A.C.-03.08.2022
Appendix-65

UNIVERSITY OF DELHI

DEPARTMENT: Chemistry/Industry Chemistry/Mathematics/Physics
COURSE NAME: Bachelor of Science in Industrial Chemistry

(Semester-I)
Based on
Undergraduate Curriculum Framework 2022 (UGCF)
(Effective from Academic Year 2022-23)

University of Delhi

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/ Prerequisite	Contents of the course and reference is in -
			Lecture	Tutorial	Practical		
Industrial Chemicals and Environment	Industrial Chemistry DSC- IC 1	04	02	-	02	Chemistry+Physics+Maths	**Annexure-I**
Basic Concepts of Organic Chemistry	Chemistry DSC- C1	04	02	-	02	NA	**Annexure-II**
Calculus	Mathematics DSC- MP 1	04	02	-	02	NA	**Annexure-III**

ANNEXURE -I

Syllabus for Undergraduate Programme in Industrial Chemistry (I Semester)

DISCIPLINE SPECIFIC CORE COURSES (DSC) SEMESTER-I

11.1.1 Course Code: Industrial Chemistry DSC-IC 1
Course Title: Industrial Chemicals and Environment
Total Credits: 04 (Credits: Theory-02, Practical-02)
Total Lectures: Theory- 30, Practical-60

Objectives:

The objective of this course is to teach the Chemistry of the general industrial separation and purification techniques. Production, uses and hazards associated with different industrial gases and chemicals. Air pollution, air pollutants, pollutants control procedures, greenhouse effect, global warming, water pollution, water pollutants, industrial effluents and their treatment, water quality parameters and water purification techniques.

Learning Outcomes:

By the end of the course, the students will be able to:

- Know the various separation and purification techniques used in industries like distillation, solvent extraction, absorption, adsorption etc.
- Know the production, uses and hazards of important gases like oxygen, helium, argon, hydrogen, acetylene, ammonia etc.
- Know the production, uses and hazards of important inorganic chemicals like hydrochloric acid, sulphuric acid, nitric acid, sodium hydroxide, potassium hydroxide etc.
- Learn about air pollution, air pollutants, their control procedure, global warming, ozone depletion, water pollution, water pollutants, effluents from different industries, their treatment, water quality parameters and water purification techniques like reverse osmosis, electrodialysis and ion exchange.

Unit 1: General industrial processes Lectures: 05

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption

Unit 2: Industrial Gases and Inorganic Chemicals Lectures: 12

(a) *Industrial Gases*: Production, uses and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, chlorine, fluorine and ammonia.
(b) *Inorganic Chemicals*: Production, uses and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, sodium hydroxide, potassium hydroxide, bleaching powder, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

Unit 3: Environment Lectures: 13

(a) *Air Pollution*: Pollutants and their sources, pollution by SO_2, CO, NOx. Methods of estimation of CO, NOx, SOx and their control procedures. Greenhouse effect and global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and halogens, Particulate matter and its types.
(b) *Water Quality Standards and Water pollution:* Water quality parameters like pH, alkalinity, DO, BOD, COD, chloride, sulphate, available chlorine etc. Water treatment and purification processes (reverse osmosis, electro dialysis, ion exchange). Pollutants and their sources. Effluent treatment (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: textile, tannery, dairy and petrochemicals and agrochemicals.

Practical

(Credits: 02, Laboratory periods: 60)

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD).
3. Determination of Biological Oxygen Demand (BOD).
4. Measurement of chloride and sulphate ions of water samples by simple titration method. (With $AgNO_3$ and potassium chromate).
5. Measurement of salinity of water samples by simple titration method. (With $AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method.
7. Determination of Percentage of available chlorine in bleaching powder.
8. Isolation of compounds using solvent extraction method.

References (Theory):

1. Stocchi, E. (1990), **Industrial Chemistry**, Vol-I, Ellis Horwood Ltd. UK.
2. Kent, J. A. (ed.) (1997), **Riegel's Handbook of Industrial Chemistry**, CBS Publishers, New Delhi.
3. Austin, G.T (2012), **Shreve's Chemical Process Industries**, Tata McGraw-Hill Education Private Limited.
4. Girard, J.E, (2011), **Principles of Environmental Chemistry**, Jones & Bartlett India Pvt. Limited.
5. Sodhi, G.S. ((2013), **Fundamental Concepts of Environmental Chemistry**, Narosa Publishing House.
6. Vermani, O.P; Narula, A.K. (2012), **Industrial Chemistry**, Galgotia Publishing Pvt. Limited.
7. Sharma, B.K. (2011), **Industrial Chemistry**, Goel Publishing House.
8. Pani, B. (2017), **Textbook of Environmental Chemistry**, I.K. International Publishing House.
9. De, A. K. (2015), **Environmental Chemistry**, New Age International Pvt, Ltd, New Delhi.

