Chemistry*, Revised Edition, (For BSc. I, II, III Year Students of All Indian Universities) S. Chand Company Pvt Limited, 2014. 4. N. K. Vishnoi, Advanced Practical Organic Chemistry, third edition, 2010.	

Course Outcome:	At the end of the course students will be able to 1. Explain reactions involved in identifying the chemical nature of organic compounds. 2. Understand role of sodium fusion extract in detecting the presence of heteroelements. 3. Explain the reactions of various functional groups present in organic compounds. 4. Understand the need for purification techniques in organic analysis.

Laboratory Course
Number of Credits: 02

Course Objective:	• To get hands on experience for the systematic qualitative analysis of the organic compounds. • To learn the purification techniques for organic compounds.	
Content		**No of hours**
	1. Purification of organic compounds: (i) Solids by recrystallization process using water and ethanol as solvent and determination of melting point. (ii) Simple distillation of acetone and determination of boiling point. (iii) Sublimation of naphthalene/ anthracene/ camphor and determination of melting point. **2. Identification of unknown organic compounds based on water solubility, chemical type, elemental analysis, group test and physical constants** (organic spotting) (i) Water soluble solids (Acid and Neutral) – *Any 3* (ii) Water insoluble solids (Acid, Base, Phenol and Neutral) – *Two compounds to be analysed of each category.* (iii) Liquids: Water miscible neutral, water immiscible (base/ neutral)	**4** **2** **2** **(3×4 = 12)** **(8×4 = 32)** **(2×4 = 08)**
Pedagogy:	Mainly laboratory work to be demonstration to students, supervision of their lab work. Prelab and Post-lab exercises / journal assessment.	
References / Readings	1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996. 2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960. 3. Pandey, O.P., Bajpai D. N. & Giri S. Practical Chemistry, Revised Edition, (For BSc. I, II, III Year Students of All Indian Universities) S. Chand Company Pvt Limited, 2014. 4. N. K. Vishnoi, Advanced Practical Organic Chemistry, third edition, 2010	
Course outcomes	At the end of the course students will be able to: 1. Get hands on experience for the systematic qualitative analysis of the organic compounds. 2. Acquire skills in applying purification and separation techniques for organic compounds	

Name of the Programme : **B.Sc. Industrial Chemistry**
Course Code : **CHC-143**
Title of the course : **Chemistry of Cosmetics and Perfumes**
Number of Credits : **1T+2P**
Effective from AY : **2023-24**

Pre-requisites for the Course	Nil	
Course Objective:	• To explain the term Cosmeticology and define cosmetics. • To describe preparation and uses of cosmetic products. • To define herb and classify herbal cosmetics. • To study the formulation and preparation of herbal skincare and haircare products. • To understand the classification of perfumes and categorise as per the ingredients. • To understand the importance of essential oils in cosmetic industries. • To describe the general methods of obtaining volatile oils from plants and its composition of volatile oils.	
Content		**No of hours**
	1. Chemistry of Cosmetics Meaning of Cosmeticology. Definition of cosmetics as per EU and Indian guidelines. A general study including preparation and uses of the following: Hair dye, shampoo, face powder, shampoo, lipsticks, talcum powder, creams (cold, vanishing and shaving creams). Definition of herb, herbal medicine, herbal medicinal product, herbal drug preparation. Classification of herbal cosmetics. Herbal cosmetics for skin care (face packs, soaps). Herbal cosmetics for hair care: Henna and Hibiscus	**08**
	2. Chemistry of Perfumes Definition of Perfume. Formulation of Perfume. Sense of perfume smell-Top notes, middle notes and base notes. Classification of perfumes: Traditional and Modern. Fragrance Wheel. Comparison between deodorant and antiperspirant. Triclosan as antibacterial agent-Structure. Benefits and adverse effects of perfumes. Natural and artificial flavours with examples. Essential oils and the importance in cosmetic industries with reference to peppermint oil-Menthol, clove Oil- Eugenol, lemongrass-Geraniol, Structure, synthesis and use of 2-phenyl ethyl alcohol, Sources, Structure and uses of Jasmone, Civetone, Muscone. Methods of separation of essential oils (steam, water and vacuum distillation), solvent extraction, mechanical expression.	**07**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers / assignments / presentations / industry visits / mini projects / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Harry's *Cosmeticology*- Wilkinson, J. B., Harry, Ralph G. **H**ill Books, Leonard, 1973	

	2. Cosmetics science and Technology, Edward Sagarin, Inter Science Publications, 1957. 3. De Navaree, *The Chemistry and Manufacture of Cosmetics*- vol. 1 to 4 (Von. Nostrand) 1962. 4. Modern Cosmetics. Edgar George Thomssen, Francis Chilson (Universal Publishing). 1964 5. Jellinek*, Formulation and Function of Cosmetics*. 6. Cosmetic & Skin. F.V. Wells and I. Lubowe, Reinhold Publications, 1964. 7. P. P. Sharma*, Cosmetics- Formulation, manufacturing and Quality Control*- 5th Edition, 2014. 8. The Principles and Practice of Modern Cosmetics: Cosmetic materials, their origin, characteristics, uses and dermatological action, Ralph Gordon Harry, Chemical Publishing Company, 1963. 9. Drug and Cosmetics Act 1940 10. Vimaladevi M. *Textbook of herbal cosmetics*, CBS Publishing 1st Ed. 2015. 11. H. Panda, *The complete technology book on herbal beauty products with formulation and processes*, Asia pacific business press Inc. 2005. 12. John Gordon, *Essential oils: A practical guide*, Aetheric publishing. 2017 13. Ernst T. Theimer, *Fragrance Chemistry: The Science of the Sense of Smell*, Academic Press, 1982. 14. Berger, Ralf Günter, *Flavors and Fragrances: chemistry, bioprocessing and sustainability (ed.)*, 1st edition. 2007. 15. K. Husnu Can Baser, Gerhard Buchbauer, *Handbook of Essential Oils: Science, Technology, and Applications*, Second Edition, CRC Press, 2015. 16. Olindo Secondini, *Handbook of Perfumes and Flavors*, 1990.
Course Outcome:	At the end of the course students will be able to 1. Define cosmetics as per EU and Indian guidelines. 2. Describe the preparation and uses of various cosmetic products mentioned. 3. Describe the formulation and packaging of cosmetics for hair - Shampoo and hair dye. 4. Classify herbal cosmetics. 5. Explain the terms herbal medicine and herbal medicinal products. 6. Describe the preparation of herbal drug. 7. Describe the formulation and preparation of Herbal cosmetics for skin care and hair care. 8. Classify the perfumes and categorize the perfume ingredients. 9. Explain the importance of essential oil in cosmetic industries. 10. Describe the composition of different volatile oils and methods of obtaining them.

Laboratory Course
Number of Credits: 02

Course Objective:	• To translate certain theoretical concepts learnt earlier into experimental knowledge by providing hands on experience of basic laboratory techniques required for Cosmeticology and perfume chemistry. • To understand the concept of cosmetics and develop formulation skills in the preparation of various cosmetic products.	
Content		**No of hours**
	1. Preparation of cosmetic products. (Any 8) Explain in brief about cosmetic ingredients Talcum powder, face powder, Shampoo, hair dye, Cold cream, Vanishing cream, Nail polish, nail polish remover, Shaving cream, Toothpaste, Lipsticks, eyeliner. 2. Preparation of Herbal cosmetics and its evaluation. (Any 4) Turmeric face pack, Papaya face pack, Henna hair dye, Herbal lotion, Herbal soap, Herbal shampoo 3. Extraction of essential oils as perfumery and identification of compound. (Any 5) a) Steam distillation of cinnamon sticks to cinnamon oil and identification of Cinnamaldehyde. b) Steam distillation of cloves to clove oil and identification of Eugenol. c) Water distillation of lemon peel/Orange peel to give D-Limonene. d) Extraction of banana oil from bananas (Esters as perfumery). e) Extraction of rose oil f) Extraction of citronella oil from lemongrass plant. g) Extraction of caffeine from tea. h) Extraction of jasmine oil from Jasmine flowers and identification of jasmone.	**(8 x 3) = 24** **(4 x 4)=16** **(5 x 4) = 20**
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment.	
References / Readings	1. A.I. Vogel, A., R. Tatchell, B. S. Furniss, A.J. Hannaford, Vogel's *Textbook of Practical Organic Chemistry*, 5th Ed., Prentice Hall; 2011. 2. Belinda Carli*, Cosmetic Formulations: A beginners Guide*, 7th Edn, 2020. 3. Andre O. Barel Marc Paye Howard I. Maibach, *Handbook of Cosmetic Science and Technology*-Third and fourth Edition, 2009. 4. ProFound Klaus Duerbeck, *Natural Ingredients for Cosmetics*, 2005.	
Course outcomes	At the end of the course students will be able to: 1. Understand the concepts of various cosmetic products. 2. Prepare various cosmetic products. 3. Prepare various herbal cosmetic products. 4. Extract naturally flavoured compounds/essential oils.	

Name of the Programme : Industrial Chemistry (Double Major)
Course Code : ICD-141
Title of the course : Analysis of food products
Number of Credits : 1T+2P
Effective from AY : 2023-24

<table>
<tr><td>Pre-requisites for the Course:</td><td colspan="2">Nil</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">• To develop a solid theoretical foundation by understanding the principles of food analysis, including the composition of macronutrients, the role of additives, contaminants in food.
• To acquire hands-on laboratory skills, enabling students to proficiently analyze food samples.
• To gain practical knowledge in quality control practices within the food industry and to apply this knowledge to maintain and ensure the safety and quality of food products.</td></tr>
<tr><td rowspan="3">Content</td><td>Theory</td><td>No of hours</td></tr>
<tr><td>Introduction to food analysis, food composition and nutritional analysis, proteins, carbohydrates, fats, food additives, food contaminants, quality control in food industry, physical, chemical and microbial analysis of food, regulatory standards in food analysis – Food Safety and Standards Authority of India, Food processing, preservation and storage.</td><td>15</td></tr>
<tr><td>Practical
1. To find out the moisture content from a given food sample by lab oven method.
2. To find out the ash in the given food sample.
3. To find out the amount of crude fat in a given food sample.
4. Estimation of titrable acidity in fruit juices
5. Determination of peroxide value
6. Separate and identify the lipids in some common foods using thin-layer chromatography
7. To find out the amount of crude fiber in a given food sample.
8. Determine the vitamin C (ascorbic acid) content in fruit juices using iodometric titration.
9. Detection of adulterants in different food products / crude drugs
a. Sugar in Honey
b. Starch in milk
c. Vanaspati or Margarine in ghee
d. Metanil yellow in food products
e. Brick powder in chilli powder
f. Tamarind seed powder and date seed powder in coffee
g. Dried papaya seeds in pepper</td><td>60</td></tr>
<tr><td>Pedagogy</td><td colspan="2">Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be</td></tr>
</table>

	interactive in nature to enable peer group learning.
References / Readings, References for practicals	1. Food chemistry by Alex V Raman, MJP publishers, 2009 2. Food Analysis Laboratory Manual, Third Edition edited by S. Suzanne Nielsen Purdue University West Lafayette, IN, USA, Springer, 2019 3. A food technology lab manual by Rashida Rajuva TA & Joy PP, Kerala Agricultural University, 2014 4. Handbook of Food Chemistry, Peter C.K. Cheung, Bhavbhuti M. Mehta, Springer, 2015
Course Outcome:	At the end of the course, 1. Students will grasp the fundamental principles of food analysis, including the composition of proteins, carbohydrates, and fats. 2. Through extensive lab work, students will cultivate practical skills, including the analysis of moisture, ash, crude fat, acidity, peroxide levels, and vitamin C in diverse food samples. 3. Students will also gain knowledge in quality control practices within the food industry, along with an understanding of regulatory standards. 4. Students will learn to apply acquired knowledge by identifying common adulterants in various food products, fostering a broader appreciation for the practical implications of food processing and safety.

