**DEPARTMENT OF CHEMISTRY**
**EVALUATION SCHEME OF UG & PG PROGRAM AS PER NEP-2020**
**w.e.f. July, 2024-25**
**B.Sc. in Industrial Chemistry with Honours**
**3rd Year / 5th Semester**

| S. No. | Course Code | Course Title | (T)Theory (P) Practical | Course Type | Periods per Week | | | Evaluation Scheme | | | End Semester | Subject Total | Total Credit | Attributes | | | | | | | United Nations Sustainable Development Goals (SDGs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lecture | Tutorial | Practical | Class Test | Teacher Assessment | Total | | | | Employability | Entrepreneurship | Skill Development | Gender Equality | Environment & Sustainability | Human Values | Professional Ethics | |
| **1.** | B190501T/CH331 | Industrial Chemicals | T | Core Major | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | ✓ | | ✓ | | ✓ | | |  |
| **2.** | B190502T/CH332 | Pollution, its Management, and Industrial Economics | T | | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | ✓ | | ✓ | | ✓ | | |  |
| **3.** | B190503P/CH333 | Industrial Chemicals and pollution Management | P | | - | - | 4 | 15 | 10 | 25 | 75 | 100 | 02 | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |  |
| **4.** | B020503P/CH339 | Qualitative Analysis | P | | - | - | 4 | 15 | 10 | 25 | 75 | 100 | 02 | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |  |
| **5.** | B190504T/CH334 | Industrial Aspects of Chemistry | T | | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | ✓ | | ✓ | | | | |  |
| **6.** | B190505T/CH335 | Food and Dairy Chemistry | T | | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | ✓ | | ✓ | | ✓ | | |  |
| **7.** | B190504R/CH336 | Industrial Chemistry Research Project-1 | P | Research Project | - | - | 10 | - | - | - | - | 100 | 05 | ✓ | ✓ | ✓ | | ✓ | | |  |
| **TOTAL** | | | | | **12** | **04** | **18** | **90** | **60** | **150** | **450** | **700** | **25** | | | | | | | | |

| Effective from Session: 2024-25 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190501T/CH331 | **Title of the Course** | Industrial Chemicals | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Fifth | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | The chemical industry comprises the companies that produce industrial chemicals. Central to the modern world economy, it converts raw materials into more than 70,000 different products. On successful completion of this course, students will gain knowledge and skills related to various industrial gases, petroleum refining processes, carbon-based chemicals and industrial catalysts, the pulp and paper industry, surfactants, soaps, detergents, and cosmetics, the cane sugar industry, the manufacture of heavy organic chemicals, heavy inorganic chemicals, and fine chemicals. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Students would be able to create key knowledge for the manufacturing of $N_2$, $O_2$, $H_2$, $CO_2$, and petroleum refining processes. |
| **CO2** | Students would be able to evaluate and analyze the physical and chemical properties of carbon-based chemicals, industrial catalysts, and adhesives. |
| **CO3** | Students would be able to analyze and understand the chemistry of surfactants, soaps, detergents, cosmetics, and cane sugar. |
| **CO4** | Students would be able to perceive the sound knowledge of methods for the formation and manufacture of heavy organic and inorganic chemicals. |
| **CO5** | Students will be able to gain knowledge of methods of formation, raw materials, production processes, quality control, hazards and safety, and effluent management. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Industrial gases | Manufacture, uses and economics of $N_2$, $O_2$, $H_2$, $CO_2$. | 6 | 1, |
| 2 | Petroleum refining process | Introduction, distillation, octane number, additives, hydro treating, cracking, reforming, alkylation and polymerization, separation of natural gas (methane production). | 8 | 1 |
| 3 | Carbon based chemicals and industrial catalysts. | Manufacture, properties and uses of methanol, formaldehyde, acetic acid, chlorofluoro carbons and fluorocarbons. Industrial catalysts like raney nickel, other forms of nickel, palladium and supported palladium, copper chromate, vanadium and platinum-based catalyst, aluminiumalkoxides, titanium tetrachloride and titaniumdioxide. | 8 | 2 |
| 4 | Adhesive: | Introduction, Classification of adhesives, adhesives action, development of adhesive strength, chemical factors influencing adhesive action. | 6 | 2 |
| 5 | Surfactants, soaps, detergents, and cosmetics: | Introduction, cationic and anionic surfactants, straight chain detergent intermediates linear alcohol sulphates (AS), linear alcohol ethoxysulphates (AES) and linear alkyl benzene sulfonates (LAS), amphoterics and detergent builders Definition and characteristics of cream, hair dyes, toothpaste, talcum powder, sun tan lotion, perfumes and essentialoils. | 8 | 3 |
| 6 | Cane sugar industry: | Manufacture of white crystalline sugar, extraction of the juice, clarification (lime defection process, by sulphate ion and by carbonation), evaporation, crystallization and refining of sugar, uses of bagasse. | 8 | 3 |
| 7 | Manufacture of heavy organic and inorganic chemicals | **Manufacture of heavy organic and inorganic chemicals (with respect to raw material, production process, quality control, hazards and safety, effluent management):**<br>***Heavy organic chemicals:***<br>Fischer-tropsch synthesis, applications, and uses of zeolites as catalyst, propyl alcohol, 1,4- butanediol, vinyl chloride, pyridines, picolines, phthalic anhydrides, glycerol, sorbitol, chloroform, ethanolamine.<br>***Heavy inorganic chemicals:***<br>Ammonium phosphates, carbonblacks, manufacture of graphite and carbon, calciumcarbide, silicon carbide, sodium thiosulphate, borax and boric acid. | 8 | 4 |
| 8 | Manufacture of fine chemicals | **Manufacture of fine chemicals (with respect to Raw material, Production process, Quality control, Hazards and safety, Effluent management):**<br>Sodium borohydrate, lithium aluminium hydride, sodium ethoxide, paracetamol, indigo, vat dyes. Essential oils, surfactants and emulsifying agents, coloring agents-manufacture of some natural and synthetic colors. Flavouring agents-fragrance and food additives. Biochemical reagents-ninhydrin, tetrazolium blue, 1,2-naphthaquinone-4-sulphonate. | 8 | 5 |

**Reference Books:**


1. B. K. Sharma, Industrial Chemistry, GOEL Publishing House (2000).
2. M. Fahim, T. Al-Sahhaf, A. Elkilani, Fundamentals of Petroleum Refining, 1st edition, Elsevier Science (2010).
3. Pesticide Calcer Publication, P. B.Pandey.
4. Principle Industrial Chemistry, C. A. Clausion, G. C.Mattson, Wiley(1978).
5. W. L. Mc. Cabe, J. C. Smith &Parriet , Unit Operators of Chemical Engineering, Mc. Graw Hill Book Company Singapore(2017).
6. A. F. Mills. Heat Transfer, CRC Press, (1992).
7. K.W. Britt, Handbook of pulp and paper technology Book on Pulp & Paper Industries, 2Ed(2004).


**e-Learning Source:**

1. https://nptel.ac.in/courses/103/107/103107082/
2. https://nptel.ac.in/courses/103/103/103103029/
3. https://nptel.ac.in/courses/103/106/103106108/
4. https://nptel.ac.in/courses/104/105/104105103/

| | Course Articulation Matrix: (Mapping of COs with POs and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 1 | 2 | - | - | - | 1 | - | 2 | - | - | 2 | 1 |
| **CO2** | 2 | 1 | - | - | - | 2 | - | 2 | - | - | 1 | 2 |
| **CO3** | 1 | 1 | - | - | - | 1 | - | 3 | - | - | 3 | 1 |
| **CO4** | 3 | 3 | - | - | - | 2 | - | 2 | - | - | 1 | 1 |
| **CO5** | 2 | 1 | - | - | - | 12 | - | 2 | - | - | 3 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

SDGs -9

| Effective from Session: 2024-25 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190502T/CH332 | **Title of the Course** | Pollution its Management, and Industrial Economics | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Fifth | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | Students gain knowledge and skills related to this paper as follows: Pollutants, their statutory limits, air pollution, water pollution, pesticide pollution, solid and gaseous wastes, factors involved in project cost estimation, capital formation, methods of determining depreciation, some aspects of marketing, pricing policy, profitability criteria, entrepreneurship, choice of technology, and quality control. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Students would be able to remember and apply the various principles of environmental pollutants, their statutory limits, and air pollution. |
| **CO2** | Students would be able to evaluate and analyze the environmental pollution and pesticide pollution. |
| **CO3** | Students would be able to understand and evaluate the physical and chemical properties, factors involved in project cost estimation, methods employed for the estimation of capital investment, and capital formation. |
| **CO4** | Students would perceive the sound knowledge of methods of determining depreciation, some aspects of marketing, pricing policy, profitability criteria, the economics of selecting alternatives, |
| **CO5** | Students will be able to gain knowledge of plant, equipment and quality control. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Pollutants, their statutory limits and air pollution | Pollutants, their statutory limits and air pollution:<br>Definition and classification of pollutants, primary and secondary pollutants, pollution evaluation methods, sources and classification of air pollution, major air pollutants and their health impacts, phenomenon of acid rain, photo chemical smog and ozonedepletion,composition of fly-ash, pollution control equipment/techniques. | 6 | 1 |
| 2 | Environmental pollution | Environmental pollution:<br>Sources, causes and effects of<br>1.Soil pollution<br>2.Water pollution<br>3.Air pollution<br>4.Noise pollution | 8 | 1 |
| 3 | Basics of Environmental pollution | Basics of Environmental pollution:<br>Meanings of some important terminologies<br>1.Global warming<br>2.Acid rain<br>3.Algal blooms<br>4.Carbon footprint<br>5.Greenhouse effect<br>6.Hazardous waste<br>7.Incineration<br>8.Landfill<br>9.Oil spill<br>10.Ozone depletion<br>11.Particulate matter<br>12.Radiation | 8 | 2 |
| 4 | Pesticide pollution | *Pesticide pollution* Classification of chemical pesticides, examples of organo-chlorines and organophosphates, persistent organic pollutants (POPs) and their half-lives, environmental effects of pesticides, soil and water contamination and its impact, bioaccumulation of pesticides and pesticide contamination in food. | 6 | 3 |
| 5 | Soil economics A | Factors involved in project cost estimation, methods employed for the estimation of capital investment, capital formation, elements of cost accounting, interest and investment costs, and time value of money equivalence. | 8 | 3 |
| 6 | Soil economics B | Methods of determining depreciation, some aspects of marketing, pricing policy, profitability criteria, economics of selecting alternatives, variation of cost with capacity, break-even point, optimum batch sizes, production scheduling etc. | 8 | 3,4 |
| 7 | Soil economics C | Need, scope and characteristics of entrepreneurship, special schemes for technical entrepreneurs' development (STED), exposure to demand based, resource based, service based, import substitute and export promotion industries, criteria for principles of products selection and developments. | 8 | 4 |
| 8 | Choice of technology and quality control | Plant and equipment, techno-economic feasibility of the projects, plant layout and process planning for the project. Quality control, quality assurance and testing of the product, packaging, advertising and after sales service. | 8 | 5 |

**Reference Books:**


1.R.K. Trivedy, N.S. Raman, Industrial Pollution and Environmental Management, Scientific Publishers Journals(2002).
2.M. Brusseau, I. Pepper, C. Gerba, Environmental and Pollution Science, Third Edition, Elsevier Science(2019).
3.H. S. Rathore, L.L.L. Nollet, Pesticides: Evaluation of Environmental Pollution, CRC Press(2012).
4.B. K. Sharma, Industrial Chemistry (including Chemical Engineering), GOEL Publishing House(2000).
5.P. F. Rad, Project Estimating & Cost Management, BerrettKochler Publisher(2001).


