

**B. Sc. Semester –III**  
**Chemistry (Major-I) Organic Chemistry**  
**BS23MJ3CH1**

**Learning Objectives:** This core course aims to introduce the learner to the fascinating chemistry of some biomolecules, i.e., carbohydrates, amino acids, peptides, proteins. It aims to build the concept of amines, diazonium salts and heterocycles by the study of their physical properties, synthesis routes and chemical reactions. The course will delve into various aspects of alkenes and alkynes chemistry with specific emphasis on mechanistic studies.

**Learning Outcomes:** On completion of this course, the students will be able to: • demonstrate understanding regarding classification, occurrence and synthesis of biomolecules such as carbohydrates, proteins, peptides and amino acids. • Gain insight into chemistry of amines, diazo compounds regarding their synthesis and physico-chemical properties. • Demonstrate understanding of various aspects regarding chemical reactions such as mechanistic studies, synthesis and reactivity of heterocyclic, alkenes and alkynes.

**UNIT-1 [A] Carbohydrates**

Carbohydrates Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projection and conformational structures; Interconversion of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation.

**[B] Amino acids, Peptides and their classification.**

$\alpha$ -Amino Acids – Synthesis (Strecker's and Gabriel's Phthalimide), ionic properties and reactions. Zwitterions, pK<sub>a</sub> values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structure-end group analysis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups, Solid-phase synthesis; primary, secondary and tertiary structures of proteins, Denaturation of proteins.

**UNIT 2[A] Amines**

Introduction, classification, chirality in amines (pyramidal inversion), importance and general methods of preparation. Properties: Physical properties, Basicity of amines: Effect of substituents, solvent and steric effects. Distinction between Primary, secondary and tertiary

amines using Hinsberg's method and nitrous acid. Discussion of the following reactions with emphasis on the mechanistic pathway: Gabriel Phthalimide synthesis, Hoffmann- Bromamide reaction, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction and Cope elimination.

**[B] Diazonium Salts:** Preparation and synthetic applications of diazonium salts including preparation of arenes, haloarenes, phenols, cyano and nitro compounds. Coupling reactions of diazonium salts (preparation of azo dyes)..

### **UNIT - 3 Heterocyclic Compounds**

Introduction, importance, classification and nomenclature of heterocyclic compounds (containing only one hetero atom). General discussion on the following aspects of heterocyclic compounds: Structure, Aromaticity in 5-membered and 6-membered rings containing one heteroatom; Basicity and relative reactivity towards electrophilic substitution reactions(amongst five membered and six membered rings i.e. pyrrole, thiophene, furan, pyridine)

General methods of synthesis for: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Properties: Physical properties, discussion on the following reaction (with mechanism) for Furan, Pyrrole, thiophene, Pyridine : Electrophilic substitution- Nitration, sulphonation, halogenation, Formylation, acylation, mercuration and carboxylation. Oxidation,Reduction, Addition, Reactions showing acidic /basic character,Nucleophilic substitution reaction.

### **Unit 4[A] Alkenes**

Addition to  $C=C$ : Mechanism, reactivity, regioselectivity (Markownikoffs and Anti-Markownikoffs additions) and stereoselectivity. Reaction: Hydrogenations, Hydrohalogenation, Hydration, Oxymercuration-demercuration, Hydroboration-Oxidation , ozonolysis, electrophilic addition to diene (conjugated dienes and allene), reaction with NBS, Birch reduction of Benzenoid aromatics, inter-conversion of E- and Z- alkenes.

### **[B] Alkynes**

Addition to  $C\equiv C$  (in comparison to  $C=C$ ): Mechanism, reactivity ,regioselectivity (Markownikoffs and AntiMarkownikoffs additions) and stereo selectivity. Reaction: Hydrogenations, Hydro halogenations, Hydration, Oxymercuration-demercuration, Hydroboration-Oxidation, ozonolysis, Birch reduction of alkynes, reactions of terminal alkynes by exploring its acidity.

## REFERENCES

1. Berg, J.M.; Tymoczko, J.L.; Stryer, L. (2006), Biochemistry. W.H. Freeman and Co.
2. Nelson, D.L.; Cox, M.M.; Lehninger, A.L.(2009), Principles of Biochemistry. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A.; Rodwell, V.W.(2009), Harper's Illustrated Biochemistry. Lange Medical Books/McGraw-Hill.
4. Brown, T.A. (2018) Biochemistry, (First Indian addition 2018) Viva Books.
4. Clayden, J., Greeves, N., Warren, S. Organic Chemistry, Second edition, Oxford University Press 2012.
5. Sykes, P. A guidebook to Mechanism in Organic Chemistry, Pearson Education, 2003.
6. Smith, J. G. Organic Chemistry, Tata McGraw-Hill Publishing Company Limited.
7. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
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**B. Sc. Semester –III**  
**Chemistry (Major-II) Physical Chemistry**  
**BS23MJ3CH1**

**Learning Objectives:** The aim of this course is to make students understand third law of thermodynamics and concept of absolute entropy, terms encountered in thermochemistry. The students will be exposed to important concepts such as solutions, colligative properties, adsorption and fundamentals of electrochemistry.