Exit Course
Name of the Programme : B.Sc. Semester II, Chemistry
Course Code : CHE- 161
Title of the course : Systematic Chemistry Laboratory Techniques
Number of Credits : 1T+3P
Effective from AY : 2023-24

Prerequisites for the course	NIL	
Course Objectives:	• To understand the various steps involved in designing of laboratory and the safety precautions. • To acquire knowledge of various laboratory apparatus and equipment.	
Content		**No. of hours**
	1. Introduction to Chemistry Laboratory General introduction of chemistry laboratory, common instructions for safe working in chemical laboratories, laboratory design, storage, ventilation, lighting, fume cupboard, arrangement of store, safety provisions. organization of practical work, maintenance of laboratory equipment/ apparatus, cleaning of laboratories and preparation room.	**05**
	2. Introduction to Laboratory Apparatus Glass apparatus - Separating funnel, Liebig Condensor, measuring cylinder, Kipp's apparatus, Column, Petridish and desiccator. Handling and storage of glass apparatus. Volumetric Apparatus and measurements - Burette, pipette, volumetric flask, analytical balance, single-pan electronic balance/ electrical analytical balance etc. Miscellaneous apparatus- Buchner funnel, burette stand, retort clamp, china dish/evaporating dish, wire gauze, cork borers, vaccum pump, crucible, Mohr clip, pipe clay triangle, mortar and pestle, spatula, thermometer, pH meter/pH paper, centrifuge machine. Apparatus for heating: Bunsen burner, water bath, oil bath, hot plate, sand bath, hot air oven, heating mantle.	**05**
	3. Preparation of solutions Water as a solvent, types of water, solutions, components of a solution, types of solutions, solubility, concentration of solutions: percentage, molarity, normality, molality, mole fraction, ppm, ppb and stoichiometric calculations.	**05**
Pedagogy	Mainly lectures and tutorials. Seminars /term papers /assignments / presentations /self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature .	
References / Readings	1. Svehla,G.,Vogel's textbook of Macro and semimicro qualitative Inorganic Analysis, 7th edition Longman Group Limited, London. 2012. 2. Jeffery, G.H., Bassett, J., Mendham, J., Denney, R.C., Vogel's textbook of chemical quantitative analysis, 5th edition Longman Scientific &	

	Technical,U K. 1989. 3. Ahluwalia,V. K.,Aggarwal, R., Comprehensive Practical Organic Chemistry, Universities Press India limited, India. 2000. 4. Bansal,R. K., Laboratory Manual of Organic Chemistry, 5th revised edition New Age International Publishers,India. 2008. 5. Khosla, B. D., Garg, V.C., Gulati, A., Senior Practical Physical Chemistry, 18th edition , R. Chand & Co, India. 2018. 6. Pandey,O. P., Bajpai, D.N., Giri, S., Practical Chemistry, revised edition S. Chand Publishing, India. 2013. 7. Singh, J., Singh, R.K p., Singh, J., Yadav, LD.S., Siddhiqui, I.R., Srivastava, J., Advanced practical chemistry, 9th edition, Pragati Prakashan, India. 2019.

Number of Credits: 03 (Laboratory course)

Course Objectives:	• To acquire knowledge in handling various laboratory glasswares. • To develop skills in common laboratory techniques. • To acquire skills in preparation of solutions and various laboratory reagents used for qualitative and quantitative chemical analysis. • To produce well trained Staff /Technicians /Assistants to work in chemistry laboratories, especially at the Schools, Colleges, industries more efficiently and productively.	
Content		**No. of hours**
	1. Calibration: burette, standard flask, bulb and graduated pipette.	**04**
	2. Cleaning of soiled glasswares.	**02**
	3. Preparation of laboratory reagents: 2N NH_4OH, 2N H_2SO_4, 2N NaOH, 2N HCl, 2N $NaNO_2$, 2N HNO_3, Aqueous $FeCl_3$, Alcoholic $FeCl_3$, sat. $NaHCO_3$, iodine solution, bromine water, 1:1 NH_4OH, 2,4-DNP reagent, Fehlings solution A and B, Chlorine water, 0.3 M NH_4OAc, Nesslers reagent, and neutral ferric chloride.	**12**
	4. Preparation of solutions: 0.1N$K_2Cr_2O_7$, 0.1N $KMnO_4$, 0.1NKHP and 0.1NNa_2CO_3, 2N Stannous Chloride	**04**
	5. Preparation of indicators:phenolphthalein, starch, xylenol orange, methyl orange, Eriochrome Black T and Murexide.	**04**
	6. Preparation of acidic and basic buffer solution and determination of its pH value.	**04**
	7. Calibration of instruments and preparation of general SOP guidelines for maintenance of balance, pH meter, conductometer, potentiometer and electrodes.	**12**
	8. Preparation of hydrogen sulphide (H_2S) gas using Kipp's apparatus, separating the precipitate using centrifuge, Incineration of $ZnCO_3$ to ZnO using incinerator.	**06**
	9. Washing methods for apparatus and drying in oven.	**02**
	10. Preparation of distilled, deionized and double distilled water.	**06**
	11. Calibration and maintenance of UV-spectrophotometer.	**04**
	12. Filtration: By gravity and vacuum.	**02**
	13. Determination of melting point of organic compounds using	**02**

	thiels tube(Any three) 14. Determination of boiling point of organic compounds using thiels tube (Any three) 15. Demonstration on using of PPE in chemistry laboratory. 16. Creation of MSDS for Inorganic and organic chemicals 17. Labelling of chemicals based on OSHA guidelines. 18. Checking the solubility of organic compounds in water and organic solvents. (8 solid and 4 liquid compounds) 19. Separation of aqueous and organic solvent using separating funnel. (mixture of water and dichloromethane) and (mixture of water and diethyl ether). Measurement of volume of each liquid using measuring cylinder.	**02** **04** **06** **06** **04** **04**
Pedagogy:	Students should be given suitable pre- and post-lab assignments and explanation revising the theoretical aspects of laboratory experiments prior to the conduct of each experiment. Each of the experiments should be done individually by the students.	
References / Readings	1. Svehla,G.,Vogel's textbook of Macro and semimicro qualitative Inorganic Analysis, 7th edition Longman Group Limited, London. 2012. 2. Jeffery, G.H., Bassett, J., Mendham, J., Denney, R.C., Vogel's textbook of chemical quantitative analysis, 5th edition Longman Scientific & Technical, U K. 1989. 3. Ahluwalia,V. K., Aggarwal, R., Comprehensive Practical Organic Chemistry, Universities Press India limited, India. 2000. 4. Bansal,R. K., Laboratory Manual of Organic Chemistry, 5th revised edition New Age International Publishers, India. 2008. 5. Khosla, B. D., Garg, V.C., Gulati, A., Senior Practical Physical Chemistry,18th edition , R. Chand & Co, India. 2018. 6. Pandey,O. P., Bajpai, D.N., Giri, S., Chemistry Practical,revised edition S. Chand Publishing, India. 2013. 7. Singh, J., Singh, R.K p., Singh, J., Yadav, LD.S., Siddhiqui, I.R., Srivastava, J.,Advanced practical chemistry, latest edition Pragati Prakashan, India. 2016.	
Course Outcomes	Students will be able to: 1. Handle commonly used chemicals, apparatus, minor equipment etc. 2. Explain theoretical aspects and working principles of chemistry lassware. 3. Handle fire extinguishers and other safety appliances. 4. Clean and maintain glassware, equipment, apparatus and laboratory premises. 5. Prepare standard solutions, buffer solutions, indicators, and common laboratory reagents. 6. Handle and maintain minor electronic equipment and electrodes.	

Semester III
Name of the Programme : Industrial Chemistry (Double Major)
Course Code : ICD-200
Title of the course : The Role of Organic and Analytical Chemistry in Industries
Number of Credits : 3T+1P
Effective from AY : 2024-25

Pre-requisites for the Course	Students should have basic knowledge of unit processes and analytical chemistry.	
Course Objectives:	• Make students aware of how organic and analytical chemistry principles and techniques are applied in various industrial settings. • Acquaint the students with the basics of analytical chemistry within the context of the chemical industry. • Encourage the students to utilize the knowledge of unit processes in related industry components.	
Content		**No. of hours**
	Nitration Introduction, Nitrating agents, Aromatic nitration, Kinetics and mechanism of aromatic nitration, Nitration of paraffinic hydrocarbons, Nitrate esters, Thermodynamics of nitrations, Process equipment for technical nitration, Mixed acid for nitrations, Typical industrial nitration processes.	**08**
	Halogenation Reagents for halogenation, Halogenation of aromatics – side chain and nuclear halogenations, Chlorination in the presence of a catalyst, Photohalogenation, Commercial manufacture – Chlorobenzenes, monochloroacetic acid, Chloromethanes.	**07**
	Sulphonation Introduction, Sulphonating agents, chemical and physical factors in sulphonation, Kinetics and mechanism of sulphonation reaction. Commercial sulphonation of benzene, naphthalene, alkyl benzene, Batch vs continuous sulphonation.	**06**
	Hydrolysis: Introduction, hydrolyzing agents, Materials susceptible to hydrolysis, mechanism of ester hydrolysis (Acid and Alkaline); **Oxidation:** Types of oxidative reactions, Oxidizing agents (Permanganates, Dichromates, Peroxides, Nitric acid, fuming sulphuric acid), Commercial manufacture of benzoic acid, phthalic anhydride, acrolein, acetaldehyde and acetic acid. **Hydrogenation:** Introduction, Hydrogen: production and properties, Catalytic hydrogenation, Industrial processes - Hydrogenation or Hardening of Fats	**09**
	The Role of Analytical Chemistry in Industries Definition and scope of analytical chemistry, Importance of analytical chemistry in chemical industries, Types of analytical methods: qualitative vs. quantitative analysis, Sampling techniques in chemical industries, Sample preparation and	**15**

	preservation, Errors in sample handling and mitigation, Types of Instrumental Methods, Instruments for Analysis, Calibration of Instrumental Methods, Selecting an Analytical Method	
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Unit Processes in Organic Synthesis by P. H. Groggins, 5th edition, McGraw Hill publishers, New Delhi, 2004 2. Industrial Chemistry by Dr. Helen Njeri Njenga, African Virtual University, Link read: **https://www.academia.edu/42781438/Prepared_by_Helen_Njeri_NJENGA** 3. "Principles of Instrumental Analysis" by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch,7th edition, Cengage India Private Limited, India, 2020. 4. Instrumental methods of chemical analysis by B K Sharma, Krisha Prakashan, Meerut, 2014 5. The Chemical Process Industries, by R. Norris Shreve Mcgraw-Hill Book Company, Inc. 1945. 6. Industrial Chemistry Vol. I & II by B. K. Sharma, 7th edition, Krisha Prakashan, Meerut, 2014 7. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015	
Laboratory course: (30 Hrs) (01 credit)		
Course Objectives	1. Acquire knowledge and practical skills in conducting nitration, halogenation and hydrolysis reactions, understanding the chemical transformations involved. 2. Learn the calibration procedures for pH meters, ensuring accurate and reliable measurements in subsequent experiments.	
Content	1. Analysis of oils and fats (iodine value, saponification value, acid value).	**4**
	2. Nitration - i) Nitration of acetanilide	**4**
	ii) Nitration of nitrobenzene	**4**
	3. Halogenation - i) Preparation of p-bromoacetanilide	**4**
	ii)Preparation of 2, 4, 6- tribromophenol	**4**
	4. Hydrolysis i) Hydrolysis of benzamide	**4**
	ii) Hydrolysis of ethylbenzoate	**4**
	5. Calibration of pH meter	**2**
Pedagogy	Laboratory practicals /industry visits/ self-study or a combination of some of these can also be used. ICT mode may be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. College Industrial chemistry practicals by Patel, Turakhia and Puniyani, Himalaya Publishing House, Mumbai, 2023 2. Sunita Rattan, Experiments in Applied Chemistry, S.K. Kataria & Sons, Second edition, India, 2008 3. Practical Industrial Chemistry by Zeba N. Siddiqui, Anmol Publication	

	New Delhi, First Edition, 2002
Course Outcome:	At the end of the course, students will be able to: 1. Demonstrate a thorough understanding of essential chemical processes, along with their mechanisms and industrial applications. 2. Apply their analytical expertise to conduct qualitative and quantitative analysis, calibrate instruments, and effectively mitigate errors in sample handling and analysis. 3. Recognize the industrial relevance of the chemical processes. 4. Apply acquired knowledge to perform organic synthesis, showcasing a practical understanding of reaction mechanisms and product formation. 5. Showcase understanding and application of iodine value, saponification value, and acid value determinations. 6. Emphasise an understanding of the chemical changes involved and the factors influencing reaction outcomes.