**e-Learning Source:**

1.https://nptel.ac.in/courses/105/103/105103205/
2.https://nptel.ac.in/courses/126/105/126105016/
3.https://nptel.ac.in/courses/126/105/126105010/

4.https://nptel.ac.in/courses/105/102/105102089/
5.https://nptel.ac.in/courses/122/106/122106030/
6.https://nptel.ac.in/content/storage2/courses/120108004/module1/lecture1.pdf

| | Course Articulation Matrix: (Mapping of COs with POs and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 1 | 2 | - | - | - | 1 | - | 2 | - | - | 2 | 1 |
| **CO2** | 2 | 1 | - | - | - | 2 | - | 2 | - | - | 1 | 2 |
| **CO3** | 1 | 1 | - | - | - | 1 | - | 3 | - | - | 3 | 1 |
| **CO4** | 3 | 3 | - | - | - | 2 | - | 2 | - | - | 1 | 1 |
| **CO5** | 2 | 1 | - | - | - | 12 | - | 2 | - | - | 3 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

| Effective from Session: 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190503P /CH333 | **Title of the Course** | Industrial chemicals and pollution management | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Fifth | 0 | 0 | 8 | 4 |
| **Pre-Requisite** | 10+2 | **Co-requisite** | - | | | | |
| **Course Objectives** | The course objective is to provide knowledge and skills encompassing the determination of flash and fire points, the analysis of (i) the acid value for gum and resin, (ii) the iodine number for linseed oil and castor oil, and (iii) the saponification value for coconut oil, as well as the synthesis of organic compounds including paracetamol, aspirin, oils of wintergreen, and urea formaldehyde resin, and the analysis of common raw materials according to industrial specifications such as phenol, aniline, formaldehyde, hydrogen peroxide, and acetone, involving both gravimetric and volumetric estimations. | | | | | | |

| Course Outcomes | |
|---|---|
| **CO1** | Students would be able to determine and evaluate flash and fire points, as well as acid value, gum, and resin. |
| **CO2** | Students would be able to understand and analyze iodine numbers (linseed oil), castor oil, saponification values (coconut oil). |
| **CO3** | Students would be able to perform and analyze the synthesis of organic compounds: paracetamol, aspirin, oils of winter green, and urea formaldehyde resin. |
| **CO4** | Students would be able to understand the synthesis of various organic compounds. |
| **CO5** | Students would be able to analyze common raw materials as per industrial specifications, such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone, gravimetric, and volumetric estimations. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Qualitative and quantitative analysis | Determination of flash and fire point<br>Determination of (i) acid value- gum and resin (ii) iodine number- linseed oil, castor oil (iii) saponification value - coconut oil. | 15 | 1,2 |
| 2 | Synthesis of organic compound | Each step reaction monitors by TLC.<br>Paracetamol, Aspirin, oils of winter green and urea formaldehyde resin. | 15 | 3 |
| 3 | Industrial analysis | Analysis of common raw materials as per the industrial specifications such asphenol, aniline, formaldehyde, hydrogen peroxide, acetone, etc. | 15 | 3,4 |
| 4 | Gravimetric and volumetric estimations | Gravimetric and volumetric estimations. | 15 | 3 |

**Reference Books:**


1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. 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.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Harris, D.C.Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
6.


**e-Learning Source:**

1. https://www.labster.com/chemistry-virtual-labs/
2. https://www.vlab.co.in/broad-area-chemical-sciences
3. http://chemcollective.org/vlabs

| | Course Articulation Matrix: (Mapping of COs with POs and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 3 | - | - |
| **CO2** | 2 | 2 | 1 | - | 2 | - | - | - | 1 | 2 | - | - |
| **CO3** | 2 | 3 | 1 | - | 1 | - | - | - | 3 | 2 | - | - |
| **CO4** | 3 | 2 | 1 | - | 1 | - | - | - | 2 | 3 | - | - |
| **CO5** | 2 | 3 | 1 | - | 1 | - | 2 | - | 1 | 2 | - | - |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

| Effective from Session: 2024-25 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190505T/CH334 | **Title of the Course** | Industrial Aspects of Chemistry | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Fifth | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | The main goal of this course is to provide knowledge of the various properties and roles of organometallic reagents in the synthesis of organic compounds such as Grignard reagents, organo-lithium, zinc, copper, palladium, nickel compounds, lithium aluminium hydride, sodium borohydride, alkoxides, boron aluminium hydride, organosilicon, gano-palladium, and lithium organo-cuprates compounds. Also introduce carbon nanotubes: synthesis, structure, characterization, mechanism, modification, and applications. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Students would be able to remember and evaluate the fundamentals of arenes, aromatic reagents, alkyl, and aryl halides. |
| **CO2** | Students will be able to think about and use the physical and chemical properties of monohydric and dihydric alcohols, including how they are named, how they are made, and how they react with aldehydes, ketones, carboxylic acids, and esters. |
| **CO3** | Students would be able to understand the chemical reactions of aldehydes and ketones. |
| **CO4** | Students would perceive the sound knowledge of methods and techniques in organic synthesis and organometallic reagents. |
| **CO5** | Students will be able to develop, create, and evaluate organic synthesis. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Arenes and Aromatics | Nomenclature of benzene derivatives. Kekule structure of benzene, Stability and carbon-carbon bond lengths of benzene, resonance, Huckel rule of aromaticity, Aromatic electrophilic substitution general pattern of the mechanism, Mechanism of nitration, halogenation. Sulphonation and Friedel-Crafts reaction. | 6 | 1, |
| 2 | Alkyl and Aryl Halides | Nomenclature, classification, methods of formation and chemical reactions of alkyl halides. Mechanims of nucleophilic substitution reaction of alkyl halides (SN1 and SN2 reactions) with energy profile diagrams. | 8 | 1 |
| 3 | Alcohols | Monohydric alcohols- nomenclature, methods of formation, reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature, Reactions of alcohols. Dihydric alcohols - nomenclature, methods of formation, chemical reactions of vicinal glycols and pinacol-pinacolone rearrangement. Trihydric alcohols –nomenclature, methods of formation and chemical reactions of glycerol. | 8 | 2 |
| 4 | Aldehydes and Ketones | Synthesis of aliphatic aldehydes and ketones with particular reference to acid chlorides, alcohols, carboxylic acids, Grignard reagent, alkenes and 1,3-dithianes. Synthesis of aromatic aldehydes by oxidation of alkyl benzene, Reimer-Tiemann reaction, gattermann-koch reaction and aromatic ketones by Friedal craft acylation. | 6 | 2 |
| 5 | Chemical Reaction of Aldehydes and Ketones | Mechanism of nucleophilic additions to carbonyl group with particular reference: aldol condensation, Cannizzaro reaction. Perkin reaction, Wittig reaction, Mannich reaction. Baeyer-Villiger oxidation, Meerwine Pondor of Verlay reduction, Clemmensen reduction and Wolff-Kishner reduction. | 8 | 3 |
| 6 | Techniques in Organic Synthesis | Bio-tranformatons – Enzyme catalysed reactions, Microwave induced reactions- Principle, conditions, advantages over conventional heating methods- Applications, sonication. | 8 | 4 |
| 7 | Organometallic Reagents | Synthesis and applications of Grignard reagents-organolithium, Zinc, Copper, Palladium, Nickel compounds in organic synthesis- Homogeneous catalytic reactions hydrogenation, hydroformylation. | 8 | 4 |
| 8 | Methods in Organic Synthesis | Organosilicon Compounds: Preparation and applications in organic synthesis; Applications of Pd (0) and Pd (II) complexes in organic synthesis- Suzuki and Sonogashira coupling, Heck reaction, Preparation and applications of lithium organocuparates.<br>Reduction with lithium aluminium hydride, sodium borohydride, alkoxides, bismethoxy ethoxy aluminium hydride, boron aluminium hydride and derivatives-catalytic<br>metal hydrogenation-dissolving metal reductions, Non-metallic reducing agents including enzymatic and microbial reductions. | 8 | 5 |

**Reference Books:**


1. Advanced Organic Chemistry, Bahl&Bahl, S. Chand & Co. Ltd.
2. Organic Chemistry Vol.I& II, I.L. Finar
3. Fundamentals of Organic Chemistry, NafisHaider, S. Chand & Co. Ltd.
4. Organic Chemistry Vol.I, II & III, Dr. Jagdamba Singh, L.D.S. Yadav, PragatiPrakashan


**e-Learning Source:**

1.https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Map%3A_Organic_Chemistry_(Smith)/Chapter_06%3A_Understanding_Organic_Reactions
2.https://www.dummies.com/education/science/biology/the-basics-of-organic-chemistry/
3.https://www.toppr.com/guides/chemistry/organic-chemistry/

| | Course Articulation Matrix: (Mapping of COs with POs and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |

| CO | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | - | - | - | 1 | - | 2 | - | - | 2 | 1 |
| **CO2** | 2 | 1 | - | - | - | 2 | - | 2 | - | - | 1 | 2 |
| **CO3** | 1 | 1 | - | - | - | 1 | - | 3 | - | - | 3 | 1 |
| **CO4** | 3 | 3 | - | - | - | 2 | - | 2 | - | - | 1 | 1 |
| **CO5** | 2 | 1 | - | - | - | 1 | - | 2 | - | - | 3 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

| Effective from Session: 2024-25 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190506T/CH335 | **Title of the Course** | Food and Dairy Chemistry | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Fifth | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | The course objective is to provide knowledge of food constituents, food additives, and food processing techniques. The study of food laws and standards informs students about quality and safety assurance and food-related hazards. To introduce students to an understanding of the chemistry of milk constituents. Milk and various dairy products are discussed from the perspective of the chemical, physical, and biological changes that occur during processing. | | | | | | |