10. Khopkar, S.M. (2012), **Environmental Pollution Analysis**, New Age International Publisher.

References (Practical):

1. Bassett,J.; Denney, R.C.; Jeffery, G.H.; Mendham, J.(1996) **Vogel Textbook of quantitative inorganic analysis**, 7th edition, ELBS edition.Prentice Hall Publications.
2. Furniss, B. S; Hannaford, A. J.; Smith, Peter W. G.; Tatchell, A. R; **Vogel's Text Book of Practical Organic Chemistry**, 5th Edition, Longman Scientific and Technical, Longman Group Ltd.
3. Mittal, K.; Chandra, L.(2013) **Experiments in organic chemistry**, Anne Books Pvt. Limited.
4. Gulati, S.; Sharma, J.L.; Manocha, S. (2017) **Practical Inorganic Chemistry**. CBS, Publications.
5. Rogers, A. (2015) **Laboratory Guide of Industrial chemistry**, Palala Press.

Teaching Learning Process:

- The teaching learning process will involve the traditional chalk and black board method.
- Along with pedagogy of flipped classroom students are encouraged to participate actively in the classroom through regular presentations on curriculum based topics, peer assessment, designing games based on specific topics etc.
- As the best way to learn something is to do it yourself, practicals are planned in such a way so as to reinforce the topics covered in theory

Assessment Methods:

The effectiveness of learning can be judged by assessing the students. Assessment can be in the form of graded assignments, conventional class tests, class seminars by students on course topics and end semester university examination for theory and practical.

Keywords:

Industrial processes, Inorganic chemicals, acids and bases, oxidizing agents, Air pollution, particulate matters, Water pollution, Water quality parameters, Industrial effluents.

11.1.2 Course Code: Chemistry DSC-C 1
Course Title: Basic Concepts of Organic Chemistry
Total Credits: 04 (Credits: Theory-02, Practical-02)
Total Lectures: Theory- 30, Practical-60

Objectives:

The course is infused with the recapitulation of fundamentals of organic chemistry and the introduction of the concept of visualizing the organic molecules in a three-dimensional space. To establish the applications of these concepts, a study of diverse reactions through mechanisms is included. The constitution of the course strongly aids in the paramount learning of the basic concepts and their applications.

Learning Outcomes:

By the end of the course, the students will be able to:

- Understand and explain the differential behaviour of organic compounds based on fundamental concepts learnt.
- Understand the fundamental concepts of stereochemistry.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Learn and identify many organic reactions and their mechanisms including electrophilic addition, nucleophilic addition, nucleophilic substitution, electrophilic substitution and rearrangement reactions.

Unit 1: Fundamentals of organic chemistry Lectures: 05

Types of Electronic displacements: Inductive effect, Resonance effect, Hyperconjugation, Electromeric Effect. Reactive intermediates and their stability: carbocations, free radicals, carbanions, benzyne, carbenes.
Acidity and basicity in organic compounds (comparison of carboxylic acids, alcohols, phenols, primary, secondary and tertiary aliphatic amines, aniline and its derivatives)

Unit 2: Stereochemistry Lectures: 07

Types of projection formulae: Flying Wedge Formula, Newmann, Sawhorse and Fischer representations and their interconversion.
Stereoisomerism: Concept of chirality (upto two carbon atoms). Configurational isomerism: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; *Cis-trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and *E*/*Z* nomenclature (for upto two C=C systems).
Conformational isomerism with respect to ethane, butane and cyclohexane.

Unit 3: Types of Organic Reactions (Including reactions of alkenes, alkyl and aryl halides, alcohols, aldehydes, ketones) Lectures: 18

Electrophilic addition reactions
Electrophilic addition reaction (with respect to propene, propyne, 3,3-dimethyl-1-butene): Hydration, Addition of HX in the absence and presence of peroxide, Hydroboration oxidation, Addition of bromine (with stereochemistry).
Nucleophilic addition reactions
Nucleophilic addition reaction of carbonyl compounds: Addition of HCN, ammonia derivatives (Hydroxylamine, Hydrazine, Semicarbazide and 2,4-DNP), the addition of carbanion (Aldol condensation, Claisen Schmidt, Benzoin condensation, Perkin reaction, reactions involving Grignard reagent).
Elimination and Nucleophilic substitution reactions
Nucleophilic substitution reaction (S_N1 and S_N2) in alkyl halides (mechanisms with stereochemical aspect), alcohols (with nucleophiles like ammonia, halides, thiols, ambident nucleophiles (cyanide and nitrite ion)), ethers (Williamson ether synthesis), Elimination reaction (E1 & E2), elimination *vs* substitution (*w.r.t.* potassium t-butoxide and KOH); Nucleophilic aromatic substitution in aryl halides-elimination addition reaction *w.r.t.* chlorobenzene, including the effect of nitro group (on the ring) on the reaction. relative reactivity and strength of C-X bond in alkyl, allyl, benzyl, vinyl and aryl halides towards substitution reactions

Electrophilic substitution reactions

Electrophilic Aromatic substitution with mechanism (benzene)- sulphonation, nitration, halogenation, Friedel craft acylation :*o*-, *m*- and *p*- directive influence giving examples of toluene/nitrobenzene/ phenol/ aniline/ chlorobenzene.