Name of the Programme : Industrial Chemistry (Double Major)
Course Code : ICD-241
Title of the course : Empowering Skills in some small-scale units
Number of Credits : 1T+2P
Effective from AY : 2024-25

Pre-requisites for the Course	Nil	
Course Objectives:	1. To impart knowledge about the manufacturing processes involved in the production of small-scale units 2. To educate students regarding the economic aspects of small-scale units and adherence to safety standards 3. To provide students with knowledge about the applications of the small-scale unit products in various industries.	
Content		**No. of hours**
	Some small-scale units Safety matches, composition of match head, side composition of match box; Incense stick (Agarbattis), composition and manufacture; Naphthalene balls; Wax candles; Shoe polish; Gum paste; Fountain pen ink; Chalk crayons; Plaster of paris; Dyes & Pigments, natural and synthetic dyes, properties and applications; economic aspects; safety and precautions used in small scale units.	**15**
	Total:	**15**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Industrial Chemistry Vol. I & II by B. K. Sharma, 7th edition, Krisha Prakashan, Meerut, 2014 2. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015 3. Synthetic dyes by Gurudeep Chatwaal, Himalaya Publishers, India, 2009. 4. The theory and practice of color by Bonnie E Snow, Alpha Edition, New Delhi, 2019.	
	Laboratory course (02 credit)	**60**
Course Objectives:	1. Learn the techniques involved in the preparation of various everyday items. 2. Gain knowledge and hands-on experience in synthesizing dyes and pigments. 3. Understand and apply safety protocols and environmental considerations associated with the synthesis of everyday products and chemicals.	
	1. Preparation of safety matches (match sticks) 2. Preparation of incense stick (agarbatti) 3. Preparation of Naphthalene balls 4. Preparation of chalk crayons 5. Preparation of shoe polish 6. Preparation of wax candles 7. Preparation of Gum paste	8 8 8 6 6 6 6

	8. Synthesis of dyes and pigments a) Azo dye via diazotization reaction b) Fluorescent dye c) Yellow pigment (Chrome yellow) d) Green pigment (Chrome green)	 3 3 3 3
	Total:	**60 hrs**
Pedagogy	Laboratory practicals /industry visits/ self-study or a combination of some of these can also be used. ICT mode may be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Industrial Chemistry Vol. I & II by B. K. Sharma, 7th edition, Krisha Prakashan, Meerut, 2014 2. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015 3. Synthetic dyes by Gurudeep Chatwaal, Himalaya Publishers, India, 2009.	
Course Outcome:	At the end of the course, students will be able to**:** 1. Develop new products within the small-scale unit domain by applying their understanding of raw materials & manufacturing processes 2. Demonstrate a strong commitment to safety in small-scale unit production, contributing to a secure working environment. 3. Have a comprehensive understanding of the small-scale unit industry, allowing them to identify business opportunities, adapt to market trends, and potentially start and manage their own ventures. 4. Demonstrate the ability to prepare a variety of products, showcasing applied knowledge in the synthesis of various everyday products. 5. Adhere to safety protocols and demonstrate awareness of environmental considerations. 6. Showcase the ability to optimize reaction conditions for improved outcomes in small scale industrial units.	

Semester IV
Name of the Programme : Industrial Chemistry (Double Major)
Course Code : ICD-201 Major
Title of the course : Unit operations in Industrial Chemistry
Number of Credits : 3T+1P
Effective from AY : 2024-25

Pre-requisites for the Course:	Students should have basic knowledge of unit operations such as distillation, crystallization, drying, evaporation & filtration.	
Course Objectives:	1. To study the laws of thermodynamics, various state functions and its significance in industrial setting. 2. To make students understand the fundamental principles of unit operations, their definition, scope, and their significance in chemical processes. 3. To develop a strong theoretical foundation in unit operations, enabling leaners to utilize this knowledge for any ancillary unit to the main industry.	
Content		**No. of hours**
	Theoretical Aspects of Unit Operations Introduction to Unit Operations, Definition and scope of unit operations, Significance in chemical processes, Material Balance Fundamentals, Material Balance without Chemical Reaction, Flow diagrams and process flowsheets, Material Balance with Chemical Reaction, First law of thermodynamics, definition of internal energy and enthalpy. Heat capacity – heat capacities at constant volume and at constant pressure and their relationship, calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and reversible conditions. Second law of thermodynamics: - statements of second law of thermodynamics. Carnot cycle and its efficiency. Concept of entropy. Entropy as a state function. Third law of thermodynamics and calculation of absolute entropies of substance (Numericals to be solved).	**15**
	Mass Transfer Unit Operations **Distillation:** Simple distillation, Flash distillation, Rectification, Azeotropic and extractive distillation, Batch and continuous distillation. **Gas Absorption:** Selection criteria for solvent in gas absorption, Mechanically agitated vessel, Packed Columns/towers, Plate Columns. **Drying:** Introduction, Free moisture, bound moisture, drying curve. Equipments – tray dryer, rotary dryer, flash dryer & spray dryer. **Crystallization:** Solubility, Solubility Curves, Supersaturation, Mechanism of crystallization, Methods of Supersaturation, Agitated tank crystalliser, vacuum crystallizer.	**15**

	Fluid mechanics and heat transfer Unit Operations **Transportation and metering of fluids:** Fluid moving machinery, positive displacement pumps, Reciprocating pumps, rotary pumps, Centrifugal pumps, vacuum pumps, Fans, blowers & compressors. **Evaporation:** Introduction, Equipments – short tube (standard) evaporator, forced circulation evaporators, falling film evaporators, climbing film (outward flow) evaporators & wiped (agitated) evaporators	**08**
	Unit operations involving particulate solids Size reduction of solids, Crushers, Grinders. **Filtration:** Concept of Filtration, Factors Affecting Rate of Filtration, Types of Filtration Equipments, Primary Filter - Sand Filters, Vacuum filters, Rotary Drum Filter, Centrifugal Filters.	**07**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Unit Operations – I [Fluid Flow and Mechanical Operations] by K. A. Gavhane, 13th edition, Nirali Prakashan, Pune, 2021. 2. Introduction to Process Calculations Stoichiometry. By K. A. Gavhane, Nirali Prakashan, Pune, 2013. 3. Principles of Physical Chemistry, B. R. Puri, Madan S. Pathania, L. R. Sharma, 47th edition, Vishal Publishing Co., New Delhi, 2020. 4. Unit Operations of Chemical Engineering by Julian Cleveland Smith, Peter Harriott, and Warren L. McCabe, 5th edition, McGraw Hill, New Delhi,1993. 5. Unit Operations - II [Heat and Mass Transfer] by K. A. Gavhane, Nirali publication, Pune, 2017. 6. The Chemical Process Industries, by R. Norris Shreve Mcgraw-Hill Book Company, Inc. 1945. 7. Industrial Chemistry Vol. I & II by B. K. Sharma, 7th edition, Krisha Prakashan, Meerut, 2014 8. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015.	
	Laboratory course (01 credit)	**30**
Course objectives	1. Acquire proficiency in various distillation methods and fractional distillation of ethanol, acetone, and toluene mixture. 2. Learn various solid separation techniques with different solvents, and determination of melting points. 3. Conduct experiments to determine the enthalpy of ionization as well as the enthalpy of neutralization.	
Content	1. Preparation of gases and their chemical analysis (i) Carbon dioxide (ii) Sulphur dioxide (iii) Hydrogen (iv) Chlorine	**3 hours each**

	2. Distillation of Acetone and Nitrobenzene mixture 3. Steam distillation of o – nitro phenol and p – nitro phenol mixture. 4. Fractional distillation of mixture (Ethanol + Acetone + Toluene) 5. Recrystallization of solids with water, alcohol and aq. alcohol and determination of its melting point. 6. Filtration (i) Simple filtration / Gravity filtration (Ordinary filter paper, Whatmann filter paper) (ii) Vacuum or Suction filtration (Buchner funnel, sintered glass crucible) 7. Determination of solid content in the given water sample by evaporation method. 8. Size reduction of solids using griding (mortar & pestle) technique and ball milling technique. 9. Determination of enthalpy of ionization of Acetic acid and NaOH 10. Determination of enthalpy of neutralization of Acetic acid and NaOH	
	Total:	**30**
Pedagogy	Laboratory practicals/industry visits/ self-study or a combination of some of these can also be used. ICT mode may be preferred. Sessions should be interactive in nature to enable peer group learning.	
References for practicals	1. Practical Chemistry by Sonia Ratnani, Swati Agrawal, Sujeet Mishra, McGraw Hill publication, Meerut, 2020 2. Practical Industrial Chemistry by Zeba N. Siddiqui, Anmol Publication New Delhi, First Edition, 2002	
Course Outcome:	At the end of the course, s**tudents will be able to:** 1. Apply thermodynamic principles to analyze and calculate energy changes in chemical processes. 2. Demonstrate a clear understanding of the theoretical aspects of unit operations and to apply material balance principles to various unit operations. 3. Develop a clear understanding of distillation, gas absorption, drying & crystallization. 4. Exhibit advanced knowledge and skills in distillation methods, showing competence in separating and purifying different liquid mixtures. 5. Showcase proficiency in solid separation techniques, highlighting skills in filtration, recrystallization, and accurate determination of melting points. 6. Apply principles of thermodynamics to determine enthalpies, reflecting a deep understanding of the thermochemical properties of acids and bases.	

