



**Rashtrasant Tukadoji Maharaj Nagpur University,  
Nagpur 440033**

**Scheme and Syllabus  
Bachelor of Science (Chemistry)**

**Submitted by  
Board of Studies,  
Bachelor of Science (Chemistry)**

## CORE PAPERS/ MINOR PAPERS

B.Sc. Semester – I

BCH1T01

Inorganic Chemistry-1 (Atomic structure, bonding and main group elements)

Theory 2 credits + Practical 1 credit

### Course Outcomes

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

1. Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of *s*, *p*, and *d* orbitals, and periodicity in atomic properties.
2. Draw the plausible structures and geometries of molecules using VSEPR theory.
3. Explain geometries and properties of molecules based on VBT.
4. Understand the concept of lattice energy using Born-Haber Cycle.
5. Rationalize the metallic properties based on various theories.
6. Elaborate structures and properties of common compounds formed by main group elements.
7. Identify acidic and basic radicals in simple inorganic salts.

### Unit-I: 7.5 h

**(A) Atomic structure:** Bohr model, Idea of de-Broglie matter Waves, Heisenberg's uncertainty principle. Schrodinger wave equation, significance of  $\psi$  and  $\psi^2$ , Quantum numbers, Concept of atomic orbital, Radial and angular wave functions and probability distribution curves for *1s*, *2s*, *2p*, *3s*, *3p* and *3d* orbitals, shapes of *s*, *p* and *d* orbitals, Aufbau principle, Bohr-Bury rule, Pauli's exclusion principle and Hund's rule of maximum multiplicity. Principle of extra stability. Electronic Configuration of elements and ions.

**(B) Periodic Properties:** Atomic and ionic radii, ionization energy, electron affinity and electronegativity- Definition, trends in periodic table. Factors affecting ionization potential. Pauling's, Mulliken's and Allred-Rochow scale of electronegativity. Effective nuclear charge and Slater's rule with some numericals.

### Unit-II: 7.5 h

**(A) Covalent Bond:** Valency Bond Theory, Formation of Hydrogen molecule with potential energy diagram with all improvements, Limitations of VBT, Bond energy, bond length, Bond order, Bond angle. Various types of hybridization and shape of inorganic molecules [ $\text{BeF}_2$ ,  $\text{BCl}_3$ ,  $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{PCl}_5$ ,  $\text{SF}_6$  and  $\text{IF}_7$ ].

VSEPR Theory: Rules/postulates and their applications to various common molecules and ions ( $\text{NH}_3$ ,  $\text{ClF}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{SF}_4$ ,  $\text{H}_3\text{O}^+$ ,  $\text{NH}_4^+$ ,  $\text{ICl}_2^-$  etc)

**(B) Ionic solids:** Close packing in ionic solids [Square, Hexagonal, Cubic, BCC and FCC], Radius ratio rule and its limitations, Ionic structures with respect to  $\text{NaCl}$  and  $\text{CsCl}$ , Lattice energy and Born- Haber cycle. Solvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rules.

### Unit -III: 7.5 h

**(A) s- block elements:** Electronic configuration, atomic and ionic radii, Ionisation potential, Reducing properties and Metallic Properties. Diagonal Relationships (Li-Mg).

**Metallic Bond** – Free electron, Valence Bond and Band theory of metallic bond. Properties of conductors, insulators and semiconductors based on Band theory.

**Hydrogen bonding** - Classification and effect of Hydrogen bonding on viscosity, solubility, melting point and boiling point.

**(B) p-block elements:** Introduction to p-block elements, comparative study of groups 15, 16 and 17 with respect to atomic and ionic radii, ionisation potential, electron affinity, electronegativity, redox properties, oxidation state. Diagonal relationship (B-Si).

#### Unit- IV:7.5 h

**Hydrides:** Comparative study with respect to structure of  $\text{NH}_3$ ,  $\text{PH}_3$ ,  $\text{AsH}_3$  and  $\text{SbH}_3$ . Structure and bonding of diborane, structure of borazine.

Allotropes of Carbon [Graphite, Diamond and Fullerene], **Carbides:** Classification and uses, **Silicates:** classification, **Nitrides of sulphur:** Structure of  $\text{S}_4\text{N}_4$ , **Fluorocarbon** and its uses.