| Course Outcomes | |
|---|---|
| **CO1** | Students would be able to understand Indian food law and food standards, the value of quality assurance, and safety assurance. |
| **CO2** | Students would be able to evaluate and develop the chemical structure and properties and argue the importance of food components, including carbohydrates, protein, lipids, vitamins, and minerals. |
| **CO3** | Students would be able to describe the principles of food processing techniques and differentiate food preservation methods like heat preservation and cold preservation, as well as food packaging. |
| **CO4** | Students will be able to describe the composition of milk, identify the approximate content, integrate their knowledge of food chemistry, and describe the physicochemical characteristics of the main components. |
| **CO5** | The student will be able to explain how dairy products (such as fluid milk, yoghurt, butter, powder, and cheese) are made and the key functions of the processing steps involved. Furthermore, students will be able to explain and apply the processing techniques to produce milk products such as butter, cream, ghee, etc. and detect adulteration. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Governmental regulations | Introduction, Food laws and standards: Indian food safety laws and standards; Quality and safety assurance in food industry; BIS Laboratory Services and Certification by BIS. | 6 | 1, |
| 2 | Constituents of food and their nutritive aspects | Carbohydrates, Proteins, Fats and oils, Vitamins and Minerals. | 8 | 1 |
| 3 | Food processing techniques | Common unit operations, Food deterioration and their control; Heat preservation and processing, Cold preservation and processing Food dehydration, Food concentration & food packaging. | 8 | 2 |
| 4 | Food additives | Preservatives, Antioxidants, Chelating agents, Surface active agents, Stabilizing and Thickening agents, buffering agents, Coloring agents, Sweetening agents & Flavoring agents. | 6 | 2 |
| 5 | Food safety, risks and hazards | Food related Hazards, Microbiological Considerations in food safety, Effects of processing and storage on microbial safety, Chemical hazards associated with foods, Prevention methods from food born disease. | 8 | 3 |
| 6 | Properties of milk | Definition, Composition, Milk lipids, Milk proteins, vitamins, and minerals. Factors affecting the composition of milk, adulterants, preservatives. Carbohydrates, Proteins, Fats and oils, Vitamins and Minerals. | 8 | 4 |
| 7 | Processing of milk | Effect of heat on milk, chemical changes taking place in milk due to processing, sterilization, homogenization and pasteurization, vacuum pasteurization, and ultra-high temperature pasteurization. | 8 | 4 |
| 8 | Milk products | Cream; definition, chemistry of creaming process. Butter: definition, composition, theory of churning, desi butter, salted butter. Ghee; major constituents, common adulterants and their detection. Fermentation of milk; definition and conditions. Ice cream. Composition, types, manufactures of ice - cream, stabilizers, emulsifiers, and their role. Milk powder, process of making milk powder. | 8 | 5 |

**Reference Books:**


Food Chemistry, Belitz and Gosch, Springer – Verlag Bertin Heiderberg, 2nd Edition, 1999
Principles of Human Nutrition, Martin Eastwood, Chapman and Hall, London, I Edition, 1997.
Food – The Chemistry of its Components, T.P. Coultate, Royal Soc. Chemistry, 4th Edition, 2002.
Food additives, Branan, Alfred Larry, Davidson P. Michae, Food Science and Technology series (35), Morcel Dekker, Inc, 1990.
Applied Chemistry-K.Bagavathi Sundari MJP Publishers Chennai. 2006.
Principles of dairy technology - Robert Jenness
Indian Dairy Products - Rangappa and Acharya, K.T.
Fundamentals of Dairy chemistry - Wond. F.P. Springer


**e-Learning Source:**

http://www.basicknowledge101.com/pdf/Food%20chemistry.pdf
https://courses.foodcrumbles.com/courses/food-chemistry-basics/
https://www.cabdirect.org/cabdirect/abstract/19710406009
https://byjus.com/chemistry/food-chemistry/
https://www.youtube.com/watch?v=S4brYhScYlc
http://ouat.nic.in/sites/default/files/2-properties_of_milk_dairy_and_food_engineering.pdf

| | Course Articulation Matrix: (Mapping of COs with POs and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 1 | 2 | - | - | - | 1 | - | 1 | - | - | 2 | 3 |
| **CO2** | 2 | 3 | - | - | - | 2 | - | 2 | - | - | 1 | 2 |
| **CO3** | 3 | 1 | - | - | - | 1 | - | 1 | - | - | 3 | 1 |
| **CO4** | 3 | 3 | - | - | - | 2 | - | 2 | - | - | 1 | 3 |
| **CO5** | 1 | 1 | - | - | - | 1 | - | 2 | - | - | 1 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

| Effective from Session: 2024-25 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190504R/CH336 | **Title of the Course** | Industrial Chemistry Research Project-1 | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Fifth | 0 | 0 | 10 | 5 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | To provide the industrial exposure and enhance technical skills of students | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Hands on training |
| **CO2** | Integrate classroom theory with laboratory practice. |
| **CO3** | Understanding professional ethics of industry and code of conduct. |
| **CO4** | Essential training in laboratory safety procedures |
| **CO5** | Compilation of data and report writing |

| | **Course Articulation Matrix: (Mapping of COs with POs and PSOs)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 1 | 2 | 3 | 1 | 2 | 1 | - | - | 2 | 2 | 2 | 1 |
| **CO2** | 2 | 1 | 1 | 2 | 1 | 2 | - | - | 3 | 2 | 1 | 1 |
| **CO3** | 1 | 1 | 3 | 3 | 1 | 3 | - | - | 3 | 3 | 2 | 1 |
| **CO4** | 1 | 3 | 2 | 1 | 1 | 1 | - | - | 2 | 3 | 1 | 1 |
| **CO5** | 2 | 2 | 1 | 3 | 3 | 1 | - | - | 3 | 2 | 1 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

# Integral University, Lucknow

| **Effective from Session:** 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190503P/CH339 | **Title of the Course** | Quantitative Analysis | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Fifth | **0** | **0** | **4** | **2** |
| **Pre-Requisite** | 10+2 | **Co-requisite** | - | | | | |
| **Course Objectives** | The main objective of this course is to deliver essential knowledge of laboratory techniques for the analysis of inorganic salts, the identification of functional groups, and the separation of organic mixtures. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Students would be able to understand the laboratory methods and tests related to inorganic mixtures and organic compounds. |
| **CO2** | Students would be able to identify acids and basic radicals in an inorganic mixture. |
| **CO3** | Students would be able to perform and analyse the separation of organic compounds from mixtures. |
| **CO4** | Students would be able to understand the elemental analysis of organic compounds. |
| **CO5** | Students would be able to identify and analyse functional groups in organic compounds and identify organic compounds. |

| **Unit No.** | **Title of the Unit** | **Content of Unit** | **Contact Hrs.** | **Mapped CO** |
|---|---|---|---|---|
| 1 | Inorganic Qualitative Analysis | Semi micro-Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals-2 +4 or 4+ or 3+3 | 16 | 1,2 |
| 2 | Elemental analysis and identification of functional groups | Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds. | 14 | 2,3 |
| 3 | Separation of Organic Mixture | Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and purification of suitable derivatives | 10 | 2,4 |
| 4 | Identification of organic compounds | Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives. Identification of the organic compounds by IR and NMR Spectroscopy. (Photocopies of the spectra to be provided to the students) | 20 | 2,5 |

**Reference Books:**


Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.

Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

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

Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960

Harris, D.C.Exploring Chemical Analysis, 9thEd. New York, W.H. Freeman, 2016

Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009. Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University


**e-Learning Source:**

https://www.labster.com/chemistry-virtual-labs/

https://www.vlab.co.in/broad-area-chemical-sciences

http://chemcollective.org/vlabs

| | **Course Articulation Matrix: (Mapping of COs with POs and PSOs)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 1 | 2 | - | 1 | 2 | - | 3 | 2 | 2 | 1 | - | - |
| **CO2** | 2 | 3 | - | 1 | 1 | - | 2 | 1 | 3 | 2 | - | - |
| **CO3** | 3 | 2 | - | 1 | 2 | - | 2 | 2 | 2 | 1 | - | - |
| **CO4** | 2 | 3 | - | 1 | 1 | - | 3 | 2 | 3 | 2 | - | - |
| **CO5** | 3 | 1 | - | 1 | 2 | - | 3 | 2 | 3 | 3 | - | - |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

SDG 4

**DEPARTMENT OF CHEMISTRY**
**EVALUATION SCHEME OF UG & PG PROGRAM AS PER NEP-2020**
**w.e.f. July, 2024-25**
**B.Sc. in Industrial Chemistry with Honours**
**3rd Year / 6th Semester**

| S. No. | Course Code | Course Title | (T)Theory (P) Practical | Course Type | Periods per Week | | | Evaluation Scheme | | | End Semester | Subject Total | Total Credit | Attributes | | | | | | | United Nations Sustainable Development Goals (SDGs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lecture | Tutorial | Practical | Class Test | Teacher Assessment | Total | | | | Employability | Entrepreneurship | Skill Development | Gender Equality | Environment & Sustainability | Human Values | Professional Ethics | |
| 1. | B020601T/CH353 | Organic Synthesis-B | T | Core Major | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | √ | | √ | | | | | |
| 2. | B020602T/CH354 | Chemical Energetics and Radiochemistry | T | | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | √ | | √ | | √ | | | |
| 3. | B020603P/CH355 | Analytical Methods | P | | - | - | 4 | 15 | 10 | 25 | 75 | 100 | 02 | √ | √ | √ | | √ | √ | √ | |
| 4. | B190604R/CH346 | Industrial Chemistry Research Project-2 | R | Research Project | - | - | 10 | - | - | - | - | 100 | 05 | √ | √ | √ | | √ | √ | √ | |
| **POLYMER SCIENCE (01*)** | | | | | | | | | | | | | | | | | | | | | |
| 5. | B190601T/CH343 | Synthetic Polymer | T | Core Major | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | √ | √ | √ | | | | | |
| 6. | B190602T/CH344 | Polymerization Techniques and Characterization | T | | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | √ | √ | √ | | | | | |
| 7. | B190603P/CH345 | Synthesis and Analysis of Polymers | P | | - | - | 4 | 15 | 10 | 25 | 75 | 100 | 02 | √ | √ | √ | | √ | | | |
| **PHARMACEUTICAL CHEMISTRY (02*)** | | | | | | | | | | | | | | | | | | | | | |
| 8. | B190605T/CH347 | Pharmaceutical and Phytochemicals | T | Core Major | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | √ | √ | √ | | | | | |
| 9. | B190606T/CH348 | Medicinal Chemistry and Toxicology | T | | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | √ | √ | √ | | | | | |
| 10. | B190607P/CH349 | Experimental Pharmaceutical Chemistry-I | P | | - | - | 4 | 15 | 10 | 25 | 75 | 100 | 02 | √ | √ | √ | | √ | | | |
| **AGROCHEMICALS (03*)** | | | | | | | | | | | | | | | | | | | | | |
| 11. | B190609T/CH350 | General & Halogenated Insecticides | T | Core Major | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | √ | √ | √ | | | | | |
| 12. | B190610T/CH351 | Fungicides and Herbicides | T | | 3 | 1 | - | 15 | 10 | 25 | 75 | 100 | 04 | √ | √ | √ | | | | | |
| 13. | B190611P/CH352 | Analysis of Agrochemicals-I | P | | - | - | 4 | 15 | 10 | 25 | 75 | 100 | 02 | √ | √ | √ | | √ | | | |
| | | | | **TOTAL** | **12** | **04** | **18** | **90** | **60** | **150** | **450** | **700** | **25** | | | | | | | | |