Name of the Programme : **B.Sc. Industrial Chemistry**
Course Code : **ICD-202 Major**
Title of the course : **Inorganic Industrial Chemistry-I**
Number of Credits : **3T+1P**
Effective from AY : **2024-25**

Pre-requisites for the Course	Students should have basic knowledge of elements in periodic table, transition metals and p & s block elements.	
Course Objectives:	• To understand the theoretical aspects related to inorganic qualitative analysis • To study the chemistry of s and p block elements • To learn and understand the chemistry of coordination compounds and their role in biological system. • To learn the properties of transition metals	
Content		**No of hours**
	Theoretical Basis for the Qualitative Inorganic Analysis Common ion effect, solubility product, complex ion formation, buffers, applications in inorganic qualitative analysis.	**03**
	Chemistry of the transition metals Introduction, General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Variable oxidation states, unusual oxidation states and their stabilities in aqueous solutions. Difference between the first, second and third transition series. Qualitative tests for the ions of first transition series.	**12**
	Introduction to Co-ordination chemistry Introduction, double salts and complex salts, Werner's theory of coordination compounds, experimental evidences for the Werner's theory, terms used in coordination complexes, naming and writing formula of coordination compounds, Effective atomic number Rule, isomerism and bonding in coordination compounds, Structural isomerism: Ionization isomers, Hydration isomers, Coordination isomers, Linkage isomers. Stereo and optical isomerism w.r.t. coordination compounds (CN = 4, 6). Role of coordination compounds in biology and medicinal sciences, Industrial applications of coordination compounds.	**15**
	s - block Elements Occurrence and extraction, Electronic configuration, Periodic trends in Properties viz. size of atom, ion, ionization potential, and reactivity. Anomalous behaviour of Li & Be. Diagonal relationship between Li & Mg. Alkali ion batteries, Fertilizer industry with special reference to Potash, Desulphurization, Refractory material with special reference to MgO. **p-block elements** Characteristic: Chemical reactivity of elements and group trends. Synthesis, properties and structure of their hydrides and halides.	**15**

	Compounds: Allotropy of boron, carbon, phosphorus and sulphur, industrial applications.	
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012. 2. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition. Pearson Education (2009). 3. J.C. Kotz, Paul M. Treichel, Grabriela C. Weaver, Chemistry and Chemical Reactivity, 6th Edn. Thomson Books/Cole (2006). 4. P.L. Soni and Mohan Katyal, Textbook of Inorganic Chemistry by, Sultan Chand and Sons, 20th Edition (1997) 5. Puri, Sharma and Kalia, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co. (2018). 6. J.D. Lee, Concise Inorganic Chemistry by, Chaman, and Hall, 5th ed. (1996). 7. F. A. Cotton, G. Wilkinson, P. L. Gauss, Basic Inorganic Chemistry, 3rd Ed.; Wiley, (Reprint 2008). 8. N. N. Greenwood, A. Earnshaw, Chemistry of the Elements, Pergamon Press, 1st Ed.; (1984). 9. Glen E. Rodgers, Inorganic Chemistry, 3rd Edn. Brooks/Cole (2012). 10. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edition (1999). 11. P. W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver & Atkins Inorganic Chemistry, 5th Ed.; Oxford Publications, (2009). 12. Geoff Raymer and Tina Overton, Descriptive Inorganic Chemistry, 4th Edition (2006). 13. J.E. Huheey, E.A. Keiter, R.L. Keiter, U.K. Medhi, Inorganic Chemistry – Principles of structure and reactivity by, 1st impression (2006) Pearson Education Publishers. 14. Neil G. Connelly, Ture Damhus, Richard M. Hartshorn, Alan T. Hutton. Nomenclature of Inorganic Chemistry. IUPAC RECOMMENDATIONS 2005 15. Catherine E. Housecroft and Alan G. Sharpe, Inorganic chemistry 4th edn., Pearsons, 2012.	
Laboratory course: (30 Hrs) (01 credit)		
Course Objectives	• To Apply the fundamental theoretical aspects of qualitative inorganic analysis in laboratory. • To use various titrimetric techniques to estimate the analytes. • To perform gravimetric methods to estimate metal ions. • To prepare coordination compounds.	

Content	1. Semi-micro qualitative analysis: (two anions and two cations): (4 Mixtures) 2. Cations: Ba^{2+}, Cu^{2+}, Fe^{2+}, Ni^{2+}, K^{+}, NH^{4+} 3. Anions: CO_3^{2-} , NO^{3-}, Cl^{-}, SO_4^{2-} 4. Estimation of the amount of nickel in the given nickel sulphate solution (EDTA method). 5. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using the internal indicator. 6. Estimation of the amount of calcium in the given calcite ore. 7. Estimate the amount of Ni as bis-(dimethylglyoximato) nickel (II) in the given solution of nickel chloride. 8. Estimation of Al as Al_2O_3 from the given solution of aluminium Sulphate.	**10** **4** **4** **4** **4** **4**
Pedagogy	Laboratory practicals /industry visits/ self-study or a combination of some of these can also be used. ICT mode may be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Svehla G. Vogel's Qualitative Inorganic analysis. Seventh Edition. Pearson Education Ltd, 2008. 2. Svehla G., Sivasankar B., Vogel's Quantitative Inorganic analysis. Seventh Edition. Pearson Education Ltd, 2012. 3. Vogel's Quantitative Chemical Analysis by Mendham J., Noida Pearson Education India, 6th Edition, 2022. 4. Alexeyev. V. Quantitative Analysis. Second edition. Mir Publishers. 1969. 5. J. Derek Woollins Inorganic experiments, WILEY-VCH, 2010. 6. College Industrial chemistry practicals by Patel, Turakhia and Puniyani, Mumbai Himalaya Publishing House, (1998). 7. Sunita Rattan, Experiments in Applied Chemistry, S.K. Kataria & Sons, Second edition, 2008	
Course Outcome:	At the end of the course, students will be able to: 1. Explain the general trends and properties of transition metals and different aspects of coordination compounds. 2. Analyze and compare the variable oxidation states and isomerism in coordination compounds. 3. Evaluate periodic trends and anomalous behaviours of s-block elements and their industrial applications. 4. Apply knowledge of coordination compounds in industry and biology. 5. Conduct qualitative and quantitative analysis of various anions and cations using semi-micro qualitative analysis. 6. Apply complexometric and gravimetric techniques to estimate the amounts of nickel, iron, zinc, and aluminum in given solutions.	

Name of the Programme : **B.Sc. Industrial Chemistry**
Course Code : **ICD-203 Major**
Title of the course : **Applied Physical Chemistry**
Number of Credits : **2T**
Effective from AY : **2024-25**

Pre-requisites for the Course	Students should have basic knowledge of general chemistry, including concepts of atomic structure and chemical bonding.	
Course Objectives:	• To make students understand the fundamental laws of photochemistry, and to describe the composition of the nucleus. • To discuss the process of photosensitization, including phenomena such as luminescence, fluorescence, phosphorescence, and chemiluminescence. • To acquaint students with the principles and applications of various detection and measurement techniques for radioactivity. • To enable students to explain the application of radioisotopes in medicine, agriculture, and industry.	
Content		**No. of hours**
	Photochemistry Introduction, Laws of photochemistry: Grothus-Draper law, Stark-Einstein law. Quantum yield or efficiency, factors affecting quantum efficiency, reasons for low and high quantum efficiency, experimental determination of quantum yield. Primary and secondary processes. Potential energy curves for primary photochemical processes, Photochemical reactions. Non-radiative and radiative transitions, Jablonski diagram. Photosensitization: luminescence, fluorescence, phosphorescence and Chemiluminescence.	**15**
	Nuclear Chemistry Composition of the nucleus, Mass defect and binding energy, Q – value of nuclear reactions, nuclear binding force; Nuclear models – shell model and liquid drop model, radioactive disintegration, decay constant, half-life and average life, Group displacement law, units of radioactivity and radiation energy, artificial radioactivity, detection and measurement of radioactivity, ionization chamber, GM counter and proportional counter, Scintillation counter. Nuclear Fission, discovery, Nuclear reactor – essential parts of the nuclear reactor, classification of nuclear reactors, chain reaction and its control, reprocessing of spent fuel, application of radio isotopes- in the field of medicine, agriculture, industry, as traces (2-3 examples of each) and in carbon dating.	**15**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Bahl and G.D. Tuli, Essentials of Physical Chemistry, S. Chand Publication, 2019, New Delhi, 26th Edition. 2. P. Sharma and Pathania, Principles of Physical Chemistry,Vishal Publishing Co, 2018, Jalandhar, Delhi, 1st edition.	

	3. J.N. Gurtu, Physical Chemistry, Pragati Prakashan, 2020, Meerut, 9th edition. 4. G. Raj, Advanced Physical Chemistry, Goel publication, 36th edition, 2010, Meerut. 5. R. L. Madan, Chemistry for degree students, S Chand publications, 2017, New Delhi, 1st edition. 6. U. N. Dash, Nuclear Chemistry, S. Chand & Sons Publications, 2010, New Delhi. 7. K. K. Rohatgi-Mukherji, Fundamentals of Photochemistry, 3rd edition, New Age international Publishers, 2017, New Delhi. 8. H. J. Arnikar, Essentials of Nuclear Chemistry, New Age International Publishers, New Delhi, 2011, Reprint 2018, 4th edition.
Course Outcome:	At the end of the course, students will be able to: 1. Understand the fundamental laws of photochemistry, the principles of quantum yield and factors affecting quantum efficiency. 2. Explain the processes of photosensitization, including luminescence, fluorescence, phosphorescence, and chemiluminescence, and their practical applications. 3. Discuss the applications of radioisotopes in various fields such as medicine, agriculture, and industry, and utilize radioisotopes as tracers and in carbon dating.

Semester V
Name of the Programme : Industrial Chemistry (Double Major)
Course Code : ICD-300
Title of the course : Environmental chemistry and pollution control
Number of Credits : 3T+1P
Effective from AY : 2025-26

Pre-requisites for the Course:	Students should have basic knowledge of different types of environmental pollution and various ways to control pollution.	
Course Objectives:	• Recall and explain the segments of the environment, chemical reactions in the atmosphere and the phenomena associated with environmental issues. • Evaluate waste management strategies, environmental legislation, and the principles of Environmental Impact Assessment (EIA) for industries, considering their significance in sustainable development. • Apply knowledge to classify air, water, soil, and noise pollutants, identifying their sources and effects on human health and the environment. • Analyze pollution monitoring techniques, atmospheric sampling, and the methods used in the estimation of environmental pollutants.	
Content		**No of hours**
	Environmental Chemistry Segments of environment – Lithosphere, hydrosphere, biosphere, atmosphere, composition of atmosphere, atmospheric structure, chemical species and particulates present in the atmosphere – Ions, radicals and particles, reactions in the atmosphere – reactions of NOx, SOx and oxidation of organic compounds, photochemical smog, Greenhouse effect, formation & depletion of ozone, CFC's, El Nino phenomenon and its effect, acid rain, global warming and climate change	**15**
	Environmental pollution and control **Air pollution:** Introduction, classification of air pollutants and their effects on man and environment, air pollutants from industrial and other sources, air quality standards, air monitoring, atmospheric sampling and analysis, techniques used in estimation of atmospheric pollutants, air pollution control, statutory limits.	**07**
	Water pollution: Introduction, classification of water pollutants – organic pollutants, inorganic pollutants, radioactive materials, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), control measures in waste water treatment – i) Physical: sedimentation, (Clarification), Filtration; ii) Chemical: Disinfection: Chlorination, UV-radiation, Ozonation, Coagulation, adsorption, Oxidation; iii) Biological: Aerobic treatment and its mechanism, Anaerobic treatment and its mechanism, statutory limits.	**08**
	Soil pollution: Introduction, sources, effects of soil pollutants – effects of modern agricultural practices (synthetic fertilizers and	**06**

	pesticides), effects of industrial effluents, effects of urban waste, control of soil pollution. **Noise pollution:** Introduction, Units and Measurements of Noise, sources & effects of noise pollution, control of Noise Pollution.	
	Waste Management in industries Introduction, importance of waste management, atom economy, 3R concept (Reduce, Reuse & Recycle), assessment procedures, types of waste, solid wastes – classification and origin, characteristics of solid wastes, methods of solid waste disposal – composting, sanitary land filling, incineration, pyrolysis, bioconversion.	**05**
	Environmental management Introduction, objectives, Environmental impact assessment (EIA), The water Act 1977, Air prevention and control of pollution Act 1981, The Environment Protection Act 1986, The Environmental Quality Management Standard, Assessment of Environment and ISO – 14000.	**04**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. A textbook of environmental chemistry and pollution control by Dr. S. S. Dara and Dr. D. D Mishra, 9th edition, S. Chand publication, New Delhi, 2015. 2. A book of Industrial Chemistry by Dr. G. S. Gugale, Dr. A. V. Nagawade, Dr. R. A. Pawar and Dr. K. M. Gadave, 1st edition, Nirali Prakashan, Pune, 2015. 3. Environmental Chemistry by B. K. Sharma, Krishna Prakashan, Meerut, 2017 4. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015 5. A textbook of Industrial Chemistry by Pol, Date, Adhav & Shinde (Manali Prakashan, Pune)	
Laboratory course: (01 credit) 30 Hrs		
Course objectives	• Develop an understanding of fundamental concepts related to water quality analysis. • Acquire practical laboratory skills in performing water quality tests. • Gain insight into the significance of monitoring water and soil quality for environmental assessment.	
Content:	1. Determination of solids content. 2. Determination of Hardness of water samples. 3. Determination of acidity of water samples. 4. Determination of Alkalinity of water samples. 5. Determination of dissolved oxygen in a water sample. 6. Determination of BOD. 7. Determination of COD. 8. Determination of turbidity in a water sample.	2 3 3 3 4 4 4 3