Reactive intermediates and Rearrangement Reactions

Free radicals (Birch Reduction); *Carbocations* (Pinacol-Pinacolone, Wagner-Meerwein, Rearrangement, and Beckmann rearrangement); *Carbanions (*Michael Addition); *Carbenes* (Reimer-Tiemann).

Practical

(Credits: 02, Laboratory periods: 60)

1. Purification of an organic compound by crystallization (from water and alcohol) and distillation, Criteria of purity: Determination of M.P.
2. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method)
3. Detection of extra element
4. Preparations: (Mechanism of various reactions involved to be discussed).

    a. Bromination of phenol/aniline.
    b. 2,4-Dinitrophenylhydrazone of aldehydes and ketones
    c. Semicarbazone of aldehydes/ ketones
    d. Aldol condensation reaction using green method.
    e. Bromination of Stilbene.
    f. Acetanilide to p-Bromoacetanilide.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

References (Theory):

1. Sykes, P.(2003), **A Guide Book to Mechanism in Organic Chemistry,** 6th Edition Pearson Education.
2. Eliel, E. L. (2001), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Pearson Education.
4. Bahl, A; Bahl, B. S. (2019), **Advanced Organic Chemistry**, 22nd Edition, S. Chand.

References (Practical):

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
3. Dhingra, S; Ahluwalia V.K., (2017), **Advanced Experimental Organic Chemistry**, Manakin Press.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

Teaching Learning Process:

- Blend of conventional blackboard teaching, modern teaching learning tools.
- Computational infrastructure- based instructions and Practical training.
- Problem solving and quizzes for enhanced understanding of the concepts.
- Explaining the handling and usage of the hardware and softwares required for solution to the given set of problems.

Assessment Methods:

- Presentations by individual student/ group of students
- Class Tests at periodic intervals.
- Written assignment(s)
- End semester University theory examination presentations by individual student/ group of students

Keywords:
Chirality, Electrophilic addition, Nucleophilic addition, Nucleophilic substitution, Electrophilic substitution

11.1.3 Course Code: Mathematics DSC-MP 1
Course Title: Calculus
Total Credits: 04 (Credits: Theory-03, Tutorial-01)
Total Lectures: Theory- 45, Tutorial -15

Course Objectives: The primary objective of this course is to introduce the basic tools of calculus which arehelpful in understanding their applications in many real-world problems. Students will be able to understand/create various mathematical models in everyday life.

Course Learning Outcomes: This course will enable the students to:

i) Understand continuity and differentiability in terms of limits and graphs of certain functions.
ii) Describe asymptotic behaviour in terms of limits involving infinity.
iii) Use of derivatives to explore the behaviour of a given function locating and classify its extrema and graphing the function.
iv) Apply the concepts of asymptotes, and inflexion points in tracing of cartesian curves.
v) Compute the reduction formulae of standard transcendental functions with applications.

Unit 1: Limits, Continuity and Differentiability

Limit of a function, $\varepsilon - \delta$ definition of a limit, Infinite limits, Continuity and types ofdiscontinuities; Differentiability of a function, Successive differentiation: Calculation of the *n*th derivatives, Leibnitz theorem; Partial differentiation, Euler's theorem on homogeneous functions.

Unit 2: Mean Value Theorems and its Applications

Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities; Taylor's

theorem, Taylor's series, Maclaurin's series expansions of e^x, $\sin x$, $\cos x$, $\log(1+x)$ and $(1+x)^m$;
Indeterminate forms.

Unit 3: Tracing of Curves and Reduction Formulae

Asymptotes (parallel to axes and oblique), Concavity and inflexion points, Singular points, Tangents at theorigin and nature of singular points, Curve tracing (cartesian and polar equations).

Reduction formulae for $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, and $\int \sin^m x \cos^n x\,dx$ and their applications.

References:

1. Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.
2. Prasad, Gorakh (2015). *Integral Calculus*. Pothishala Pvt. Ltd. Allahabad.

Additional Readings:

i. Apostol, T. M. (2007). *Calculus*: *One-Variable Calculus with An Introduction to Linear Algebra* (2nded.). Vol. 1. Wiley India Pvt. Ltd.

ii. Ross, Kenneth. A.(2013). *Elementary Analysis*: *The Theory of Calculus* (2nd ed.). Undergraduate Texts inMathematics, Springer. Indian reprint.