CBCS: B. Sc. (Honours) with CHEMISTRY
Discipline Specific Elective (DSE) Course

CHEMISTRY
(Honours)
(5th Semester)
Course No.: **CHEMISTRY-DSE-502**

(Green Chemistry)

Contact Hours: 60

Full Marks = 70 [End Semester Exam (56) Internal Assessment (14)**]**

Objective of the Course: To develop the basis knowledge of green chemistry and its future trends.

Expected Learner Outcome: Students will gain an understanding of

i. concept of green chemistry
ii. Use of safer chemicals
iii. Concept of atom economy
iv. Use of green solvent
v. Use of green chemistry in our day to day life

Unit I: Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.
Limitations? Obstacles in the persuit of the goals of Green Chemistry.

4 Lectures, Marks - 4

Unit II: Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following

i) Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products, Atom Economy,Calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
ii) Prevention/ minimization of hazardous/ toxic products reducing toxicity
iii) Green solvents- supercritical fluids, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized solvents and how to compare greenness of solvents.
iv) Energy reuirements for reactions- alternative sources of energy: use of microwaves and ultrasonic energy.
v) Selection of starting materials; avoidance of unnecessary derivatization- careful use of blocking/ protecting groups.
vi) Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis.

vii)Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD " What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.
viii)Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

30 Lectures, Marks - 27

Unit III: Examples of Green Synthesis/ Reactions and some real world cases

Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents, Diels-Alder reaction and Decarboxylation.
Ultrasound assisted reactions: sonochemical Simmons- Smith Reaction (Ultrasonic alternative to Iodine)
Surfactants for carbon dioxide- replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning garments.
Designing of Environmentally safe marine antifoulant.
Rightfit pigments: synthetic azopigments to replace toxic organic and inorganic pigments.
An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.
Healthier Fats and Oil by Greeen Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils.
Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting.

16 Lectures, Marks - 15

Unit IV: Future Trends in Green Chemistry:

Oxidation reagents and catalysts; Biominimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C^2S^3); Green chemistry in sustainable development.

10 Lectures, Marks - 10

Reference Books:

1. V. K. Ahluwalia & M. R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. P. T. Anastas & J. K. Warner: Oxford Green Theory and Practical, University Press (1998).
3. A. S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
4. M. C. Cann & M. E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
5. M. A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

CBCS: B. Sc. (Honours) with CHEMISTRY

Discipline Specific Elective (DSE) Course

CHEMISTRY

(Honours)

(5th Semester)

Course No.: **CHEMISTRY-DSE-502-LAB**

(Green Chemistry)

Contact Hours: 60

Full Marks = 30 [End Semester Exam (24) Internal Assessment (6)**]**

Time: 6 hours

A. ***Any 2 (two) experiments to be set in examination*** **Marks - 10×2=20**

a. Safer Starting Materials

The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch – study of effect of concentration on clock reaction

b. Using Renewable Resources

Preparation of biodiesel from vegetable oil.

c. Avoiding Waste

Principle of atom economy.
Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of acetanilide from aniline using acetic acid in presence of zinc dust.
The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

d. Green Reactions

Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.

Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

B. Viva – voce **Marks - 4**

Reference Books:

1. Anastas, P. T & Warner, J. C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
2. Kirchoff, M. & Ryan, M. A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).

3. Ryan, M. A. Introduction to Green Chemistry, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
4. Sharma, R. K.; Sidhwani, I. T. & Chaudhari, M. K. I. K. Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore CISBN 978-93-81141-55-7 (2013). 56
5. Cann, M. C. & Connelly, M. E. Real world cases in Green Chemistry, AmericanChemical Society (2008).
6. Cann, M. C. & Thomas, P. Real world cases in Green Chemistry, American Chemical Society (2008).

Pavia, D. L. Lamponan, G. H. & Kriz, G. S. W B Introduction to organic laboratory

Discipline Specific Elective (DSE) Course

CHEMISTRY
(Honours)
(6th Semester)
Course No.: **CHEMISTRY-DSE-602**

(Industrial Chemicals and Environment)

Contact Hours: 60

Full Marks = 70 [End Semester Exam (56) Internal Assessment (14)**]**

Objective of the Course: To impart knowledge about nuclear pollution, ecosystem, handling of industrial gases, semi conductor technology etc.

Expected Learner Outcome: Students will gain an understanding of

i. Stored and handle different types of industrial gases and chemicals
ii. Semiconductor technology
iii. The effect of hazardous chemicals, purification method of water and industrial waste management.