	9. Analysis of soil sample (pH, moisture content, conductivity, organic content).	4
Pedagogy	Laboratory Practicals /industry visits/ self-study or a combination of some of these can also be used. ICT mode may be preferred. Sessions should be interactive in nature to enable peer group learning.	
References for practicals	1. Practical Industrial Chemistry by Zeba N. Siddiqui, 1st edition, Anmol Publications, India, 2002. 2. Practical Chemistry by Sonia Ratnani, Swati Agrawal, Sujeet Mishra, 1st edition, Mc Graw Hill publication, Meerut, 2020. 3. Vogel's Quantitative Chemical Analysis by G. H. Jeffery, J. Bassett, J. Mandham & R. C. Denney, Fifth edition, Wiley Publications. 4. Vogel's Qualitative Inorganic Analysis by Arthur Vogel & G. Svehla, 7th edition, Pearson Education, India, 2012.	
Course Outcome:	At the end of the course, students will be able to: 1. Demonstrate a comprehensive understanding of the segments of the environment and the chemical composition of the atmosphere. 2. Gain awareness of different types of environmental pollution and its effects on human health and the environment. 3. Develop proficiency in monitoring air and water quality, estimating atmospheric pollutants, and implementing modern pollution control techniques. 4. Demonstrate expertise in concepts of waste management, including the 3R concept, various methods of solid waste disposal and important environmental laws. 5. Apply various analytical techniques to quantify and assess different water and soil parameters. 6. Demonstrate expertise in analysing a range of water parameters, ensuring a thorough understanding of water quality. 7. Effectively communicate findings through well-structured laboratory reports, demonstrating critical analysis and problem-solving skills.	

Name of the Programme : **B.Sc. Industrial Chemistry (Double Major)**
Course Code : **ICD-301**
Title of the course : **Inorganic Industrial Chemistry-II**
Number of Credits : **3T+1P**
Effective from AY : **2024-25**

Pre- requisites for the Course	Student should have basic knowledge of periodic properties, solid state chemistry and coordination chemistry	
Course Objectives:	• To study the preparations, chemical properties, structure and bonding of halogen compounds. • To understand fundamentals of the metal ligand bond in accordance with VBT and CFT. • To learn the fundamentals of solid-state chemistry, superconductivity and to study their applications. • To comprehend the concepts of acid bases and non-aqueous solvents.	
Content		**No of hours**
	1. Chemistry of halogens Introduction to Group 17: General methods of preparation, structure, bonding and chemical properties of: i) Interhalogens ii) Polyhalides ions iii) Oxoacids of halogens in different oxidation states	**08**
	2. Coordination Chemistry-I Valence Bond Theory: Hybridisation of the central metal orbitals sp3 , dsp2 , sp3d/dsp3 , sp3d 2 /d2 sp3 Inner and Outer orbital complexes (suitable examples), electroneutrality principle and limitations of Valence Bond Theory. Crystal field theory: Postulates, effect of crystal field on central metal valence orbitals in various geometries. splitting of d orbitals in octahedral and tetrahedral crystal fields. Crystal field splitting parameters Δ, factors affecting Δ, Spectrochemical series. Crystal Field Stabilization Energy (CFSE), calculation of CFSE, for octahedral complexes with d1 to d10 metal ion configuration. Consequences of crystal field splitting on various properties such as ionic radii, hydration energy, lattice energy, enthalpies of formation, colour and magnetic properties. Limitations of CFT. Evidences for covalency in metal complexes: i) intensities of d-d transitions, ii) ESR spectrum of [IrCl6] 2- , iii) Nephelauxetic effect iv) NMR spectra.	**15**
	3. Acid Bases and Non-aqueous Solvents Arrhenius theory, Lowry-Bronsted theory, Lux–Flood, Solvent systems and Lewis concept of Acids and Bases, HSAB Concept of Acids and Bases, Classification of solvents and importance of nonaqueous solvents. Supercritical carbon dioxide and ionic liquids as solvents. Levelling effect, reactions in non-aqueous solvents with respect to liquid NH3, liquid SO2 and liquid HF.	**08**
	4. Introduction to Solid State Chemistry Structures of Solids: Importance of solid-state chemistry, types of	**10**

	solids, crystal lattice, lattice points, unit cells and lattice constants. Close packing of rigid spheres (hcp, ccp), packing density in simple cubic, bcc, fcc and hcp lattices (numerical problems expected). Relationship between density of unit cell and lattice parameters (numerical problems expected). Tetrahedral and octahedral interstitial voids in ccp lattice, limiting radius ratios of different coordination numbers and their significance. Calculation of limiting radius ratio for coordination number	
	5. Superconductivity Discovery of Superconductivity. Explanation of terms: Superconductivity, Transition temperature and Meissner effect. Different types of superconductors viz, conventional superconductors, organic superconductors, alkali metal fullerides and high temperature superconductors.	**04**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. P.L. Soni and Mohan Katyal, Textbook of Inorganic Chemistry by, Sultan Chand and Sons, 20th Edition (1997) 2. Puri, Sharma and Kalia, Principles of Inorganic Chemistry, 33rd Edition, Vishal Publishing Co. (2018). 3. J.D. Lee, Concise Inorganic Chemistry by Chaman and Hall, 5th ed. (1996). 4. J.C. Kotz, Paul M. Treichel, Grabriela C. Weaver, Chemistry and Chemical Reactivity, 6th Edn. Thomson Books/Cole (2006). 5. F. A. Cotton, G. Wilkinson, P. L. Gauss, Basic Inorganic Chemistry, 3rd Ed.; Wiley, (Reprint 2008). 6. N. N. Greenwood, A. Earnshaw, Chemistry of the Elements, Pergamon Press, 1st Ed.; (1984). 7. Glen E. Rodgers, Inorganic Chemistry, 3rd Edn. Brooks/Cole (2012). 8. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edn (1999). 9. P. W. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, Shriver & Atkins, Inorganic Chemistry, 5th Ed.; Oxford Publications, (2009). 10. J.E. Huheey, E.A. Keiter, R.L. Keiter, U.K. Medhi, Inorganic Chemistry – Principles of structure and reactivity by, 1st impression (2006) Pearson Education Publishers. 11. K. V. S. Laxmi Devi, N. C. Patel, S.S. Dhume, A. Venkatachalam, S. P. Turakhia, Chhaya Dixit and R. A. Mirji, College Inorganic Chemistry for T.Y. B. Sc. 21st Edn, Himalaya Publishing House, (2014). 12. Sharpe, Inorganic Chemistry, 3rd Edn. Pearson Education (2009). 13. Lesley E. Smart, Elaine A. Moore, Solid State Chemistry- An Introduction, 3 rd Edn. Taylor and Francis, (2005)	
Laboratory course: (30 Hrs) (01 credit)		
Course Objectives:	• To use various titrimetric techniques to estimate the analytes. • To perform gravimetric methods to estimate metal ions.	

	• To prepare coordination compounds.	
Content	**Volumetric Analysis** 1. Determination of the strength of the given H2O2 solution using N/20 KMnO4 solution. 2. Estimation of the amount of aluminium in the given aluminium sulphate solution by EDTA method (Back titration). **Gravimetric Analysis** 3. Estimation of iron as Fe2O3 and Ba as BaSO4 from the given solution of ferric chloride, barium chloride and free HCl. 4. Estimation of barium as BaCrO4 from the given solution of barium chloride. 5. Estimation of manganese as manganese pyrophosphate from the given solution of manganese chloride. 6. Estimation of Zn as zinc pyrophosphate in the solution of zinc chloride containing free HCl. 7. Estimation of Ni as Ni-DMG in the solution of nickel chloride containing copper chloride and free HCl. **Inorganic Preparations (ANY TWO)** 8. Bis-(ethylenediamine)copper (II) sulphate. 9. Preparation of diaquabis-(acetylacetonato)nickel (II) 10. Preparation of tris-(ethylenediamine)nickel (II) thiosulphate	4 4 4 2 2 4 4 3 x 2 = 6
Pedagogy	Students should be given suitable explanation revising the theoretical aspects prior to the conduct of each experiment. Pre- and post-laboratory assignments to be given. Each student performs the experiment individually.	
References for practicals	1. Svehla G. Vogel's Qualitative Inorganic analysis. Seventh Edition. Pearson Education Ltd. 2008 2. Vogel's Quantitative Chemical Analysis by Mendham J., Noida Pearson Education India, 6th Edition, 2022. 3. J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, B. Sivasankar, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edn. Pearson Education. 2022 4. O. P. Pandey, D. N. Bajpai and S. Giri, Practical Chemistry, Revised Edn. S. Chand., 2010.	
Course Outcome:	At the end of the course, students will be able to: 1. explain the preparations, chemical properties, structure and bonding in halogen compounds. 2. apply and differentiate VBT and CFT approaches for Metal-ligand bonding. 3. explain the fundamentals of solid-state chemistry, superconductivity and their applications. 4. correlate the concepts of acid bases and non-aqueous solvents 5. perform the redox and complexometric titrations. 6. explain the chemistry behind the strategies used for the removal of interfering ions in gravimetric estimations. 7. apply experimental skills in inorganic preparations.	