*Choose Any One Combination (01, 02, 03)

| Effective from Session: 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190601T/CH343 | **Title of the Course** | Synthetic Polymer | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Six | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | The main goal of this course is to give students a basic understanding of the science behind large molecules. This includes how to classify polymers, molecular weight principles, and polymer solutions. Students will delve into the synthesis, properties, and applications of diverse polymers, including thermosetting, thermoplastics, conducting, light-emitting, and biodegradable polymers. With a focus on career-oriented aspects, the course covers polymer synthesis, processing, testing, degradation, reactions, composites, and real-world applications, opening doors to diverse opportunities in the dynamic field of polymers. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Students will gain knowledge of the brief history, basic chemistry, and nomenclature of polymers. |
| **CO2** | Students will get insight into the types and general classification of polymers. |
| **CO3** | Students evaluate the fundamentals of molecular weight, molecular weight distribution, and polymer solutions. |
| **CO4** | Students would gain knowledge of the structure and morphology, synthesis, properties, and applications of the following thermosetting polymers: thermoplastic polymers and conducting polymers. |
| **CO5** | Students would get key insights from the study of polymer synthesis, polymer properties, polymer processing, polymer testing, polymer degradation, polymer reaction, composites, and applications. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | The science of large molecules | Brief history, general definitions, basic chemistry and nomenclature of polymers, brief history of macromolecular science, general characteristics of polymers. | 8 | 1 |
| 2 | Types & general classification of polymers: | Natural and synthetic polymers, organic & inorganic polymers, thermoplastics & thermosetting polymers, homo, hetero and copolymers, necessity of copolymers and copolymerization, block and graft copolymers, conducting polymers, biopolymers. Mechanism of Addition, condensation, free radical, ionic (anionic and cationic) and coordination polymerization. | 8 | 2 |
| 3 | Molecular weight and molecular weight distribution | Number, weight & viscosity average molecular weights of polymers, methods of determining molecular weights, significance of molecular weight distribution. | 6 | 2 |
| 4 | Polymer solutions, structure and morphology | Criteria of polymer solubility, solubility parameters, fractionation of polymers with special reference to gel permeation chromatography. | 6 | 3 |
| 5 | Polymer structure and morphology | A brief idea of microstructure of polymers based on chemical and geometrical structures, intermolecular forces and chemical bonding in polymers, linear, branched and cross linked polymers, stereoregular polymers, crystallinity in polymers, effect of crystallinity on the properties of the polymers, factors affecting the crystallinity. | 8 | 3 |
| 6 | Synthesis, properties and applications of the following Thermosetting polymers | Unsaturated polyesters: Fibre reinforced plastics (FRP), Polyurethanes, Phenol-formaldehyde, urea-formaldehyde, melamine-formaldehyde, Polycarbonates, Alkyl resins and amino resins, Epoxy resins – grades and curing process and its importance with mechanism, Silicones. Elastomers – polyisoprene, polybutadiene and neoprene. | 8 | 4 |
| 7 | Synthesis, properties and applications of the following Thermoplastics polymers | Polyethylene – HDP, LDP, LLDP. Polyvinyl chloride, PTFE (Teflon). Polystyrene – SBR, ABS, SAN. Vinyl polymers – PVA, PVB. Polyacetals, Polyamides – nylon-6, nylon-66 Polyethers and Polyesters – terephthalates (PET). Cellulosic polymers. Acrylic Plastics-PMMA | 8 | 4 |
| 8 | Synthesis, properties and application of specific polymers | 1.Conducting polymers: Polyacetylene (PAc), Polyaniline (PANI), Polythiophene (PTh) 2. Light emitting polymers: Polyparaphenylene (PPP), Polyparaphenylenevinylene (PPPV), Polyfluorene (PF). 3.Biodegradable polymers:Polyglycolic acid (PGA),Polyhydroxybutyrate (PHB), Polyhydroxybutyrate-co-valerate (PHBV) | 8 | 5 |

**Reference Books:**


U. R. Gowariker, N.V. Vishwanathan and J. Shreedhar, Polymer Science by, New Age International Publishers, New Delhi (1987).

H. G. Elias, an introduction to polymer science, Wiley (1997

An Introduction to polymer science and Technology, N. B. Singh, S. S. Das, New age Internal Publisher, New Delhi (2017).

P. Chandrasekhar Conducting Polymers, Fundamentals and Applications, Springer (2013).

A. Lendlein, A. Sisson, Handbook of Biodegradable Polymers: Isolation, Synthesis, Characterization and Applications, Wiley-VCH (2011).

A. J. Domb, J. Kost, D.d Wiseman, Handbook of Biodegradable Polymers, CRC Press (2019).

Handbook of Thermoset Plastics, 4th Edition, Hanna Dodiuk, Elsevier (2021).

F.W. Billmeyer, Textbook of polymer Science, John Wiley &Sons, New York (1984).


**e-Learning Source:**

https://nptel.ac.in/courses/103/106/105106205/

https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod16.pdf

https://onlinecourses.nptel.ac.in/noc21_cy50/preview

https://nptel.ac.in/courses/103/107/103107139/

| | Course Articulation Matrix: (Mapping of COs with POs and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 2 | - | - | - | - | 1 | 2 | 2 | - | - | 3 | 3 |
| **CO2** | 2 | 1 | - | - | - | 1 | 3 | 2 | - | - | 2 | 2 |
| **CO3** | 1 | - | - | - | - | 1 | 3 | 3 | - | - | 3 | 2 |
| **CO4** | 3 | 2 | - | - | - | 1 | 3 | 2 | - | - | 2 | 3 |
| **CO5** | 2 | 3 | - | - | - | 1 | 2 | 3 | - | - | 3 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

| | |
|---|---|
| **SDG 4- Quality Education** |   |
| **SDG 8- Decent Work and Economic Growth** |   |

| Effective from Session: 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190602T/CH344 | **Title of the Course** | Polymerization Techniques and Characterization | **L** | **T** | **P** | **C** |
| **Year** | Three | **Semester** | Six | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | This course mainly includes the study of polymer synthesis, polymer properties, polymer processing, polymer testing, polymer degradation, polymer reaction, composites, and applications. This course is career-oriented and can provide various opportunities in the field of polymers. After successful completion of this paper, students will gain knowledge and skills related to the following: rheology and mechanical properties of polymers, degradation of polymers, polymerization techniques, plastic technology, fibre technology, elastomer technology, additives, and compounding. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Students would be able to perceive the sound knowledge and understanding of the rheology and mechanical properties of polymers. |
| **CO2** | Students will develop a comprehensive knowledge of the degradation of polymers and polymerization techniques. |
| **CO3** | Students will develop a comprehensive knowledge of various plastic technologies. |
| **CO4** | Students will gain knowledge of various concepts of fibre and elastomer technology. |
| **CO5** | Students will gain comprehensive knowledge of various additives and compounding ingredients in polymers. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Rheology and mechanical properties of polymers | Viscous flow, rubber elasticity, visco elasticity, glassy state and the glass transition temperature, (GTT) factors affecting glass transition temperature, optical, electrical and thermal properties of polymers. | 8 | 1 |
| 2 | Degradation of polymers | Degradation of polymers by thermal, oxidative, mechanical and chemical methods, randomdegradation and chain depolymerization. | 8 | 2 |
| 3 | Polymerization techniques | A general idea of bulk, solution, suspension, emulsion, polymerization processes. | 8 | 2 |
| 4 | Plastic technology | General concept of plastics; A brief idea of compression molding, injection molding, extrusion and blow molding techniques, thermoforming and foaming, casting, extrusion, fiber spinning, coating and calendaring, vulcanization of elastomers, reinforcing (fiber reinforced plastics - FRP). | 6 | 3 |
| 5 | Fiber technology | General concept of fibers; A brief idea of textile and fabric properties, fiber spinning (wet, dryand melt spinning) | 8 | 4 |
| 6 | Elastomer technology | General concept of elastomers; Vulcanization of elastomers, and its chemistry. | 8 | 4 |
| 7 | Additives | A general idea of fillers, plasticizers, antioxidants, colourants, fire retardants, thermal stabilizers. | 8 | 5 |
| 8 | Compounding | A general idea compounding ingredient etc. | 6 | 5 |

**Reference Books:**


Joel R. Fried, Polymer Science &Technology, Pearson Prentice Hall; 3rd edition (2014).

B. K. Sharma, Polymer Chemistry,. Krishna Prakashan Media (2020).

D. J. Williams, Polymer Science & Engineering, Prentice Hall Inc (1971).

J.A. Brydson. Plastics Material, A. Brydson, Vth Edition, Butter Worth Heinemonn (1989).

G. Odian, Principle of Polymerization, Godian IInd edition, John Wieley & Sons (2004).


**e-Learning Source:**

https://www.digimat.in/nptel/courses/video/103103139/L20.html 2. https://nptel.ac.in/courses/113/105/113105028/

https://www.youtube.com/watch?v=GltrPpUJS9Q 4. https://nptel.ac.in/courses/112/107/112107221/

https://nptel.ac.in/courses/116/102/116102026/


https://www.digimat.in/nptel/courses/video/103103139/L20.html 2. https://nptel.ac.in/courses/113/105/113105028/

https://www.youtube.com/watch?v=GltrPpUJS9Q 4. https://nptel.ac.in/courses/112/107/112107221/


**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**

| PO-PSO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | - | - | 2 | - | 3 | 3 | - | 3 | 3 | 3 |
| **CO2** | 3 | 3 | - | - | 2 | - | - | 3 | - | 3 | 3 | 3 |
| **CO3** | 3 | 3 | - | - | 2 | - | - | 3 | - | 3 | 3 | 3 |
| **CO4** | 3 | 3 | - | - | 2 | - | - | 3 | - | 3 | 3 | 3 |
| **CO5** | 3 | 3 | - | - | 2 | - | 3 | 3 | - | 3 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |
|---|---|