Unit I: Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: Oxygen, nitrogen, argon, neon,helium, hydrogen, acetylene, crbon monoxide,chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic materials: Manufacture, application, analysis, and hazards in handling of the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

10 Lectures, Marks - 10

Unit II: Industrial Metallurgy

Preparation of metals (ferrous and non ferrous) and ultrapure metals for semiconductor technology.

4 Lectures, Marks - 4

Unit III: Environment and its segments

Ecosystem, Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources,particle size and chemical nature. Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, major sources of air pollution.

Pollution by SO_2, CO_2, CO, NO_x, H_2S and other foul smeling gases, Methods of estimation of CO, NO_x, SO_x and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone

Letion by oxides of nitrogen, chlorofluorocarbons and halogens, removal of sulphur from coal. Control of particulates.

Water pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile. Tannery, diary, petroleum and petrochemicals, agro, fertilizers etc. Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (Reverse osmosis, electro dialysis, ion-exchange). Water quality parameters for waste watter, industrial water and domestic water.

30 Lectures, Marks - 30

Unit IV: Energy & Environment

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion/ Fission, Solar energy, Hydrogen, Geothermal, Tidal and Hydel etc.

Nuclear pollution: Disposal of nuclear waste, nuclear disaster and its management.

10 Lectures, Marks - 8

Unit V: Biocataysis

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

6 Lectures, Marks - 4

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-1, Ellis Horwood Ltd, UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi
4. S.S.Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd, New Delhi
5. K.De, *Environmental Chemistry*: New Age International Pvt. Ltd., New Delhi
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi
7. S.E. Manahan, *Environmental Chemistry*, CRC Press (2005)
8. G. T. Miller, *Environmental Science*, 11th Ed. Brooks/ Cole(2006)
9. A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005)

CBCS: B. Sc. (Honours) with CHEMISTRY

Discipline Specific Elective (DSE) Course

CHEMISTRY

(Honours)

(6th Semester)

Course No.: **CHEMISTRY-DSE-602-LAB**

(Industrial Chemicals and Environment)

Contact Hours: 60

Full Marks = 30 [End Semester Exam (24) Internal Assessment (6)**]**

Time: 6hours

A. ***Any 2 (two) experiment to be set in examination*** **Marks - 10×2=20**

i) Determination of dissolved oxygen in water.

ii) Determination of Chemical Oxygen Demand

(COD)iii)Determination of Biological Oxygen Demand (BOD)

iv) Percentage of available chlorine in bleaching powder.

v)Estimation of total alkalinity of water samples (CO_3^{-2}, HCO^-) using double titrationmethod.

vi) Measurement of dissolved CO_2

B. Viva-Voce **Marks - 4**

Reference Books:

1. E. Stocchi: *Industrial Chemistry*, Vol-1, Ellis Horwood Ltd, UK.
2. R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, WileyPublishers, New Delhi
3. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi
4. S.S.Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd, New Delhi
5. K.De, *Environmental Chemistry*: New Age International Pvt. Ltd., New Delhi
6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi

B. SC. IN CHEMISTRY PROGRAM (NEP)

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course : Basic Analytical

ChemistryCourse Code : SEC123

Nature of the Course : SKILL ENHANCEMENT COURSE

Total Credits : 3

Distribution of Marks : 80 (End Sem) (60T+20P) + 20 (In-Sem)

COURSE OBJECTIVES:

- To provide a basic understanding of chemical analysis of soil, water, food products, cosmetics and separation techniques (viz. chromatography, ion exchange, etc.)

UNITS	CONTENTS	L	T	P	Total Hours
I (18 Marks)	**Introduction:** Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.	3	0	-	3
	Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.	5	0	-	5
II (18 Marks)	**Analysis of water :** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. a. Determination of pH, acidity and alkalinity of a water sample. b. Determination of dissolved oxygen (DO) of a water sample.	5	0	-	5
	Analysis of food products: Nutritional value of foods, idea about food processing and food preservations and adulteration. a. Identification of adulterants in some common food	5	0	-	5

	items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. b. Analysis of preservatives and colouring matter.				
III **(24 Marks)**	**Chromatography:** Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. a. Paper chromatographic separation of mixture of metal ion ($Fe^{3+}$and Al^{3+}). b. To compare paint samples by TLC method.	**4**	**0**	**-**	**4**
	Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).	**4**	**0**	**-**	**4**
	Analysis of cosmetics: Major and minor constituents and their function a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.	**4**	**0**	**-**	**4**
IV **(20 Marks)**	**Any one experiment :** (i) Determination of dissolved oxygen in water. (ii) Determination of Chemical Oxygen Demand (COD) (iii) Determination of Biological Oxygen Demand (BOD) (iv) Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry (v) Spectrophotometric determination of Iron in Vitamin / Dietary Tablets. (vi) Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drinks	**0**	**0**	**30**	**30**
	Total	**30**	**0**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Sessional Examination
  - Assignment