Semester VI
Name of the Programme : Industrial Chemistry (Double Major)
Course Code : ICD-302
Title of the course : Instrumentation in Industrial Chemical Analysis
Number of Credits : 2T
Effective from AY : 2025-26

Pre-requisites	Students should have basic knowledge of analytical tools and techniques used in chemical and pharmaceutical industries.	
Course Objectives:	• Describe the principles and procedures of techniques used in pharmaceutical analysis. • Understand the basic principles of ^{1}H NMR spectroscopy and identify molecules based on spectral data. • Learn the principles, instrumentation, and applications of various electroanalytical techniques	
Content		**No. of hours**
	Pharmaceutical Analysis Disintegration Test, Dissolution Test, Uniformity of Weight of Single-Dose Preparations, Uniformity of Content of Single-Dose Preparations, Friability of Uncoated Tablets, Hardness of tablet, Powder Fineness, Particle Size by Microscopy, Particulate Contamination, Karl Fischer titration, High-performance capillary electrophoresis: Introduction, Instrumentation, Control of separation, Applications of CE in pharmaceutical analysis.	**10**
	Nuclear Magnetic Resonance Spectroscopy Basic Principles of 1H NMR spectroscopy, Number of signals, Position of signals, Chemical shift: Reference standard, Shielding and deshielding effect, anisotropic effects in aldehydes, Intensity of signals: Peak area and proton counting. Spin-Spin coupling: Coupling constant (J). Interpretation of NMR spectra of simple compounds. (acetone, acetaldehyde, toluene, ethyl bromide, anisole). Instrumentation & applications. Simple problems based on NMR spectral data for identification of molecule.	**10**
	Electroanalytical Techniques Polarography - Introduction, Dropping mercury electrode (DME), Instrumentation, Ilkovic equation and its verification, Determination of half wave potential, applications. Principles and applications of the following techniques: i. amperometry ii. cyclic voltammetry iii. electrochemical impedance spectroscopy	**10**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References /	1. INDIAN PHARMACOPOEIA, Volume 1, Indian Pharmacopoeia, Ghaziabad,	

Readings	2010. 2. "Principles of Instrumental Analysis" by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, New York, 2017. 3. Instrumental methods of chemical analysis by B K Sharma, Krishna Prakashan Media, Meerut, 2011 4. Industrial Chemistry Vol. I & II by B. K. Sharma, 7th edition, Krisha Prakashan, Meerut, 2014 5. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015 6. Modern Electrochemistry: by J.O.M. Bockris and A.K.N. Reddy, Vol. 1, 2 and 3, Plenum, New York, 1998 7. A. J. Bard, L. R. Faulkner, Electrochemical Methods, Wiley, 2001 8. C. N. Banwell and E. M. McCash, "Fundamentals of Molecular Spectroscopy", 4th Ed., Tata McGraw Hill, New Delhi,1994 9. P.S. Kalsi, Spectroscopy of Organic compounds, New Age International Pub. Ltd. & Wiley Eastern Ltd., Second edition, India, 1995. 10. Instrumental Methods of analysis by Willard, Merrit, Dean and Settle, 7th edition, CBS publisher, New Delhi, 2004.
Course Outcome:	At the end of the course, students will be able to: 1. Recall and explain the principles and procedures involved in various pharmaceutical analysis techniques 2. Interpret ^{1}H NMR spectra and the principles & applications of Nuclear Magnetic Resonance Spectroscopy. 3. Apply their knowledge in quantitative analysis and utilize electro analytical methods for diverse applications in analytical chemistry and materials science.

Name of the Programme : **B.Sc. Industrial Chemistry**
Course Code : **ICD-303**
Title of the course : **Industrial Pharmaceutical Chemistry**
Number of Credits : **3T+1P**
Effective from AY : **2025-26**

Pre-requisites for the Course	Students should have basic knowledge of crude drugs, pharmaceutical excipients and chemistry of pharmaceutical industries.	
Course Objectives:	1. Grasp fundamental drug development concepts, including sources, dosage forms, and routes of administration. 2. Understand major pharmacopoeias, regulatory compliance, and the structure of pharmaceutical laws in India. 3. Acquire knowledge of crude drugs, addressing cultivation, collection, processing, and issues like adulteration. 4. Gain knowledge in evaluating crude drugs and applying various extraction techniques, including modern methods.	
Content		**No. of hours**
	Fundamentals of drug development and regulations Introduction, Drugs, sources of drugs, classification of dosage forms, routes of administration. Historical background and development of pharmaceutical industry in India in brief. Introduction to Pharmacopoeias – Monographs, Development of Indian pharmacopoeias. Introduction to British Pharmacopoeia, United States Pharmacopoeia and European Pharmacopoeia, Drugs & Cosmetics Act 1940, Drugs & Cosmetics Rules 1945 - Introduction, Definitions of various important terms, Study of Schedule G, M (GMP & cGMP). Licensing authorities, controlling authorities.	**07**
	Introduction to Crude Drugs Cultivation, collection and processing of crude drugs (preparation for the market and storage of medical plants). Drug adulteration, deterioration substitution, types of adulterants. Introduction, occurrence and distribution of different phytochemical constituents like alkaloids, glycosides, volatile oils, resins, tannins, carbohydrates, Lipids (fixed oils, fats, waxes) and proteins.	**10**
	Evaluation, Isolation and extraction of Crude Drugs Definition and different methods of evaluation of crude drugs like: Organoleptic, Physical, Chemical, Biological and Microscopical. Introduction to different methods of extraction – maceration, percolation, infusion, decoction, Soxhlet extraction. Introduction to spectroscopic & chromatographic methods of identification of crude drugs.	**10**
	Pharmaceutical Excipients Introduction, classification of various pharmaceutical excipients, their chemistry, uses and quality specifications of glidants, lubricants, binders, diluents, disintegrating agents, coating agents, organoleptic additives, preservatives, antioxidants, buffers,	**10**

	emulsifying agents, suspending agents, viscosity modifiers, gelatine, sorbitol, mannitol, microcrystalline cellulose, pharmaceutical waters.	
	Chemistry of pharmaceutical industries Introduction, classification of drugs, nomenclature, structure activity relationship (SAR), action of drugs, factors affecting drug action, metabolism of drugs, pharmacological activity, Analgesics, antipyretics, diuretics, anaesthetics, antibiotics, anti-inflammatory, antiviral, tranquilizers, antihistamines, cardiovascular, anti-hypertensive, anti-neoplastic, contraceptive, sedatives and hypnotics (definition and examples)	**08**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. A book of Industrial Chemistry by Dr. G. S. Gugale, Dr. A. V. Nagawade, Dr. R. A. Pawar & Dr. K. M. Gadave, 1st edition, Nirali Prakashan, Pune, 2015 2. Textbook of pharmacognosy and phytochemistry by Biren N. Shah & A.K. Seth, First Edition, Elsevier, New Delhi, 2010 3. Trease and Evans Pharmacognosy by William Charles Evans, 16th edition, Elsevier, New York, 2009.	
Laboratory course: (01 credit) 30 hrs		
Course Objectives	1. Develop practical skills in the extraction of active constituents from crude drugs. 2. Learn and perform chemical tests for the identification of different crude drugs. 3. Understand the principles of UV spectrophotometry and its application in pharmaceutical analysis. 4. Understand the principles of complexation reactions and their application in pharmaceutical analysis.	
	1. Extraction of active constituent from crude drugs i) Caffeine from tea powder. ii) Pectin from lemon peel iii) Ammonium Glycyrrhizinate from Liquorice. 2. Chemical tests for identification of any two crude drugs. 3. Preparation of standard calibration curve of drug by UV spectrophotometry. 4. Estimation of drug content from drug dosage form using UV spectrophotometry. 5. Determination of magnesium in antacids by complexometric titration. 6. Determination of calcium in calcium supplements by complexometric titrations. 7. Assay by titration of the following i) Ibuprofen ii) Aspirin	**9** **3** **3** **3** **2** **2** **3**

	8. Separation and identification of pharmaceutical sample using thin layer chromatography. 9. Simultaneous estimation of Ibuprofen and paracetamol in pharmaceutical sample using UV-vis spectrophotometer.	**2** **3**
Pedagogy	Laboratory practicals /industry visits/ self-study or a combination of some of these can also be used. ICT mode may be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. College Industrial chemistry practicals by Patel, Turakhia and Puniyani, Himalaya Publishing House, Mumbai, 2023 2. Sunita Rattan, Experiments in Applied Chemistry, S.K. Kataria & Sons, Second edition, India, 2008 3. Kokate, C. K., Practical Pharmacognosy, 3rd Ed., Vallabh Prakashan, New Delhi. 1991. 4. Furniss, B. S., Hannaford, A. J., Smith P. W. G. and Tatchell, A. R., Vogel's Textbook of Practical Organic Chemistry, 5th edition, Pearson Education Ltd., New Delhi, 2011. 5. Siddique, A.A., Laboratory Manual-Selected experiments in pharmaceutical analysis, 2nd ed., CBS Publishers, India, 2020. 6. Mondal, P.; and Mondal,S., Handbook of Practical, Pharmaceutical Organic, Inorganic and Medicinal Chemistry, Educreation Publishing, New Delhi, 2019.	
Course Outcome:	At the end of the course, students will be able to: 1. Demonstrate strategic awareness in the drug development process, emphasizing regulatory compliance. 2. Apply knowledge of pharmaceutical laws, licensing authorities, and controlling bodies in practical scenarios. 3. Execute effective cultivation, collection, and processing techniques for crude drugs, ensuring quality and authenticity. 4. Develop expertise in extracting active constituents from crude drugs. 5. recognize specific chemical reactions and identify drug components based on qualitative analysis. 6. Estimate drug content in dosage forms, demonstrating their ability to apply UV spectroscopy in pharmaceutical analysis.	

Semester VII
Name of the Programme : Industrial Chemistry (Double Major)
Course Code : ICD-400
Title of the course : Advanced Industrial Inorganic Chemistry
Number of Credits : 3T+1P
Effective from AY : 2024-25

Pre-requisites for the Course:	Students should have basic knowledge of metals and alloys, corrosion chemistry and some inorganic chemical industries.	
Course Objectives:	• To acquire knowledge of metals, alloys, and their applications, emphasizing occurrence, properties, and manufacturing processes. • To understand corrosion mechanisms, economic aspects, and implement effective prevention strategies. • To gain expertise in ceramics, refractories, and the glass industry, covering properties, manufacturing, and applications. • To master processes in inorganic chemical industries, including chlor-alkali production, sulphuric acid manufacturing, and cement production.	
Content		**No. of hours**
	Metals and alloys – important metals and alloys: iron, copper, nickel, and their alloys (Occurrence, mechanical & chemical properties and their application), manufacture of iron (blast furnace), manufacture of steel (Bessemer process, Open Hearth process, Electric furnace method), Preparation of alloys (Fusion, simultaneous electrodeposition, reduction and compression method).	**08**
	Corrosion and its control Introduction, economic aspects of corrosion, dry or chemical corrosion, wet or electrochemical corrosion and its mechanism, galvanic or bimetallic corrosion, concentration cell corrosion, passivity, factors influencing corrosion, prevention of corrosion.	**07**
	Ceramics, refractories & Potteries Ceramics – Introduction, subdivision of ceramics, properties of ceramics, basic raw materials, manufacture of porcelain. Refractories – Classification, properties & manufacture of refractories. Pottery – Introduction, Indian industry and Art pottery.	**07**
	Glass Industry – Introduction, physical & chemical properties of glass, different constituents in glass, raw materials used in manufacture of glass, glass making (pot & tank furnaces), General process of glass making, some special glasses (High silica glass, optical glass, borosilicate glass (Class A), sodalime glass (Class B), coloured glass, safety glass, glass wool), The Indian glass industry	**08**

	Inorganic Chemical Industries **Chlor-alkali Industries:** Manufacture of soda ash, sodium bicarbonate, chlorine and caustic soda, Bleaching powder, calcium and sodium hypochlorite. **Sulphur and sulphuric acid:** Occurrence, mining & refining of sulphur, manufacture of sulphuric acid by Chamber process, Contact process, Oleum manufacture. **Cement:** Types, raw materials, manufacture and process of Portland cement, Setting and hardening of cement, White cement, coloured cement, gypsum.	**15**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Industrial Chemistry by M. G. Arora & M. Singh, Anmol Publisher, New Delhi, 2002. 2. Industrial Chemistry Vol. I & II by B. K. Sharma, 7th edition, Krisha Prakashan, Meerut, 2014 3. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015. 4. Concise Inorganic Chemistry by Lee, J.D., Oxford University Press, 5th edition, UK, 2007. 5. Basic Inorganic Chemistry by Cotton, F.A., Wilkinson, G. & Gaus, P.L., 3rd edition, Wiley, USA, 2007	
Laboratory course: (01 credit) 30 hrs		
Course objectives	1. Develop proficiency in conducting volumetric analysis for the determination of brass components. 2. Gain practical knowledge and understanding the electrochemical principles involved in the process of electrodeposition. 3. Understand the principles behind various analytical methods employed in alloy analysis. 4. Understand the importance of constituents in cement composition.	
Content	1. Analysis of Brass (Volumetrically) 2. Electrodeposition of copper. 3. Analysis of solder. 4. Cement analysis: Analyze the given sample of cement for its following constituents. i) SiO_2 - Gravimetrically ii) Calcium, Volumetrically iii) Iron, Volumetrically 5. To find out the percentage of available chlorine in the given sample of bleaching powder. 6. Analysis of iron ore. 7. Rate of Corrosion w.r.t. Al and Fe plates	**4** **4** **4** **6** **4** **4** **4**
Pedagogy	Laboratory practicals/industry visits/ self-study or a combination of some of these can also be used. ICT mode may be preferred. Sessions should be interactive in nature to enable peer group learning.	