**SDG-4,8**

| Effective from Session: 2024-25 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190603P/CH345 | **Title of the Course** | Synthesis and Analysis of Polymers | **L** | **T** | **P** | **C** |
| **Year** | Second | **Semester** | Third | **0** | **0** | **4** | **2** |
| **Pre-Requisite** | Diploma | **Co-requisite** | | | | | |
| **Course Objectives** | On successful completion, students will gain knowledge and basic laboratory techniques for the synthesis and characterization of polymers, the determination of saponification values, material testing, and the determination of the molecular weight of polymers by various techniques. | | | | | | |

| Course Outcomes | |
|---|---|
| **CO1** | Students would be able to remember and analyse the laboratory techniques for the synthesis and characterization of polymers. |
| **CO2** | Students would be able to develop and create representative polymers such as bulk polymerization like polystyrene, PMMA nylon, and polysulphide rubber, solution polymerization like phenol formaldehyde and urea formaldehyde. |
| **CO3** | Students would be able to understand and evaluate the (i) saponification value of polyester, (ii) viscosity of PMMA, and (iii) hydroxyl value of a resin. |
| **CO4** | Students would be able to perform and test plastics and rubber, Young's modulus, optical, thermal, mechanical, and electrical properties. |
| **CO5** | Students would be able to analyze and determine the molecular weights of the polymers based on viscosity measurements and the Tg value of phosphate glasses. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Preparation of representative polymers | Bulk polymerization: Polystyrene, PMMA, Nylon and polysulphide rubber Solution polymerization: Phenol formaldehyde, urea formaldehyde | 15 | 1,2 |
| 2 | Determination of saponification value and viscosity | Determination of (i) saponification value - polyester (ii) viscosity of PMMA (iii) hydroxyl value of a resin. | 15 | 2,3 |
| 3 | Material testing | Testing of plastics/rubber, Young's modulus, optical, thermal, mechanical and electrical properties | 15 | 2,4 |
| 4 | Determination of molecular weights | Determination of molecular weights of the polymers by viscosity measurements and Tg value of phosphate glasses. | 15 | 2,5 |

**Reference Books:**


Armarego, W.L.F. Chai, C.L.L. Purification of Laboratory Chemicals (Elsevier, Burlington, 2009)

J. B. Rabek, Experimental methods In Polymer Chemistry, Wiley–Blackwell (1980).

Sorensen, W.R. Campbell, T.W. Preparative Methods of Polymers Chemistry (Wiley, New York, 1968)

Davis, F.J. Polymer Chemistry: A Practical Approach (Oxford, London, 2004)


**e-Learning Source:**

http://chemcollective.org/vlabs

https://www.vlab.co.in/broad-area-chemical-sciences

https://www.labster.com/chemistry-virtual-labs/

**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**

| PO-PSO CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | - | 1 | 2 | - | 3 | 2 | 2 | 1 | - | - |
| **CO2** | 2 | 3 | - | 1 | 1 | - | 2 | 1 | 3 | 2 | - | - |
| **CO3** | 3 | 2 | - | 1 | 2 | - | 2 | 2 | 2 | 1 | - | - |
| **CO4** | 2 | 3 | - | 1 | 1 | - | 3 | 2 | 3 | 2 | - | - |
| **CO5** | 3 | 1 | - | 1 | 2 | - | 3 | 2 | 3 | 3 | - | - |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

**SDG 4**

| Effective from Session: 2024-25 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190604R/CH346 | **Title of the Course** | Industrial Chemistry Research Project-1 | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Sixth | 0 | 0 | 10 | 5 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | To provide the industrial exposure and enhance technical skills of students | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Hands on training |
| **CO2** | Integrate classroom theory with laboratory practice. |
| **CO3** | Understanding professional ethics of industry and code of conduct. |
| **CO4** | Essential training in laboratory safety procedures |
| **CO5** | Compilation of data and report writing |

| | **Course Articulation Matrix: (Mapping of COs with POs and PSOs)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 1 | 2 | 3 | 1 | 2 | 1 | - | - | 2 | 2 | 2 | 1 |
| **CO2** | 2 | 1 | 1 | 2 | 1 | 2 | - | - | 3 | 2 | 1 | 1 |
| **CO3** | 1 | 1 | 3 | 3 | 1 | 3 | - | - | 3 | 3 | 2 | 1 |
| **CO4** | 1 | 3 | 2 | 1 | 1 | 1 | - | - | 2 | 3 | 1 | 1 |
| **CO5** | 2 | 2 | 1 | 3 | 3 | 1 | - | - | 3 | 2 | 1 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

| Effective from Session: 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190605T /CH347 | **Title of the Course** | Pharmaceutical and Phytochemicals | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Six | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | After successful completion of this course, students will gain the knowledge and skills related to this paper, which are as follows: pharmaceutical industry and pharmacopoeias, various types of pharmaceutical excipients, evaluation of crude drugs, surgical dressing, sutures, ligatures, phytochemicals, chemical constitution of plants, various isolation procedures for active ingredients, pharmaceutical quality control, and packaging materials | | | | | | |

| Course Outcomes | |
|---|---|
| **CO1** | Students would be able to perceive and analyze the sound knowledge of the pharmaceutical industry, pharmacopoeias, and various types of pharmaceutical excipients. |
| **CO2** | Students would be able to gain insight into the evaluation of crude drugs, surgical dressings, sutures, and ligatures. |
| **CO3** | Students would be able to evaluate the fundamentals of phytochemical plant classification and crude drugs, cultivation, collection, preparation for the market, and storage of medicinal plants. |
| **CO4** | Students would be able to perceive and remember sound knowledge of the chemical constitution of plants and various isolation procedures for active ingredients. |
| **CO5** | Students would be able to understand and analyse pharmaceutical quality control and packaging materials. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Pharmaceutical industry and Pharmacopoeias | Historical background and development of pharmaceutical industry in India in brief, development of Indian pharmacopoeia and introduction to B.P., U.S.P., E.P., N.F. and other important pharmacopoeias, introduction to various types of formulations and roots of administration, aseptic conditions, need for sterilization, various methods of sterilization. | 6 | 1 |
| 2 | Various types of pharmaceutical excipients | Chemistry, process of manufacture and quality specifications – Glidants, lubricants, diluents, preservatives, antioxidants, emulsifying agents, coating agents, binders, colouring agents, flavouring agents, gelatin and other additives, sorbitol, mannitol, viscosity builders etc. | 6 | 1 |
| 3 | Evaluation of crude drugs | Moisture contents, extractive value, volatile oil content, foreign organic matter, quantitative microscopic exercises including of starch, leaf content (palisade ratio, stomatal number, vein islet number and vein termination number) and crude fiber content, various isolation procedures for active ingredients. | 10 | 2 |
| 4 | Surgical dressing, sutures, ligatures | with respect to the process, equipments used for manufacture, methods of sterlization and quality control. | 6 | 2 |
| 5 | Phytochemicals | Introduction to plant classification and crude drugs, cultivation, collection, preparation for the market and storage of medicinal plants. | 8 | 3 |
| 6 | Chemical constitution of plants | including carbohydrates, amino acids, proteins, fats, waxes, volatile oils, terpenoids, steriods, saponins, flavonoids, tannins, glycosides, alkaloids. | 8 | 4 |
| 7 | Various isolation procedures for active ingredients | With example for alkaloid, e.g., vincaalkaloids, reserpine; one for steriods-sapogenin, diosgenin, diagroh. | 8 | 4 |
| 8 | Pharmaceutical quality control and packaging materials | Sterility testing, pyrogenic testing, glass testing, bulk density of powders, etc. (other than the analytical methods covered under core subject), ancillary materials, packaging machinery, quality control of packaging materials. | 8 | 5 |

**Reference Books:**


L. Patrick. L. Graham, An Introduction to Medicinal Chemistry, OUP Oxford; 4th edition (2009).

C. O. Wilson, O. Gisvold & R. F. Doerge, Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins; 8th edition (1982).

W. O. Foye, T. L. Lemice and D. A. Williams Principles of Medicinal Chemistry (2019).

D J. Abraham, M. Myers, Burger's Medicinal Chemistry, Drug Discovery and Development (1-8 volume), Wiley (2021)

G.L. Patrick, An Introduction to Medicinal Chemistry, Oxford; Fifth edition (2013).

John T. Arnason, Rachel Mata, John T. Romeo, Phytochemistry of Medicinal Plants, Springer (2019)


**e-Learning Source:**

https://nptel.ac.in/courses/104/106/104106106/

https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cy16/

https://nptel.ac.in/LocalChapter/statistics/2537

| | Course Articulation Matrix: (Mapping of COs with POs and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 3 | 2 | - | - | - | - | - | 3 | - | - | 2 | 3 |
| **CO2** | 1 | 1 | - | - | - | - | - | 2 | - | - | 3 | 2 |
| **CO3** | 3 | 2 | - | - | - | - | - | 3 | - | - | 3 | 2 |
| **CO4** | 1 | 2 | - | - | - | - | - | 3 | - | - | 2 | 3 |
| **CO5** | 2 | 3 | - | - | - | - | - | 2 | - | - | 3 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

| Effective from Session: 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190606T /CH348 | **Title of the Course** | Medicinal Chemistry and Toxicology | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Six | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | The main objective of this course is to provide pharmacy students with a thorough understanding of drug mechanisms of action, acid-base and physicochemical properties, and absorption, distribution, metabolism, excretion, and toxicity profiles. Students gain knowledge and skills related to this paper, as follows: Pharmacology drug classification, introduction to medicinal chemistry, drug metabolism, principles of toxicology, biotransformation processes, and enzymes. | | | | | | |

| Course Outcomes | |
|---|---|
| **CO1** | Students would be able to understand and analyze the pharmacology, drug classification, and introduction to medicinal chemistry. |
| **CO2** | Students would be able to evaluate and remember the drug metabolism and principles of toxicology. |
| **CO3** | Students would be able to understand and evaluate the fundamentals of microbial fermentation, the general principles of fermentation processes and product processing, and a brief idea of microorganisms, their structure, growth, and usefulness. |
| **CO4** | Students would be able to remember and understand the process of manufacturing the following bulk drugs and biotransformation processes. |
| **CO5** | Students would be able to understand and analyze the enzyme systems that are useful for transformation, microbial products, enzyme-catalyzed transformation, and the manufacture of ephedrine. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Pharmacology and Drugs classification | Pharmacology classification and therapeutic classification with example, history of the CSA, DEA and FDA, drugs & cosmetics act, schedule of drugs 1 to 5, concept of drug master file (DMF), infringing and non-infringing process concept, introduction of patent and its filing process in brief. | 8 | 1 |
| 2 | Introduction to medicinal chemistry | History and development of medicinal chemistry, physicochemical properties in relation to biological action, ionization, solubility, partition coefficient, hydrogen bonding, protein binding, chelation, bioisosterism, optical and geometrical isomerism. | 8 | 1 |
| 3 | Drug metabolism | Drug metabolism principles- phase I and phase II, factors affecting drug metabolism including stereo chemical aspects. | 6 | 2 |
| 4 | Principles of Toxicology | Definition of poison, general principles of treatment of poisoning with particular reference to barbiturates, opioids, organophosphorous and atropine poisoning, heavy metals and heavy metal antagonists | 6 | 2 |
| 5 | Microbial fermentation | General principle of fermentation processes and product processing, brief idea of microorganisms, their structure, growth and usefulness, enzyme systems useful for transformation microbial products. | 6 | 3 |
| 6 | Process of manufacture of the following bulk drugs | (i) Sulpha drugs- Sulphaguadine, Sulphamethoxazole (ii) Antimicrobial- Chloraamphenicol, Furazolidine, Mercurochrome, Isoniazid, Na- PAS (iii) Antalgesic- anti-inflammatory- Salicylic acid and its derivatives, Ibuprofen, Mefenamic acid. (iv) Steroidal hormones- Progesterone, Testosterone, Methyl testosterone (v) Vitamins- Vitamin-A, Vitamin-B6, Vitamin-C. (vi) Barbiturates- Pentobarbital (vii) Blockers- Propranolol, Atenolol (viii) Cardiocascular agent- Methyl dopa (ix) Antihistamines- Chloropheneramine maleate. 16h 41 41 (x)Antibiotics drugs – Penicillin-G, semi synthetic penicillin, Rifamycin, Tetracycline, and Vitamin-B12. (xi)Antimalarial drugs. Anticancerous drugs. Anti AIDS vaccines | 16 | 4 |
| 7 | Biotransformation processes | For prednisolone, 11-hydroxylation in steroids, enzyme catalyzed transformation, manufacture of ephidrine. | 5 | 4 |
| 8 | Enzyme systems | Useful for transformation, microbial products, enzyme catalyzed transformation - manufacture of ephedrine. | 5 | 5 |

**Reference Books:**


M.E. Wolff, Burgers Medicinal Chemistry and Drug Discovery Wiley–Blackwell; 5th edition (1997).