**Learning Outcomes:** By the end of the course, students will be able to Understand the third law of thermodynamics and its applications. Derive various expressions of thermochemistry. Explain the various concepts regarding solutions and colligative properties and adsorption. Explain the basic terms of electrochemistry.

**UNIT-1 Third law of Thermodynamics and Thermochemistry**

Statement of third law, unattainability of absolute zero, calculation of absolute entropy of molecules, concept of residual entropy, calculation of absolute entropy of solid, liquid and gases.

Enthalpy of reactions, standard states, enthalpy of neutralization, enthalpy of hydration, enthalpy of formation and enthalpy of combustion and its applications, bond dissociation energy and bond enthalpy, Hess's law of constant heat summation and its application, bond energies, applications of bond energies.

**UNIT-2 Solutions and Colligative properties**

Dilute solutions; lowering of vapour pressure, Raoult's law, Henry's law. Thermodynamic basis of the colligative properties - lowering of vapour pressure, elevation of Boiling Point, Depression of Freezing point and Osmotic pressure and derivation of expressions for these using chemical potential. Application of colligative properties in calculating molar masses of normal, dissociated and associated solutes in solutions. Concept of activity and activity coefficients.

**UNIT-3 Adsorption**

Definition of terms, Types of adsorption, Applications of adsorption, Factors affecting adsorption, Adsorption isobar and isostere, Desorption activation energy, Derivation of Freundlich adsorption isotherm, Derivation of Langmuir adsorption isotherm, Types of adsorption isotherms

**UNIT- 4 Introduction of Electrochemistry**

Electrodes, cell emf, emf and free energy, Standard electrode potentials, Nernst equation, emf and activities, activity coefficients from emf's, equilibrium constant from emf's, electrode concentration cells, electrolyte concentration cells, thermodynamic properties from cell emf's.

## REFERENCES

1. Peter, A.; Paula, J. de. (2011), Physical Chemistry, 9th Edition, Oxford University Press.
2. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.
3. Kapoor, K.L.(2015), A Textbook of Physical Chemistry, Vol 2, 6th Edition, McGraw Hill Education.
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**BS23MJ3CH3**  
**B. Sc. Semester –III**  
**Chemistry (Major-III)**  
**[Organic & Physical Practical]**

**Learning Objectives:** To introduce fundamentals of organic spotting and estimation of organic compounds. To familiarize students with the concept of hydrolysis, conductometric titrations, adsorption, refraction and viscosity through practical methods.

**Learning outcomes:** After completion of course the students will be able to explain and perform organic spotting and estimation. The students will be able to perform experiment regarding measurements of temperature coefficient, strength of acids and conductometric titrations.

**A. Organic Spotting and Estimation:**

**Organic spotting** minimum eight compounds (5 solids and 3 liquids)

**Acids:** Salicylic acid, Cinnamic acid, Phthalic acid, Anthranilic acid

**Phenols:** p-Nitro phenol,  $\alpha$ -Naphthol,  $\beta$ -Naphthol

**Bases:** p-Toluidine, Diphenyl amine,  $\alpha$ -Naphthyl amine

**Neutral:** Solids:-Acetanilide, m-Dinitrobenzene, Glucose, Bazamide

**Liquids:** Acetophenone, Carbon tetrachloride (CCl<sub>4</sub>), Methyl acetate, Ethyl acetate

**Estimations:**(1)Glucose

(2) Ketone

(3) Phenol/Aniline

**B. Physical Experiment**

1. To determine the relative strength between HCl and H<sub>2</sub>SO<sub>4</sub> by studying hydrolysis of methyl acetate.
2. To determine the temperature coefficient and energy of activation of hydrolysis of methyl acetate catalyzed by acid.
3. To study the adsorption of an organic acid by Animal Charcoal.(Acetic acid/Oxalic acid).
4. Conductometric titration.
  - (i) Strong acid vs Strong base (HCl vs NaOH)
  - (ii) Weak acid vs Strong base (CH<sub>3</sub>COOH vs NaOH)
  - (iii) Mixture of acids vs Strong base (HCl+CH<sub>3</sub>COOH vs NaOH)
5. To determine specific refraction and molar refraction of liquid A,B and their mixture(OnlyDemo)
6. To determine absolute viscosities of liquid A, B and their mixture (Only Demo)