References / Readings	1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, India, 2012. 2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson Education, India, 2009. 3. Practical Chemistry by Sonia Ratnani, Swati Agrawal, Sujeet Mishra, McGraw Hill publication, Meerut, 2020 4. Practical Industrial Chemistry by Zeba N. Siddiqui, Anmol Publication New Delhi, First Edition, 2002.
Course Outcome:	At the end of the course, students will be able to: 1. Demonstrate competence in evaluating and applying properties of metals and alloys for innovative material solutions. 2. Implement effective corrosion control strategies with an understanding of economic implications. 3. Exhibit skill in the production and application of ceramics, refractories, and glass. 4. Demonstrate proficiency in volumetric analysis, accurately determining the components of brass. 5. Acquire practical skills in the electrodeposition of copper. 6. Gain expertise in the analysis of cement, iron ore, solder and understand the role of each constituent in determining the properties of the product.

Name of the Programme : Industrial Chemistry (Double Major)
Course Code : ICD – 401
Title of the course : Advanced Industrial Organic Chemistry
Number of Credits : 2T
Effective from AY : 2024-25

Pre-requisites for the Course	Students should have basic knowledge of some organic chemical industries and industrially important organic compounds.	
Course Objectives:	• To provide students with a comprehensive understanding of the petrochemical industry and the production of various petroleum products. • To acquaint students with the principles and applications of fermentation in industries and emphasize the importance of fermentation in the production of various products. • To delve into the chemistry of soaps and detergents, covering the raw materials, manufacturing processes, and the environmental aspects of detergent production. • To enable students to comprehend the formulation of cosmetics, including skin care and hair care products.	
Content		**No. of hours**
	Petrochemical Industry Introduction, classification, fractionation of crude oil using Bubble cap fractionating column, refining, cracking, polymerization, knocking, types of petroleum products and their applications, octane number, cetane number, flash point, ignition point, auto-ignition point.	**07**
	Fermentation Industry Introduction, importance, basic requirements of fermentation process, factors favoring fermentation, Manufacture of Ethyl alcohol using molasses and starch, Manufacture of vinegar, wine, whisky and rum.	**05**
	Soaps, Detergents and Cosmetics **Soap** Introduction, Chemistry of soap, types of soap, raw materials, manufacture of soap, washing action of soap **Detergents** Introduction, classification, Anionic detergents, Cationic detergents, non-ionic detergents, amphoteric detergents, Eco-friendly detergents, raw materials for detergents, manufacture of detergents, washing action of detergent. **Cosmetics** Skin care: Introduction, raw materials for cosmetics, key ingredients of skin cleansing, toners, Moisturizers, protective sunscreen, talcum powder, bleaching products.	**10**

	Hair care- Introduction, classification of hair care products, ingredients in hair care products, special additives for conditioners and scalp health, hair colorants, herbs used in hair cosmetics	
	Industrially important Organic Compounds Introduction, Chemical processes used in industrial organic synthesis of: Methyl alcohol, Acetic acid, Ethylene Glycol, Glycerin, Formaldehyde, Ethyl acetate and Styrene.	**08**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Unit Processes in Organic Synthesis by P. H. Groggins, 5th edition, McGraw Hill publishers, New Delhi, 2004 2. Industrial Chemistry Vol. I & II by B. K. Sharma, 7th edition, Krisha Prakashan, Meerut, 2014 3. Industrial Chemistry by Dr. Helen Njeri Njenga, African Virtual University, Link read: **https://www.academia.edu/42781438/Prepared_by_Helen_Njeri_NJENGA** 4. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015 5. A book of Industrial Chemistry by Dr. G. S. Gugale, Dr. A. V. Nagawade, Dr. R. A. Pawar & Dr. K. M. Gadave, 1st edition, Nirali Prakashan, Pune, 2015	
Course Outcome:	At the end of the course, students will be able to: 1. Apply their knowledge of petrochemical processes and identify different types of petroleum products and their applications. 2. Demonstrate competence in the fermentation industry and the importance of fermentation in various applications. 3. Analyze the chemistry of soaps and detergents and the mechanisms involved in the washing action of both soaps and detergents. 4. Formulate cosmetics products, including skin care and hair care items, by applying their knowledge of raw materials, key ingredients, and production processes.	

Semester VIII
Name of the Programme : B.Sc. Industrial Chemistry
Course Code : ICD – 402
Title of the course : Study of materials in Industrial Chemistry
Number of Credits : 3T+1P
Effective from AY : 2024-25

Pre-requisites for the Course:	Students should have basic knowledge of nanomaterials, semiconducting materials and catalysis.	
Course Objectives:	• Understand the fundamental principles, history, and terminology of nanoscience and technology, along with exploring various synthetic methods and applications in nanotechnology • Acquire a thorough knowledge of semiconductors, including their classification, doping effects, and the applications of semiconductor devices • Gain proficiency in catalysis, covering the types of catalysis, catalyst preparation, and the application of catalysts in industrially significant processes	
Content		**No. of hours**
	Nanotechnology and its applications: Introduction to nanoscience and technology, terminology and history, morphological, mechanical, electrical, optical and semiconducting properties of nanoparticles, metallic nanoparticles, top-down and top-up fabrication, solution based and vapour phase synthesis, physical and chemical vapour deposition, applications of nanomaterials. **Nanocomposites:** Introduction to Nanocomposites, Composite material, properties of Nano composite material, Synthetic methods for various nanocomposite materials: mechanical alloying, thermal spray synthesis etc. Polymer nanocomposites; Thin film nanocomposites; Applications of nanocomposites.	**15**
	Semiconducting materials Introduction, classification of semiconductors: intrinsic and extrinsic semiconductors, electron-hole recombination, n & p type semiconductor, doping, dopants, effect of doping and temperature on electrical conductivity, donor & acceptor states, Fermi level, carrier concentration, forward & reverse biased conditions of semiconductors, semiconductor devices and their applications: P – N junction, Zener diodes, photodiode, solar cell, light emitting diodes (LED).	**15**
	Catalysis Introduction, types of catalysis, mechanism of catalytic reaction, characteristics of catalyst, preparation of catalyst, promoters, inhibitors and catalytic poisons, parameters affecting catalytic processes, phase transfer catalyst, Industrially important catalyst: Methanol synthesis, Ziegler – Natta catalyst in polymerization of alkenes, zeolites in petroleum cracking,	**15**

	catalytic converters, rhodium catalysed hydroformylation of propene. Photocatalysis: Introduction, mechanism & applications.	
	Total:	**45 hrs**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. The Chemical Process Industries, by R. Norris Shreve Mcgraw-Hill Book Company, New Delhi, Inc. 1945. 2. Industrial Chemistry Vol. I & II by B. K. Sharma, 7th edition, Krisha Prakashan, Meerut, 2014 3. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015 4. Materials Science and Engineering: An introduction by William D. Callister & David G. Rethwisch, 10th edition, United States of America, 2018. 5. Photocatalysis: Principles and Applications, by Rakshit Ameta Suresh C. Ameta, Taylor & Francis Group, New York, 2017. 6. Nanoparticle technology handbook by Makio Naito, Toyokazu Yokoyama, Kouhei Hosokawa & Kiyoshi Nogi, 3rd edition, Elsevier, New Delhi, 2018. 7. Nanomaterials: Synthesis, Properties and Applications Edited by A S Edelstein and R C Cammarata, Paperback edition, UK, 2001	
Laboratory course: (01 credit) 30 hrs		
Course Objectives	1. Develop practical skills in the synthesis of silver nanoparticles through the chemical reduction method and study their optical properties. 2. Explore the characteristics of Light Emitting Diodes (LEDs), gaining hands-on experience in the measurement and analysis of electrical properties. 3. Acquire knowledge about mechanism and the factors influencing the optical properties of carbon-based nanoparticles.	
	1. Synthesis of silver nanoparticles by chemical reduction method using sodium citrate as a reducing agent. 2. Investigation of Optical properties of Ag nanoparticles by using UV-Vis spectroscopy. 3. Preparation of fluorescent carbon nanoparticles by acidic carbonization of sucrose. 4. To study the electrical and semiconducting properties of Diode and LED's. 5. Use of hydrothermal method for the synthesis of nanomaterials. 6. To determine the photocatalytic activity of nanomaterial (TiO_2 / ZnO) through dye degradation using colorimeter. 7. Synthesis of metal oxide nanoparticles by co-precipitation method.	**4** **4** **4** **4** **5** **5** **4**
Pedagogy	Institutional visits/industry visits/ self-study or a combination of some of	

	these can be used. ICT mode may be preferred. Sessions should be interactive in nature to enable peer group learning.
References / Readings	1. Materials Science and Engineering: An introduction by William D. Callister & David G. Rethwisch, 10th edition, United States of America, 2018. 2. Photocatalysis: Principles and Applications, by Rakshit Ameta Suresh C. Ameta, Taylor & Francis Group, New York, 2017. 3. Nanoparticle technology handbook by Makio Naito, Toyokazu Yokoyama, Kouhei Hosokawa & Kiyoshi Nogi, 3rd edition, Elsevier, New Delhi, 2018. 4. Quick and low-cost synthesis of sulphur doped carbon dots by simple acidic carbonization of sucrose for the detection of Fe^{3+} ions in highly acidic environment by V. Naik *et al*., Diamond and Related Materials, Elsevier, 2018 5. Nanomaterials: Synthesis, Properties and Applications Edited by A S Edelstein and R C Cammarata, Paperback edition, UK, 2001 6. B.Sc. Chemistry Experiments by M. S. Hegde, Talent Development Centre, IISc, 2021.
Course Outcome:	At the end of the course, students will be able to: 1. Apply nanoscience and technology concepts to create innovative materials with unique properties, fostering creativity in research and development. 2. Exhibit a deep understanding of semiconductor devices and their applications. 3. Apply knowledge of catalysis to industrial processes, contributing to the development of environmentally friendly and efficient chemical processes. 4. Understand and apply diverse techniques in nanomaterial synthesis, along with the ability to assess and utilize their functional properties in applications such as photocatalysis. 5. Demonstrate competence in synthesizing silver nanoparticles, showcasing practical skills in nanomaterial preparation. 6. Interpret UV-Vis spectroscopy data, providing insights into the optical properties of nanoparticles. 7. Prepare fluorescent carbon nanoparticles and understand their potential applications in various fields.