W. David, Pharmaceutical Chemistry, Elsevier-Health U.K. (2011).

C. Donald, Essential of Pharmaceutical Chemistry, Pharmaceutical press, London (2012).

L. Patrick. L. Graham, An Introduction to Medicinal Chemistry, OUP Oxford; 4th edition (2009).

C. O. Wilson, O. Gisvold & R. F. Doerge. Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins; 8th edition (1982).

W. O. Foye, T. L. Lemice and D. A. Williams Principles of Medicinal Chemistry (2019).

D J. Abraham, M. Myers, Burger's Medicinal Chemistry, Drug Discovery and Development (1-8 volume), Wiley (2021).

G.L. Patrick, An Introduction to Medicinal Chemistry, Oxford; Fifth edition (2013).

| |
|---|
| John T. Arnason, Rachel Mata, John T. Romeo, Phytochemistry of Medicinal Plants, Springer (2019). |
| **e-Learning Source:** |
| https://nptel.ac.in/courses/104/106/104106106/ |
| https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cy16/ |
| https://nptel.ac.in/LocalChapter/statistics/2537/ |
| https://onlinecourses.nptel.ac.in/noc20_cy16/preview<br>https://onlinecourses.nptel.ac.in/noc21_cy05/preview<br>https://chemistry-europe.onlinelibrary.wiley.com/journal/23656549<br>https://www.griffith.edu.au/study/courses/principles-of-toxicology-2021PHM#trimester-1-gold-coast campus |
| |

| | **Course Articulation Matrix: (Mapping of COs with POs and PSOs)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 1 | 2 | - | - | - | - | - | 3 | - | - | 2 | 1 |
| **CO2** | 3 | 2 | - | - | - | - | - | 2 | - | - | 1 | 2 |
| **CO3** | 2 | 1 | - | - | - | - | - | 1 | - | - | 3 | 3 |
| **CO4** | 2 | 2 | - | - | - | - | - | 1 | - | - | 1 | 1 |
| **CO5** | 1 | 1 | - | - | - | - | - | 2 | - | - | 1 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

| Effective from Session: 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190607P/CH349 | **Title of the Course** | Experimental Pharmaceutical Chemistry | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Six | **0** | **0** | **4** | **2** |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | Students gain knowledge and skills related to this paper as follows: Demonstration of various pharmaceutical packaging materials, quality control tests of some materials (aluminium strips, cartons, glass bottles), active ingredient analysis of a few types of formulations representing different methods of nalysis (aacidmetry, alkametry, nonaqueous complexometry, potentiometry, etc.), evaluation of crude drugs, microbiological testing. | | | | | | |

| Course Outcomes | |
|---|---|
| **CO1** | Students would be able to understand and analyse the laboratory methods and tests related to pharmaceutical packaging. |
| **CO2** | Students would be able to understand and perform the quality control tests of some materials, such as aluminium strips, cartons, and glass bottles. |
| **CO3** | Students would be able to remember and perform the active ingredient analysis using different methods of analysis: acidmetry, alkametry, nonaqueous complexometric, potentiometry, etc. |
| **CO4** | Students would be able to evaluate and perform microscopic examinations—the determination and identification of starch granules and calcium oxalate. |
| **CO5** | Students would be able to evaluate and perform microbiological testing and determine the MIC of some antibacterial and antifungal drugs. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Pharmaceutical packaging | Demonstration of various pharmaceutical packaging materials and quality control tests of some materials- aluminium strips, cartons, glass bottles. | 10 | 1,2 |
| 2 | Active ingredient analysis | Active ingredient analysis of few types of formulations representing different methods of analysis- acidmetry, alkametry, nonaqueous complexometry, potentiometry, etc. | 10 | 3 |
| 3 | Evaluation of crude drugs | Microscopic examination- determination and identification of starch granules, calcium oxalate. | 20 | 2,4 |
| 4 | Microbiological testing | Determination of MIC of some antibacterial and antifungal drugs by zone/cup plate methods. | 20 | 2,5 |

**Reference Books:**


Dickson, Experiments in Pharmaceutical Chemistry, CRC Press (2014).

S. K. Dwivedi, Practical Lab Manual of Pharmaceutical Organic Chemistry – I, IP, innovative publication pvt ltd (2014).

C. Kokare Pharm. Biotechnology Experiments & Techniques - Pharmaceutical Biotechnology - Experiments and Techniques Fifth Edition, Nirali Prakashan (2019).


**e-Learning Source:**

| | Course Articulation Matrix: (Mapping of COs with POs and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 3 | 2 | - | - | - | - | - | - | 3 | 3 | - | - |
| **CO2** | 2 | 3 | - | - | - | - | - | - | 3 | 2 | - | - |
| **CO3** | 2 | 2 | - | - | - | - | - | - | 2 | 3 | - | - |
| **CO4** | 3 | 3 | - | - | - | - | - | - | 3 | 2 | - | - |
| **CO5** | 2 | 1 | - | - | - | - | - | - | 3 | 2 | - | - |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

| Effective from Session: 2024-25 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190609T/CH350 | **Title of the Course** | General & Halogenated Insecticide | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Six | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | Agrochemicals are used to prevent the deterioration of crops from insects, pest infestations, and disease. The global agrochemicals market report offers the latest trends, growth factors, industry competitiveness, investment opportunities, and a detailed profile of the top players in the market during the forecast period. The global agrochemicals market is segmented by product type (fertilisers, pesticides, adjuvants, and plant growth regulators), application (crop-based and non-crop-based), and geography. Students gain knowledge related to pesticides: inorganic insecticides, insecticides of plant origin, organophosphorus insecticides, organothiophosphorus insecticides, carbamate insecticides, chemical and biological fertilisers, and chlorinated pesticides. | | | | | | |

| Course Outcomes | |
|---|---|
| **CO1** | Students would be able to create and develop different types of pesticides and their effects on soil and the environment. |
| **CO2** | Students would be able to remember and analyse inorganic insecticides and insecticides of plant origin. |
| **CO3** | Students would be able to evaluate the fundamentals of phosphoric acid, dhiophosphoric acid, and dithiophosphoric acid derivatives of organophosphorus insecticides. |
| **CO4** | Students would be able to evaluate the modes of action and their applications in carbamate insecticides and chemical and biofertilizers for crop protection. |
| **CO5** | Students will be able to gain knowledge of SAR and the mode of action of chlorinated hydrocarbons. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Types of pest and pesticides | Stomach poison, contact poisons systemic poisons, fumigants. Effect of pesticides on soil and environment. | 7 | 1 |
| 2 | Inorganic insecticides | Arsenic insecticides, Paris green, Fluoro insecticides | 5 | 2 |
| 3 | Insecticides of plant origin | Nicotine, Nornicotine, Pyrethroids, Rotenoids, Anabasin, Aliethrin | 6 | 2 |
| 4 | Organophosphorus insecticides | Phosphoric acid derivatives- Dimecron, dichlorovos, naled, phosphinon, etc. SAR in the class | 5 | 3 |
| 5 | Organothiophosphorus insecticides: | Thiophosphoric acid derivatives- Parathion, Methyl parathion, Thiophos, Demetron, Chlorthion, Paraoxon, etc.<br>Dithiophosphoric acid derivatives- Melathion, Dimethoate, Thiocron, Formathion, Mecarbam, etc. | 10 | 3 |
| 6 | Carbamate insecticides | Carbaryl, Isolan, Mesurol, Zactran, Demetram, Pyrolan, Baygon, mode of action | 8 | 4 |
| 7 | Chemical and Biofertilizers | Introduction, Types of fertilizer, direct application fertilizers, mixed fertilizers (nitrogen, phosphorus and potassium sources, ammoniation), controlled release fertilizers and biofertilizers, liquid vs solid fertilizers, biopesticides. | 9 | 4 |
| 8 | Chlorinated hydrocarbons | DDT, DDD, Nestran, Dilan, Perthan, Dimite, Chlorobenzilate, Sulphenex, Ovotran, Aramite, DFDT, SAR in the class and mode of action, BHC, Chlordane, Heptachlor, Aldrin, Dieldrin, endrin, Faodrin, Endosulfan, SAR in the class and mode of action. | 10 | 5 |

**Reference Books:**


Knowles, Alan (Ed.) "Chemistry and Technology of Agrochemical formulations" Springer Netherland (1998)

J. P. Kumar and S. Bharat " Soil fertility, Fertilizers and Agrochemicals, Daya Publishing House (2016)

H. Ohkawa, H. Miyagawa, P. W. Lee Pesticide Chemistry: Crop Protection, Public Health, Environmental Safety, Wiley (2007).