**Oxides of Phosphorus:** Structure and bonding in  $\text{P}_2\text{O}_3$  and  $\text{P}_2\text{O}_5$ .

**Oxyacids of Phosphorous:** Structures of  $\text{H}_3\text{PO}_2$ ,  $\text{H}_3\text{PO}_3$ ,  $\text{H}_3\text{PO}_4$ ,  $\text{H}_4\text{P}_2\text{O}_6$  and  $\text{H}_4\text{P}_2\text{O}_7$

**Peroxyacids of Sulphur:** Preparation and structure of Caro's and Marshall's acids.

**Interhalogens and Polyhalides:** Preparation, properties and structure of Interhalogen compounds. Polyhalides- Classification, Structure of  $\text{I}_3^-$ ,  $\text{I}_5^-$ ,  $\text{ICl}_4^-$ .

#### Inorganic Chemistry Practical (1 credit)

##### A) Introduction to Chemistry Laboratory:

1. Safety rules in laboratory
2. Introduction to nomenclature of glassware and instruments
3. Demonstration of handling pipette, burette, volumetric flask and other common glassware.
4. Pipettable and non-pipettable liquids (aqueous, organic, volatile, viscous, carcinogenic etc)
5. Common mistakes in chemistry laboratory

**B) Semimicro Qualitative Analysis:** Qualitative analysis of inorganic salt mixture containing two acidic radicals of different group and two basic radicals of same groups.

**Note:** At least eight mixtures should be analyzed.

#### Reference books

1. Lee, J.D. (2010), Concise Inorganic Chemistry, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J.(1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins Inorganic Chemistry, 5th Edition, Oxford University Press.
5. Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited.
6. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson.
7. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.
8. Svehla, G. (1996), Vogel's Qualitative Inorganic Analysis, Prentice Hall.

**B.Sc. Semester – I**  
**BCH1T02**  
**Organic Chemistry-1 (Fundamentals, stereochemistry and hydrocarbons)**  
**Theory 2 credits + Practical 1 credit**

**Course Outcomes**

*On completion of the course, the student will be able to:*

- 1. Understand and explain the different nature and behaviour of organic compounds based on fundamental concepts learnt.*
- 2. Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.*
- 3. Learn and identify many organic reaction mechanisms including Free Radical Substitution, Electrophilic Addition and Electrophilic Aromatic Substitution.*
- 4. Understand the fundamental concepts of stereochemistry.*
- 5. Elaborate various properties of aliphatic and aromatic hydrocarbons.*
- 6. Experimentally identify extra element and functional group in the given organic compound.*
- 7. Synthesize various organic compounds making use of selective reagents.*

**Unit – I: 7.5h**

**A) Structure and Bonding :** Hybridization in case of Methane, Ethane, Ethylene and acetylene, Bond lengths, bond angles and bond energies. Inductive effect, Electromeric effect. Resonance effect. Hyperconjugation definition, examples and application of these effects. Hydrogen bonding in organic compounds (with reference to alcohol, phenols, amines, acids) and consequences.

**B) Mechanism of Organic Reactions :** Homolytic and heterolytic bond breaking examples and factors favouring the bond fission. Electrophiles and nucleophiles definition and example both neutral and charged. Types of organic reactions addition, substitution, elimination, rearrangement. Energy consideration. Reactive intermediates carbocations, carbanions, free radicals, carbenes, formation, geometry, stability and reactions given by these intermediates.

**Unit - II: 7.5h**

**A) Stereochemistry of Organic Compounds :** Concept of isomerism. Types of isomerism with suitable examples. Optical isomerism-elements of symmetry, molecular chirality, enantiomers, stereogenic centre(lactic acid as example). Optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres (Tartaric acid) diastereomers, mesocompound. Resolution of enantiomers biological and chemical methods. Inversion retention and racemisation. Asymmetric synthesis. Relative and absolute configuration, sequence rules, D and L and R and S system of nomenclature.

**B) Geometrical isomerism :** E and Z system of nomenclature, geometric isomerism in alkenes with examples, maleic acid and fumaric acid, 2-butene.

**Conformational isomerism :** Conformational analysis of ethane, n-butane and substituted n-butane, conformations of Cyclohexane, axial and equatorial bonds. Newman's projection and sawhorse formulae. Difference between configuration and conformation.

**Unit - III: 7.5h**

**A) Alkanes:** IUPAC nomenclature of branched and unbranched alkanes. Alkyl group, Isomerism in alkanes. Methods of formation (Ethane)– Wurtz reaction, Kolbe reaction, decarboxylation of carboxylic acid. Physical properties and chemical reactions of alkanes-halogenation, nitration, sulphonation, isomerization, cyclization, aromatization, pyrolysis and cracking oxidation, L.P.G., Octane number. Mechanism of free radical halogenation of alkane.