LEARNING OUTCOMES:

At the end of this course, students will be able

I. To understand the analysis of soil, water, food products, cosmetics and principles of different types of chromatography.
II. To operate flame photometer and spectrophotometer in determination of macro nutrients present in soil and iron in vitamin
III. To determine pH, physical and chemical parameter in soil and water which are significant in day to day life.
IV. To separate mixtures using separation techniques.

SUGGESTED READINGS:

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA,1988.
2. Skoog, D.A., Holler, F.J. & Crouch, S. *Principles of Instrumental Analysis*, Cengage Learning India Edition, 2007.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Analytical Chemistry: An Introduction 6th Ed.,* Saunders College Publishing, Fort Worth, Philadelphia (1994).
4. Harris, D. C. *Quantitative Chemical Analysis*, 9th ed. Macmillan Education, 2016.
5. Dean, J. A. *Analytical Chemistry Handbook*, McGraw Hill, 2004.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India, 1992.
7. Freifelder, D.M. *Physical Biochemistry 2nd Ed.,* W.H. Freeman & Co., N.Y. USA (1982).
8. Cooper, T.G. *The Tools of Biochemistry,* John Wiley & Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.,* Prentice Hall, 1996.
10. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
11. Robinson, J.W. *Undergraduate Instrumental Analysis 5th Ed.,* Marcel Dekker, Inc., NewYork (1995).
12. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004
13. Higson, S. P.J. (2003), Analytical Chemistry, Oxford University Press.
14. Fifield, F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
15. Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.

Title of the Course : Basic Analytical Chemistry (Fuel Chemistry)Course Code : SEC223
Nature of the Course : SKILL ENHANCEMENT COURSE
Total Credits : 3
Distribution of Marks : 80 (End Sem) (60T+20P) + 20 (In-Sem)

COURSE OBJECTIVES:

- The course aims to provide students with a basic scientific and technical understanding of the production, behaviour and handling of hydrocarbon fuels, petrochemicals and lubricants. This will enable them to be industry ready to contribute effectively in the field of petroleum chemistry and technology.

UNITS	CONTENTS	L	T	P	Total Hours
I (18 Marks)	Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value.	3	0	-	3
	Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas— composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals.	6	0	-	6
II (25 Marks)	*Petroleum and Petrochemical Industry*: Composition of crude petroleum; Different types of petroleumproducts and their applications. Principle and process of fractional distillation, Cracking - Thermal andcatalytic cracking; Qualitative treatment of non- petroleum fuels - LPG, CNG, LNG, bio-gas, fuels derived from biomass, fuel from waste; synthetic fuels -gaseous and liquids.	9	0	-	9
	Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.	6	0	-	6
III (17 Marks)	*Lubricants*: Classification of lubricants, lubricating oils (conducting and non-conducting),Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants – viscosity index, cloud point, pore point.	6	0	-	6
IV (20 Marks)	**Any one experiment :** (i) To determine the Aniline point of a given lubricating oil. (ii) To determine the acid value of a given oil	0	0	30	30

	(iii) To determine the enthalpy of combustion of liquid fuels using spirit / alcohol burner. (iv) To perform the proximate analysis of coal (v) To perform the ultimate analysis of the coal sample.				
	Total	**30**	**0**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Sessional Examination
  - Assignment

LEARNING OUTCOMES:

At the end of this course, students will be able

I. To *distinguish* conventional petroleum-based fuels and alternative & renewable fuels.

II. To *gain* the knowledge of the origin of petroleum, crude oil, composition, differentrefining processes employed industrially to obtain different fractions of petroleum.

III. To *perform* various test used to qualify different types of fuels.

SUGGESTED READINGS:

1. E. Stocchi (1990) Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.
2. P. C. Jain, M. Jain: Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
3. B. K. Sharma: Industrial Chemistry, Goel Publishing House, Meerut.