R. Pohanish, Sittig's Handbook of Pesticides and Agricultural Chemicals, Elsevier Science (2014)

Insecticides and Pesticides: Techniques for Crop Protection, Larsen and Keller Education, Technology & Engineering -


**e-Learning Source:**

https://nptel.ac.in/courses/103/107/103107086/

https://nptel.ac.in/courses/103/107/103107082/

chemistry-europe.onlinelibrary.wiley.com/journal/23656549

https://www.youtube.com/watch?v=qspUM9tV5WY

https://nptel.ac.in/courses/126/104/126104003/

| | Course Articulation Matrix: (Mapping of Cos with Pos and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 3 | 2 | - | - | - | 1 | 2 | 1 | - | 3 | 1 | 3 |
| **CO2** | 2 | 2 | - | - | - | 1 | 2 | 2 | - | 3 | 1 | 2 |
| **CO3** | 2 | 3 | - | - | - | 3 | 2 | 1 | - | 3 | 2 | 2 |
| **CO4** | 3 | 2 | - | - | - | 2 | 3 | 1 | - | 3 | 2 | 3 |
| **CO5** | 2 | 3 | - | - | - | 2 | 1 | 1 | - | 3 | 1 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

SDGs 2, 8, 12

| Effective from Session: 2024-25 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190610T/CH351 | **Title of the Course** | Fungicides and Herbicides | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Six | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | Fungicides, herbicides, and insecticides are all pesticides used in plant protection. Herbicides are a broad class of pesticides that are used to remove nuisance plants, such as grasses and weeds, that may compromise the growth and yield of desired crops that are in proximity. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Students would be able to create and develop types of fungicides and organomercuric compounds. |
| **CO2** | Students would be able to understand dithiocarbamates and miscellaneous fungicides. |
| **CO3** | Students would be able to evaluate the fundamentals of herbicides and their applications in plant protection. |
| **CO4** | Students will be able to understand the synthesis and uses of fumigants, rodenticides, nematicides, and plant growth regulators. |
| **CO5** | Students would be able to learn about different types of formulations of pesticides. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Fungicides | Introduction, Sulphur, lime sulphur, copper sulphate, bordeaux mixture, bordeaux paste, bordeaux paint, burgundy mixture, copper oxychloride, cuprous oxide, mercurous chloride | 8 | 1 |
| 2 | Organomercuric compounds | Ethyl mercuric chloride, ceresan-M, panagen, agalol, uspulan, puratized, germisan; mode of action, agrosan GN. | 8 | 1 |
| 3 | Dithiocarbamates | Ziram, ferbam, thiram, nabam, zineb, maneb, captan, hinosan, vapam, etc.; mode of action. | 6 | 2 |
| 4 | Miscellaneous fungicides | Dithanon, diclone, captan, polpet, diflolatan, mesulfan, brestan, dodine, glyodin, methyrimol, terrazole | 8 | 2 |
| 5 | Herbicides | Introduciton, heterocyclic nitrogen herbicides: 2,4-D; 2,4-DB; 2,4-DES; MCPB; 2,4,5-I, Monujron, fenuron, TCA, paraquat. | 6 | 3 |
| 6 | Fumigants, Rodenticides and Nematicides | Fumigants: HCN, CS2, ethylene halides, durofume, methyl halides. Rodenticides: Zice phosphide, warfarin Nematicides: DD mixture, aldicarb, fensulfothion | 8 | 4 |
| 7 | Plant growth regulators | Introduction, gibberilic acids, indole acetic and butyric acids, naphthalene acetic acid, cycocil, mode of action | 8 | 4 |
| 8 | Formulation of pesticides | Dry formulations- Dusts, grannules, wettable powders, seed disinfectants, liquid formulations emulsions, suspensions, etc., aerosols and sprays. | 8 | 5 |

**Reference Books:**


P. N. Nene, Y. L. Thapliyal , Fungicides in Plant Disease Control, Medtech (2017).

H. Panda,The Complete Technology Book on Pesticides, Insecticides, Fungicides and Herbicides with Formulae & Processes, National Institute of Industrial Research (2003).

Knowles, Alan (Ed.) "Chemistry and Technology of Agrochemical formulations" Springer Netherland (1998)

J. P. Kumar and S. Bharat "Soil fertility, Fertilizers and Agrochemicals, Daya Publishing House (2016)

C.T. Lacal, Plant growth regulators, Arcler Education Inc (2017).

E. E. Fletcher, R. C. Kirkwood, Herbicides and Plant Growth Regulators, Methuen (1981).

C.L .Foy, C. L. (ed.) Adjuvants for Agrichemicals, CRC Press, Boca Raton, FL. (1992).


**e-Learning Source:**

https://youtu.be/lJEeGMMcYCI?si=zWbjZmKMWy8aZQfg

https://youtu.be/lH_8N9HRsys?si=oPAAVp0XdxyG1t4A

https://youtu.be/eF_fbTbHdyg?si=yPzU40XpiLi6vlbD

https://youtu.be/PEoCQEW62kU?si=U-BvRjgheL6I_dQl

https://youtu.be/snpTwZMsf1U?si=q1U08gr2XrDmPoEl

| | **Course Articulation Matrix: (Mapping of Cos with Pos and PSOs)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 3 | 2 | - | - | - | 1 | 2 | 1 | - | 3 | 1 | 3 |
| **CO2** | 2 | 2 | - | - | - | 1 | 2 | 2 | - | 3 | 1 | 2 |
| **CO3** | 2 | 3 | - | - | - | 3 | 2 | 1 | - | 3 | 2 | 2 |
| **CO4** | 3 | 2 | - | - | - | 2 | 3 | 1 | - | 3 | 2 | 3 |
| **CO5** | 2 | 3 | - | - | - | 2 | 1 | 1 | - | 3 | 1 | 2 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

SDGs 2, 8, 12

| Effective from Session: 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B190611P/CH352 | **Title of the Course** | Analysis of Agrochemicals | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Six | **0** | **0** | **4** | **2** |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | The chemistry lab for this course is designed to provide students with detailed knowledge of the isolation, estimation, and formulation of pesticides. | | | | | | |

| Course Outcomes | |
|---|---|
| **CO1** | Students would be able to perform and evaluate the isolation of active ingredients in commercially available insecticide formulations. |
| **CO2** | Students would be able to analyze the estimation of active ingredients in commercially available insecticide formulations. |
| **CO3** | Students would be able to understand the preparation of selected pesticide formulations. |
| **CO4** | Students would be able to develop a basic knowledge of the estimation of pesticide residues in food. |
| **CO5** | Students would be able to remember and understand the comprehension of different isolations of nicotine. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Estimation of insecticide | Isolation and estimation of active ingredients of commercially available insecticide Formulations. | 12 | 1,2 |
| 2 | Formulations of pesticide | Preparation of selected pesticide formulations in the form of dusts, emulsions, sprays. | 12 | 3 |
| 3 | Estimation of pesticide in food | Estimation of pesticide residues in food articles | 12 | 4 |
| 4 | Isolation of nicotine | Isolation of nicotine from tobacco leaves/ wastes or Tea leave | 24 | 5 |

**Reference Books:**


B. S. Furniss, A.J. Hannaford, P.W. G. Smith, A.R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5e, Pearson (2003).

Lab manual 11, FSSAI Manual of methods of analysis of foods https://old.fssai.gov.in/Portals/0/Pdf/Draft_Manuals/PESTICIDE_RESIDUE.pdf

D. A. Knowles, Chemistry and technology of agricultural formulations. Kluwer Academic, London (1998).

S. Ippolito, J. R Mendieta, Formulations of Agrochemicals, Scitus Academics Llc (2020).

A. Knowles, Chemistry and Technology of Agrochemical Formulations, Springer, 1998.


**e-Learning Source:**

https://youtu.be/eiO-Cqzqd04?si=-nRB3a_5Monq-35p

https://www.youtube.com/live/tc8BhEPj9b0?si=0yZ5n9xREkOg0eCT

https://youtu.be/QYXSbcfIL4c?si=vd92YF4-iYKiXczP

| | Course Articulation Matrix: (Mapping of COs with POs and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 2 | 2 | | | | 2 | 3 | 2 | | 1 | 2 | 2 |
| **CO2** | 2 | 2 | | | | 1 | 2 | 1 | | 2 | 2 | 2 |
| **CO3** | 1 | 1 | | | | 2 | 3 | 2 | | 1 | 1 | 1 |
| **CO4** | 2 | 2 | | | | 1 | 2 | 2 | | 2 | 2 | 2 |
| **CO5** | 3 | 3 | | | | 3 | 3 | 1 | | 3 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

SDG 3

| Effective from Session: 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B020601T/CH353 | **Title of the Course** | Organic Synthesis B | **L** | **T** | **P** | **C** |
| **Year** | Three | **Semester** | Six | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | This paper provides detailed knowledge of the synthesis of various classes of organic compounds and functional groups through interconversion. Organic synthesis is the most important branch of organic chemistry, which provides jobs in production and QC departments related to chemicals, drugs, medicines, FMCG, etc. industries. The study of natural products and heterocyclic compounds offers an excellent strategy towards identifying novel biological probes for several diseases. Historically, natural products have played an important role in the development of pharmaceutical drugs for a few diseases, including cancer and infection. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Students would perceive the sound knowledge of various reagents for oxidation and reduction in organic synthesis. And understand organomagnesium, organozinc, and organolithium compounds, including their formation and diverse chemical reactions. |
| **CO2** | Students will develop a comprehensive knowledge of aldehydes, ketones, and carboxylic acids. Learn how to name them, make them, what their physical properties are, and how they react to different things. For example, learn how nucleophilic additions work and how to make functional derivative preparations. Achieve proficiency in organic synthesis. |
| **CO3** | Students will develop the knowledge necessary for a proficient understanding of organic synthesis via enolates and the organic chemistry of nitrogen-containing compounds. |
| **CO4** | Students would perceive the sound knowledge and comprehensive understanding of heterocyclic molecular structures, synthesis, reactions, and substitution mechanisms. |
| **CO5** | Students will develop a comprehensive understanding of alkaloids and terpenes: their structures, physiological roles, synthetic methods, and medicinal importance. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | Reagents in Organic Synthesis | Oxidation with DDQ, CAN and $SeO_2$, mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetraoxide. Reduction with $NaBH_4$, $LiAlH_4$, Meerwein-Ponndorf-Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL-H | 8 | 1 |
| 2 | Organometallic Compounds | Organomagnesium compounds: the Grignard reagents, formation, structure, and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions. | 8 | 1 |
| 3 | Chemistry of Aldehydes and ketones | Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones uses 1, 3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophillic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, | 8 | 2 |
| 4 | Carboxylic acids and their Functional Derivative | Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, adipic and phthalic acids and unsaturated carboxylic acids such as acrylic and cinnamic acids, Reactions: Action of heat on hydroxy and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification. | 6 | 2 |
| 5 | Organic Synthesis via Enolates | Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1, 3-dithianes, Alkylation and acylation of enamines. | 8 | 3 |
| 6 | Organic Compounds of Nitrogen | Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid. Halonitroarenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrities), reductive amination of aldehydic and ketonic compounds, Gabriel-phthalimide reaction, Hofmann bromamide reaction. | 8 | 3 |
| 7 | Heterocyclic Chemistry | Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, | 8 | 4 |
| 8 | Natural Products | Alkaloids & Terpenes: Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification; Medicinal importance of Nicotine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule. | 6 | 5 |

**Reference Books:**


Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.

Carey, F. A., Guiliano, R. M.Organic Chemistry, Eighth edition, McGraw Hill Education, 2012.

Loudon, G. M. Organic Chemistry, Fourth edition, Oxford University Press, 2008.