## REFERENCES

1. I Vogel, "*Elementary Practical Organic Chemistry Part-II, Qualitative Organic Analysis*", CBS Publishers & Distributers, New Delhi, Second Edition, 2004.
2. I Vogel, "*Elementary Practical Organic Chemistry Part III Quantitative*
3. *Organic Analysis*", CBS Publishers & Distributers, New Delhi, Second Edition, 2004.
4. V.K. Ahluwalia, Sunita Dhingra, "*Comprehensive Practical Organic Chemistry – Qualitative Analysis*", University Press (India) Private Limited, Hyderabad, First Indian Edition, 2010.
5. Mohan Jag, "*Organic Analytical Chemistry theory and Practice*", Narosa Publication, New Delhi, 2003.
6. J. Leonard, B. Lygo, G. Procter, "*Advanced Practical Organic Chemistry*", Stanley Thorne (Publishers) Ltd., First Indian Edition, 2004.
7. J. B. Yadav, "*Advance Physical Practical Chemistry*", Goel Publishing House, Meerut
8. P. H. Parsania, "*Experiments in Physical Chemistry*", Neminath Printers Rajkot First Edition 2004.
9. A. M. James and F. E. Prichard "*Practical Physical Chemistry*", Longman Group Limited London Third Edition Reprinted 1979

**BSC Semester- III (SEC)**  
**Business Skills for Chemists**  
**BSC23SE302**

**Learning Objectives:** The objective of this course is to enhance the business and entrepreneurial skills of undergraduate chemistry students and improve their employment prospects. The course will orient the students to understand the Industry linkage with chemistry, challenges and business opportunities. It will expose the students to the concepts of intellectual property rights, patents and commercialisation of innovations.

**Learning Outcomes:** By the end of this course, students will be able to: Learn basics skills of business and project management. Learn the process by which technical innovations are conceived and converted into successful business ventures. Understand the intellectual property rights and patents which drive business viability and commercialization of innovation. They will effectively use the skills to contribute towards the well-being of the society and derive commercial value.

**UNIT- 1: Chemistry in industry**

Current challenges and opportunities for the chemistry based industries, Role of chemistry in India and global economies, Supply chains of chemistry, important raw materials, Chemistry based products in the market.

**Business Basics**

Key business concepts, Business plans, Market need, Project management, Routes to market, Concept of entrepreneurship

**UNIT - 2: Project Management**

Different stages of a project: Ideation, Bench work, Pilot trial, Production, Promotion/ Marketing, Intellectual Property Rights, Introduction to IPR & Patents, Agencies and regulators for IPR in India, Funding agencies for startups.

**REFERENCES**

1. [www.rsc.org](http://www.rsc.org)
2. Nwaeke, L.I.(2002), Business Concepts and Perspectives, Springfield Publishers.
3. Silva, T. D. (2013), Essential Management Skills for Pharmacy and Business Managers, CRC Press.



**Shri Govind Guru University, Vinzol**  
**B. Sc. Semester –III**  
**BSC23VA301(IKS)**

**ANCIENT INDIAN SCIENCE, ENGINEERING AND TECHNOLOGY**

**Learning objectives:** To review & strengthen the ancient discovery and research in physics, chemistry, maths, metallurgy, astronomy, architecture, textile, transport, agriculture and Ayurveda etc. To help students to trace, identify and develop the ancient knowledge systems to make meaningful contribution to development of science today.

**Learning outcomes:** After the completion of the course students will be able to trace historical development of science and technology in Indian subcontinent. This course will enhance students' understanding regarding the research of ancient Indian scientists and will help them to appreciate Indian culture of science and further build upon their research work.

**UNIT - 1: Indian Traditional Science and Practices**

Introduction to the Science and way of doing science and research in India, Ancient Science in Intra & Inter Culture Dialogue & coevolution. Traditional water-harvesting practices, Traditional Livestock and veterinary Sciences Traditional Houses & villages, Traditional Forecasting, Traditional Ayurveda & plant based medicine, Traditional writing Technology.

**Physics in India:** Vaisheshikadarshan, Atomic theory & law of motion, theory of panchmahabhoota, BrihathShathaka (divisions of the time, unit of distance), bhaskarachaya (theory of gravity, suryasiddhanta&sidhantashriomani), Lilavati (gurutvakashan Shakti).

**Chemistry in India:** Vatsyayana, Nagarjuna, Khanda, Al-Biruni, Vagbhaṭa –building of the ras-shala (laboratory), working arrangements of ras-shala, material and equipment, YaśodharaBhaṭṭa-process of distillation, apparatus, saranasamskara, saranataila.

**Mathematics in India:** Baudhayana's Sulbasutras, Aryabhata, Bhaskaracharya-I, Severus Sebokht, Syria, Brahmagupta, Bhaskaracharya-II, Jyesthadeva.