Name of the Programme : Industrial Chemistry (Double Major)
Course Code : ICD – 403
Title of the course : Selected topics in Industrial Chemistry
Number of Credits : 3T+1P
Effective from AY : 2024-25

Pre-requisites	Students should have basic knowledge of sugar industry, paints and pigments, perfumes, fertilizers and pesticides.	
Course Objectives:	• Provide students with a comprehensive understanding of the sugar industry and to learn the chemistry of dyes, paints, and pigments, including the theory of color, classification, and structure of various dyes. • Enable students to appreciate the chemistry and production processes involved in the manufacturing of perfumes and flavors. • Comprehend the history, classification, and explosive properties of different types of explosives and applications of pesticides, including insecticides, herbicides, fungicides, and rodenticides.	
Content		**No. of hours**
	Sugar Industry Introduction, importance, Manufacture of cane sugar- Raw materials, processes involved, Testing of sugar, utilization of By -products of sugar industries and their economic importance.	**05**
	Dyes, Paints and pigments **Dyes** Introduction, Qualities of good dye, theory of colour – colour and constitution, classification of dyes (chemical constitution and mode of application), Methods of dyeing, Structure and uses of following dyes: Nitro dyes- Picric acid, Martius yellow Azo dyes- Methyl orange, congo red, Chrysoidine Phthaleins- Phenolphthalein Xanthene – Fluorescein, xanthene Thiazine- Methylene blue Anthraquinone dyes- Alizarin Indigoids- Indigo Tryphenylmethane dyes- Malachite green, crystal violet **Paints and pigments** Introduction, distinction between paints and pigments. **Paints:** Classification of paints, constituent of paints, extenders or fillers, film foaming materials, driers, thinners, or diluents, anti-skinning agents, plasticizers, resins, binders, requirement of the good paint, pigment volume concentration (PVC) formula, importance of PVC. Types of paints (only applications are expected), emulsion paints, luminescent paints, heat resistant paints. **Pigments:** Types of pigments, manufacture and uses of the following i) White pigment e.g. White lead (by Dutch process) ii) Blue pigment e.g. Iron blue (by precipitation method) iii) Green pigment e.g. Chrome green	**15**

	iv) Yellow pigment e.g. Chrome yellow.	
	Perfumes and flavours Introduction, Nitro musks such as Musk xylene, Musk ketone, Musk ambrette. Production of natural perfumes, Floral perfumes. Fruit flavours, artificial flavours.	**05**
	Explosives and Toxic chemical weapons Introduction, history of explosives, definition, classification of explosives A) Detonating or high explosives, primary or initiating explosives, secondary high explosives. B) Deflagrating or low explosives, military, and industrial explosives (examples are expected) C) Characteristics of explosives, power of explosion, sensitivity of explosives, heat of explosion, and rate of detonation D) Preparation and explosive properties of i) PETN ii) Nitroglycerine and dynamite iii) RDX or cyclonite (by Wolfram method) E) Toxic chemical weapons with reference to Formula, products per formula weight, heat of explosion, explosion temperature, potential etc.	**08**
	Pesticides Introduction, Classification of insecticides according to their mode of actions. Inorganic insecticides, Natural or Plant insecticides, Organic insecticides e.g., DDT, Methoxychlor, BHC (benzene hexa chloride), Gammexane, Aldrin, Dieldrin, Endrin, Malathion, Parathion (only applications are to be expected). Attractants and Repellents, Fumigants, Miticides, Rodenticides, Fungicides, Herbicides, and Acaricides.	**07**
	Fertilizers Major and minor plant nutrients (mention only their role). Need for fertilizers, fertility of the soil, and pH value of the soil. Classification of the fertilizers, Manufacture of the following fertilizers and their action with soil – $(NH_4)_2SO_4$, Urea, NH_4Cl, triple super phosphate. NPK fertilizers. Pollution caused by fertilizers.	**05**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations / self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. Industrial Chemistry Vol. I & II by B. K. Sharma, 7th edition, Krisha Prakashan, Meerut, 2014 2. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015, 3. Unit Processes in Organic Synthesis by P. H. GROGGINS, 5th edition, McGraw Hill publishers, New Delhi, 2004 4. Industrial Chemistry by Dr. Helen Njeri Njenga, African Virtual University, Link read:	

	https://www.academia.edu/42781438/Prepared_by_Helen_Njeri_NJENGA	
Laboratory course (1 Credit)30 hrs		
Course Objectives:	• Develop proficiency in the synthesis of various dyes. • Acquire knowledge and practical skills in the preparation of inorganic pigments. • Emphasizing analytical techniques such as iodometric titrations and gravimetric analysis commonly used in chemistry laboratories. • Understand the principles of color mixing, pigment compatibility, and formulation to achieve desired shades and hues.	
Content:	1. Synthesis of dyes a) Diazoaminobenzene b) Picric acid 2. Preparation of malachite [$CuCO_3.Cu(OH)_2$] 3. Estimation of copper ions from malachite iodometrically 4. Preparation of chrome yellow 5. Preparation of Prussian blue 6. Preparation of red pigment 7. Preparation of white pigments 8. Preparation of different shades of pigments using different proportions of i. White and blue pigments ii. White and red pigments iii. Yellow and blue pigments iv. Red and yellow pigments v. Red and blue pigments 9. Estimation of calcium in calcium ammonium nitrate fertilizer. 10. Determination of % sulphur in ammonium sulphate by gravimetric analysis.	**3 hours each**
Pedagogy	Industry visits/pre-explanation regarding experiments/laboratory practicals/ self-study or a combination of some of these can also be used. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. College Industrial chemistry practicals by Patel, Turakhia and Puniyani 2. Sunita Rattan, Experiments in Applied Chemistry, S.K. Kataria & Sons, Second edition, 2008	
Course Outcome:	At the end of the course, students will be able to: 1. Apply their knowledge of sugar industry processes, demonstrating an understanding of the raw materials, manufacturing steps, and testing procedures involved in the production of cane sugar. 2. Analyze the chemistry of dyes and to understand the production processes and applications of pigments, with a focus on specific examples. 3. Formulate perfumes and flavors, applying their knowledge of nitro musks, natural perfumes, floral fragrances, and artificial flavors. 4. Evaluate the impact of explosives, understanding their classification, characteristics, and preparation. 5. Assess the classification, modes of action, and applications of pesticides, considering their role in agriculture and potential environmental impact.	

	6. Independently carry out the synthesis of dyes, demonstrating competence in organic chemistry laboratory techniques. 7. Gain practical knowledge in the preparation of malachite, chrome yellow, Prussian blue, and various pigments, understanding the principles of inorganic synthesis. 8. Formulating different shades of pigments, showcasing an understanding of color theory and pigment manipulation.

Name of the Programme : **B.Sc. Industrial Chemistry**
Course Code : **ICD-404**
Title of the course : **Chemical Analysis in Industrial Applications**
Number of Credits : **1T+1P**
Effective from AY : **2024-25**

Pre-requisites for the Course	Students should have basic knowledge of analytical tools and techniques used in chemical and pharmaceutical industries.	
Course Objectives:	• Describe the principles and procedures of techniques used in surface analysis. • Understand the basic principles of Mass spectrometry and identify molecules based on spectral data. • Comprehend the principles and operations of Atomic spectrometric methods.	
Content		**No. of hours**
	Chemical Analysis of surfaces Introduction to photoelectron spectroscopy, Secondary Ion Mass Spectrometry, Auger Electron Spectroscopy. Basic principles, Instrumentation and applications of these techniques.	**05**
	Atomic spectrometric methods Fluorimetry: principles of fluorescence, chemical structure and fluorescence. Relationship between concentration & fluorescence intensity, instrumentation and applications. (numerical problems are expected to be solved)	**04**
	Mass spectrometry Introduction, basic principle, Instrumentation, Ionization methods: Electron ionization (EI), Chemical ionization (CI), Matrix-assisted laser desorption ionization (MALDI). Analyzers: Schematic diagram of quadrupole mass analyzer and Time of-Flight mass analyzers, Advantages of Quadrupole Mass Spectrometer, spectrum resolution. Interpretation of mass spectra: Nitrogen rule, ring plus double bond rule, even electron rule, rule of 13. Applications of mass spectrometry.	**06**
Pedagogy	Mainly lectures and tutorials. Seminars / term papers /assignments / presentations /industry visits/ self-study or a combination of some of these can also be used. ICT mode should be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. "Principles of Instrumental Analysis" by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch, New York, 2017. 2. Instrumental methods of chemical analysis by B K Sharma, Krishna Prakashan Media, Meerut, 2011. 3. Industrial Chemistry Vol. I & II by B. K. Sharma, 7th edition, Krisha Prakashan, Meerut, 2014 4. Engineering chemistry by Jain & Jain. 17th Edition, Dhanpat Rai Publishing company, New Delhi, 2015 5. C. N. Banwell and E. M. McCash, “Fundamentals of Molecular Spectroscopy”, 4th Ed., Tata McGraw Hill, New Delhi,1994	

	6. D. Briggs and M. Seah, "Practical surface analysis by AES & XPS", John Wiley, 1983. 7. P.S. Kalsi, Spectroscopy of Organic compounds, New Age International Pub. Ltd. & Wiley Eastern Ltd., Second edition, India, 1995. 8. Instrumental Methods of analysis by Willard, Merrit, Dean and Settle, 7th edition, CBS publisher, New Delhi, 2004.	
Laboratory course: (30 hrs) (01 credit)		
Course objectives	1. Develop proficiency in interpreting Mass spectra. 2. Gain practical knowledge of XPS techniques and data analysis in surface science. 3. Understand the principles of quantitative analysis using spectrophotometry. 4. To learn different chromatographic technique.	
Content	1. Interpretation of mass spectra a) Mass spectrum of simple organic compounds (8 compounds) 2. To plot XPS data using data plotting software. (3 compounds) 3. Purity of two pharmaceutical samples (paracetamol and ibuprofen) spectrophotometrically. 4. To estimate the Quinine sulphate in given sample by Fluorimetry. 5. Separation of chlorophyll and xanthophyll from plant extract by paper Chromatography /Thin Layer Chromatography. 6. Determination of ion exchange capacity of the given cation/anion exchange resin. 7. Zn2+ & Mg2+ separation by an anion exchanger & volumetric estimation of Magnesium and zinc with standard EDTA.	**6** **6** **4** **3** **3** **4** **4**
Pedagogy	Laboratory practicals/industry visits/ self-study or a combination of some of these can also be used. ICT mode may be preferred. Sessions should be interactive in nature to enable peer group learning.	
References / Readings	1. College Industrial chemistry practicals by Patel, Turakhia and Puniyani, Himalaya Publishing House, Mumbai, 2023 2. Sunita Rattan, Experiments in Applied Chemistry, S.K. Kataria & Sons, Second edition, New Delhi, 2008 3. Kokate, C. K., Practical Pharmacognosy, 3rd Ed., Vallabh Prakashan, New Delhi. 1991. 4. Anil J. Elias, Collection of Interesting chemistry experiments, University 5. Press (India) private limited, Hyderabad 2002 6. John Kenkel, Analytical chemistry for Technicians 4th edition, CRC press, Tylor & Francis Group, Boca Raton, London 2002.	
Course Outcome:	At the end of the course, students will be able to: 1. Interpret mass spectra and the principles & applications of surface analysis techniques. 2. Apply their knowledge in quantitative analysis, & utilize Atomic spectrometric methods for diverse applications in analytical chemistry and materials science. 3. Plot XPS data using specialized software for different compounds, demonstrating their understanding of surface analysis techniques.	

	4. Demonstrate competence in conducting a spectrophotometric assay for pharmaceutical drugs. 5. Perform separation and estimation using different chromatographic techniques.