Clayden, J., Greeves, N. &Warren, S. Organic Chemistry, 2nd edition, Oxford University Press, 2012.

| e-Learning Source: |
|---|
| http://heecontent.upsdc.gov.in/Home.aspx https://nptel.ac.in/courses/104/103/104103111/ |
| https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm https://nptel.ac.in/courses/104/103/104103071/# |
| https://swayam.gov.in/ |
| http://heecontent.upsdc.gov.in/Home.aspx https://nptel.ac.in/courses/104/103/104103111/ |
| https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm https://nptel.ac.in/courses/104/103/104103071/# |

| | Course Articulation Matrix: (Mapping of COs with POs and PSOs) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 3 | 3 | - | - | 2 | - | - | 3 | - | 2 | 3 | 3 |
| **CO2** | 3 | 3 | - | - | 2 | - | - | 3 | - | 2 | 2 | 3 |
| **CO3** | 3 | 3 | - | - | 2 | - | - | 3 | - | 2 | 3 | 3 |
| **CO4** | 3 | 3 | - | - | 2 | - | - | 3 | - | 2 | 2 | 3 |
| **CO5** | 3 | 3 | - | - | 2 | - | 3 | 3 | - | 2 | 3 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

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| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

**SDG-3,4**

| Effective from Session: 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B020602T/CH354 | **Title of the Course** | Chemical Energetics and Radio Chemistry | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Six | 3 | 1 | 0 | 4 |
| **Pre-Requisite** | Diploma | **Co-requisite** | - | | | | |
| **Course Objectives** | The main aim of this course is to convey fundamental knowledge of the laws of thermodynamics and their applications, phase equilibria of one- and two-component systems, electrochemistry, ionic equilibrium applications of conductivity, and potentiometric measurements. Higher education studies have proven that to be quite important. The learner will be able to investigate topics in their appropriate dimensions after completing the course. | | | | | | |

| Course Outcomes | |
|---|---|
| **CO1** | Students would perceive the sound knowledge of the first law of thermodynamics and various energies such as internal energy and enthalpy. Students would also gain insight into the knowledge of thermochemistry and various reaction enthalpies. Students gained insight into the laws of thermodynamics, the importance of entropy, and gibbs free energy. Nernst heat theorem, statement, and concept of residual entropy. |
| **CO2** | Students would evaluate the fundamentals of electrochemistry and enhance their knowledge of the basics of electrochemistry, conductometric titrations, and the Ostwald dilution law. Degree of ionization. Students also learn about electrodes, electrochemical cells, pH, buffer solutions, and salt hydrolysis. |
| **CO3** | Students would evaluate the fundamentals of the surface chemistry laws of adsorption and colloids. Students also learn about dilute solutions and colligative properties. It enables us to understand the reactants in catalysis. |
| **CO4** | Students would have a solid knowledge of the basics of photochemistry, the Jablonski diagram, and different photophysical processes. |
| **CO5** | Students would be able to learn about radioactivity. It enables us to understand the applications of radiochemistry in energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, and nuclear medicine. |

| Unit No. | Title of the Unit | Content of Unit | Contact Hrs. | Mapped CO |
|---|---|---|---|---|
| 1 | First Law of Thermodynamics | Statement, definition of internal energy and enthalpy. Heat capacity,heat capacities at constant volume and pressure and their relationship. Joule's law– Joule Thomson coefficient and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process. Thermochemistry: Standard state, standard enthalpy of formation – Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from thermo-chemical data, temperature dependence of enthalpy. Kirchhoff's equation | 8 | 1 |
| 2 | Thermodynamics-II | Second Law of Thermodynamics, Need for the law, different statements of the law, Carnot cycle andits efficiency. Carnot theorem. Thermodynamic scale of temperature. Concept of Entropy, Entropy as a state function, entropy as a function of V & T, entropy as a functionof P & T, entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Gibbs and Helmholtz Functions Gibbs function (G) and Helmhotz work function (A) as thermodynamic quantities. A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, Variation of G and A with P, V and T. Third Law of Thermodynamics; Nernst heat theorem, statement and concept of residual entropy. Nernst distribution law – Thermodynamic derivation, applications | 8 | 1 |
| 3 | Electrochemistry | Electrical transport:- Conduction in metals and in electrolyte solutions, specificconductance molar and equivalent conductance, measurement of equivalent conductance, variationof molar, equivalent and specific conductances with dilution. Migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations. Weak and strong electrolytes . Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf method and moving boundary method. | 7 | 2 |
| 4 | Ionic Equilibrium | Electrode reactions, Nernst equation, derivation of cell EMF and single electrode potential, standard hydrogen electrode-reference electrodes and their applications, standard electrode potential, sign conventions, Electrolytic and Galvanic cells–Reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurement. Definitionof pH and pKa , determination of pH using hydrogen, quinhydrone and glass electrodes by potentiometric methods. Buffers – Mechanism of buffer action, Henderson-Hazel equation, application of buffer solution. Hydrolysis of salts. | 8 | 2 |
| 5 | Surface Chemistry | Adsorption: Physical and chemical adsorption; Freundlich and Langmuir adsorption isotherms; multilayer adsorption and BET isotherm (no derivation required); Gibbs adsorption isothermand surface excess; Heterogenous catalysis (single reactant);<br>Colloids:Lyophobic and lyophilic sols, Origin of charge and stability of lyophobic colloids,Coagulation and Schultz-Hardy rule, Zeta potential and Stern double layer (qualitative idea), Tyndall effect; Electrokinetic phenomena (qualitative idea only); Stability of colloids and zeta potential; Micelle formation | 7 | 3 |
| 6 | Colligative Properties | Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient. Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination, Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure, Elevation of boiling point and depression of freezing, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, Van't Hoff factor, Colligative properties of degree of dissociation and association of solutes. | 8 | 3 |
| 7 | Photo Chemistry | Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus- Drapper law, Stark-Einstein law, Jablonski diagramdepicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantumyield, photosensitized reactions – energy transfer processes (simple examples), kinetics of photochemical reaction. | 6 | 4 |
| 8 | Radiochemistry | Natural and induced radioactivity; radioactive decay-a-decay, b-decay, g-decay; neutromemission, positrom emission, electron capture; unit of radioactivity (Curie); half life period; Geiger-Nuttal rule, radioactive displacement law, radioactive series. Measurement of radioactivity: ionization chamber, Geiger counters scintillation counters. Applications: energy tapping, dating of objects, neutron activation analysis, isotopic labelling studies, nuclear medicine-99mTc radiopharmaceuticals. | 8 | 5 |

**Reference Books:**

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|---|
| Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010). |
| Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009). |
| Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006). |
| Castellan, G. W. Physical Chemistry 4th Edn. Narosa (2004). |
| **e-Learning Source:** |
| https://www.mooc-list.com/tags/physical-chemistry |
| https://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/intro1.htm |
| https://www.coursera.org/learn/physical-chemistry |


| | **Course Articulation Matrix: (Mapping of COs with POs and PSOs)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
| **CO1** | 3 | 3 | - | - | - | - | 2 | 3 | - | - | 2 | 3 |
| **CO2** | 3 | 3 | - | - | - | - | 2 | 3 | - | - | 2 | 3 |
| **CO3** | 3 | 3 | - | - | - | - | 2 | 3 | - | - | 2 | 3 |
| **CO4** | 3 | 3 | - | - | - | - | 3 | 3 | - | - | 2 | 3 |
| **CO5** | 3 | 3 | - | - | - | - | 3 | 3 | - | - | 2 | 3 |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

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|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |

**SDG:** 4, 8

# Integral University, Lucknow

| **Effective from Session:** 2024-2025 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Course Code** | B020603P/CH355 | **Title of the Course** | Analytical Methods | **L** | **T** | **P** | **C** |
| **Year** | Third | **Semester** | Six | **0** | **0** | **4** | **2** |
| **Pre-Requisite** | 10+2 | **Co-requisite** | - | | | | |
| **Course Objectives** | The main objective of this course is to provide essential knowledge of laboratory techniques and tests for estimating metal ions and chromatographic separation of amino acids and sugars. The lab course also delivers knowledge and experimentation-based understanding of the ionization enthalpies of acids and bases. | | | | | | |

| **Course Outcomes** | |
|---|---|
| **CO1** | Students would be able to learn about laboratory methods and tests related to the estimation of metal ions and gravimetric analysis. |
| **CO2** | Students would be able to understand and evaluate the chromatography separation and perform the paper chromatography experimentation. |
| **CO3** | Students would be able to remember, understand, and perform the thin layer chromatography experimentation. |
| **CO4** | Students would be able to understand the solubility behavior of compounds at different temperatures. |
| **CO5** | Students would be able to understand, analyze, and perform experiments related to the enthalpy of neutralizing acids and bases and lattice energy calculations. |

| **Unit No.** | **Title of the Unit** | **Content of Unit** | **Contact Hrs.** | **Mapped CO** |
|---|---|---|---|---|
| 1 | Gravimetric Analysis | Estimation of one anion and cation in a given salt:<br>1. Analysis of Cu as CuSCN,<br>2. Analysis of Ni as Ni(dimethylgloxime)<br>3. Analysis of Ba asBaSO4 | 15 | 1 |
| 2 | Paper Chromatography | Ascending and Circular Rf of organic compounds, Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid.<br>Spray reagent ninhydrin. Separation of a mixture of D, L alanine, glycine, and L-leucine using n-butanol:acetic acid: water (4:1:5). Spray reagent ninhydrin.<br>Separation of monosaccharaides a mixture of D- galactose and D –fructose using n- butanol: acetone: water (4:5:1). Spray reagent aniline hydrogen phthalate | 15 | 2,3 |
| 3 | Thin Layer Chromatography | Determination of Rf values and identification of organic compounds: Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2,4- dinitro phenyl hydrazones of acetone, 2- butanone, hexan-2, and 3-one using toluene and light petroleum (40:60), Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5) | 15 | 2,3 |
| 4 | Thermochemistry | To determine the solubility of benzoic acid at different temperatures and to determine H of the dissolution process.<br>To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base.<br>To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle. | 15 | 4,5 |

**Reference Books:**


Practical Chemistry: For B.Sc, S. Chand Limited, OP pandey, DN Bajpai, 2022.

Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.

B.Sc.-III Practical Chemistry, Dr. Pradip P. Deohate, ISBN : 978-93-5445-764-7

Instrumental Methods of Analysis, CBS Publishers & Distributors, Willard M.H., ISBN 9788123909431


**e-Learning Source:**

https://youtu.be/UHYfgwjE2i4

http://zd2.chem.uni.wroc.pl/files/chemistry/10A_ENG.pdf

https://ncert.nic.in/pdf/publication/sciencelaboratorymanuals/classXII/chemistry/lelm103.pdf

https://rltsc.edu.in/wp-content/uploads/2021/03/E-Book-B.Sc_.-III-Practical-Chemistry.pdf

**Course Articulation Matrix: (Mapping of COs with POs and PSOs)**

| **PO-PSO CO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | - | - | - | - | 1 | - | 2 | 1 | - | - |
| **CO2** | 2 | 3 | - | - | - | - | 2 | - | 3 | 2 | - | - |
| **CO3** | 2 | 2 | - | - | - | - | 2 | - | 2 | 1 | - | - |
| **CO4** | 3 | 3 | - | - | - | - | 1 | - | 3 | 2 | - | - |
| **CO5** | 3 | 1 | - | - | - | - | 1 | - | 3 | 3 | - | - |

**1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

| | |
|---|---|
| **Name & Sign of Program Coordinator** | **Sign & Seal of HoD** |