**UNIT - 2: Ancient Indian Science (Textile, Agriculture, Transport)**

**Textile Technology in India:** Cotton (natural cellulose fiber), silk, wool (natural protein fibers), bast and leaf fibers, mridhudhautadhupitambaram (meaning a practice of fumigating the fabric with incense smoke before use as a part of the finishing process), sitadhautavasayanayugala (bleached white—a finishing process); suchhastah, sutradharah (needle and thread – tools for stitching). Dyeing, washing spinning and weaving technology,

**Agriculture in India:** Traditional agricultural practices, krishisuktas, Krishiparashara, Brihatsamhita, Types of crops, Manures, Types of land- devamatraka, nadimatruka, use of animals in warfare, animal husbandry, Animals for medicines. Ancient transport in India.

## REFERENCES

1. Textbook on IKS by Prof. B Mahadevan, IIM Bengaluru.
2. Kapur K and Singh A.K (Eds) 2005). Indian Knowledge Systems, Vol. 1. Indian Institute of Advanced Study, Shimla. Tatvabodh of sankaracharya, Central chinmay mission trust, Bombay, 1995.
3. Nair, Shantha N. Echoes of Ancient Indian Wisdom. New Delhi: Hindology Books, 2008.
4. SK Das, The education system of Ancient hindus, Gyan publication house, India.
5. R P Kulkarni, Glimpese of Indian Engineering and Technology (Ancient & Medieval period, MunshiramManoharlal Publishers Pvt. Ltd. 2018.
6. AK Pathak, Science and Technology in India, Anshikaprakashanpratapgarh, 2016.
7. PB Sharma, S. Narain, Doctors Scientists and Engineers of Ancient India, Kalpaz Publications 2017.

**B. Sc. Semester –III**  
**Chemistry Theory (MDC)**  
**Chemistry of Air and Water pollution**  
**BS23MD3CH1**

**Learning Objectives**

To familiarise the students about environmental chemistry, especially with respect to air and water.

**Learning outcomes**

By studying this course, the students will be able to: describe the composition of air, various air pollutants, effects and control measures of air pollutants, list different sources of water, water quality parameters, impacts of water pollution, water treatment, identify different industrial effluents and their treatment methods.

**UNIT – 1 Air Pollution**

Major regions of atmosphere, chemical and photochemical reactions in atmosphere.

Air pollutants: types, sources, particle size and chemical nature, Major sources of air pollution, Pollution by SO<sub>2</sub>, CO<sub>2</sub>, CO, NO<sub>2</sub>, H<sub>2</sub>S and other foul-smelling gases, methods of estimation of CO, NO<sub>2</sub>, SO<sub>2</sub> and control procedures. Chemistry and environment impact of the following: Photochemical smog, Greenhouse effect, Ozone depletion Air pollution control, Settling Chambers, Venturi Scrubbers, Electrostatic Precipitators (ESPs).

**UNIT – 2 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 cycle and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment).

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

**REFERENCES**

1. Stanley E. Manahan, 10th edition, Environmental chemistry, CRC Press, Taylor and Francis Group, US, 2017
2. Baird, C. and Cann, M., Environmental Chemistry, (2012), Fifth Edition, W. H. Freeman & Company, New York, US.
3. VanLoon, G.W. and Duffy, J.S. (2018) Environmental Chemistry - A global perspective, Fourth Edition, Oxford University Press
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5. Masters, G.M., (1974) Introduction to Environmental Science and Technology, John Wiley & Sons.
6. Masters, G.M., (2015) Introduction to Environmental Engineering and Science. JPrentice Hall India Learning Private Limited.
7. De, A.K. (2012), Environmental Chemistry, New Age International Pvt., Ltd.

**BS23MD3CH1**  
**B. Sc. Semester –III Chemistry Practical (MDC)**  
**[Organic Spotting]**

**Organic Spotting and Estimation:**

**Organic spotting** minimum eight compounds (5 solids and 3 liquids)

**Acids:** Salicylic acid, Cinnamic acid, Benzoic acid, Phthalic acid

**Phenols :** p-Nitro phenol,  $\alpha$ -Naphthol,  $\beta$ -Naphthol

**Bases :** m and p-Nitro anilines, p-Toludine

**Neutral:** Solids:-Acetanilide, m-Dinitrobenzene, Glucose,

**Liquids:** Acetophenone, Carbontetrachloride( $\text{CCl}_4$ ), Methyl acetate, Ethyl acetate

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1. I Vogel, "*Elementary Practical Organic Chemistry Part-II, Qualitative Organic Analysis*", CBS Publishers & Distributers, New Delhi, Second Edition, 2004.
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