**B) Cycloalkanes :** Nomenclature, methods of formation of cyclohexane from dihalides, benzene and cyclohexanone, chemical reactions of cyclohexane oxidation, aromatization, chlorination, Baeyer's strain theory and its limitations. Ring strain in small rings cyclopropane and cyclobutane. Theory of strainless rings.

**C) Alkenes :** Nomenclature of alkenes, methods of formation- dehydrogenation, dehydrohalogenation of alkyl halides, dehydration of alcohol dehalogenation of dihalides. Mechanism of dehydration of alcohol and dehydrohalogenation of Alkyl halides. Saytzeff rule, Hofmann elimination reaction. Chemical reactions of alkenes- hydroboration, oxidation  $\text{KMnO}_4$ ,  $\text{HIO}_4$ , Epoxidation, Ozonolysis, Hydroxylation, Polymerization Substitution in allylic and vinylic position of alkenes. Industrial applications of ethylene and propylene. Markownikoff Rule and peroxide effect. Ionic Mechanism of addition of  $\text{Br}_2$  to ethene and  $\text{HBr}$  to propene. Free radical mechanism of addition of  $\text{HBr}$  to propene. Stereochemistry of bromine and  $\text{KMnO}_4$  addition to alkene.

#### Unit - IV: 7.5h

**A) Dienes:** Nomenclature and classification of dienes Methods of formation of 1, 3 - butadiene. 1,2 and 1,4 addition reactions of substituted 1,3-butadiene, Diels-Alder reaction.

**B) Alkynes:** Nomenclature, structure and bonding in Alkynes. Methods of formation of acetylene from - calcium carbide, dehydrohalogenation of dihalides Chemical reaction - hydroboration, oxidation metal ammonia reduction and polymerization. Oxyacetylene flame. Acidity of alkynes.

**C) Aromatic Compounds and Aromaticity:** Nomenclature of Benzene derivatives, structure of benzene, Molecular formula and Kekule structure. Resonance structure, MO picture, Huckel rule, aromatic ions (cyclopentadienyl anion and cycloheptatrienyl cation). Aromatic electrophilic substitution mechanism with energy profile diagram (eg. nitration and sulphonation).

#### Organic Chemistry Practical (1 credit)

A) Qualitative Analysis:

1. Element detection (N, S and halogens)
2. Identification of functional groups (-COOH, Phenolic -OH, -CHO, -NH<sub>2</sub>, -NO<sub>2</sub>, -CONH<sub>2</sub>)
3. Melting and Boiling Points

B) Preparations and determination of yield (%) and melting points of products:

1. Hydrolysis : Preparation of Benzoic acid from Benzamide
2. Oxidation: Preparation of Benzoic acid from Benzaldehyde
3. Bromination of Phenol

#### Reference books

1. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1& 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Chandra, R. ; Singh, S.; Singh, A. (2019), Basic Organic Chemistry, Arcler Press.
4. Eliel, E. L.; Wilen, S. H.(1994),Stereochemistry of Organic Compounds; Wiley: London.
5. Singh, S.P.; Prakash, O.,(2017), Reaction Mechanism in organic chemistry, Laxmi
6. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education.
7. Ahluwalia, V.K.; Dhingra, S. (2004),Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press.
8. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),Vogel's Textbook of Practical Organic Chemistry, Pearson.
9. Leonard, J.; Lygo, B.; Procter, G. Advanced Practical Organic Chemistry, CRC Press.

**B.Sc. Semester – I**  
**Vocational Skill Course (VSC)**  
**BVS1P01: Soap, detergent and disinfectant Technology**  
**Practical 2 credits**

**Course Outcomes**

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

1. *Gain an understanding of the history and influences behind modern soap creation processes and projected trends in the future of soap.*
2. *The analytical approach of this course is to enhance the reasoning and to understand the mechanical part of the industry.*
3. *Learn the most common formulations of soap products by exploring compositions and physical chemistry.*
4. *Understand the different aspects of industrial processes of Manufacturing disinfectants.*
5. *Optimise use of limited resources of harmful chemicals.*
6. *Suggest remedial measures for surfactant quality and threshold quantity improvement.*

**List of Experiments**

1. Brief History of Soap and Soap-Making Processes, Formulation and Marketing Challenges
2. Sustainable development in cleaning action of disinfectant technology and Innovations in advances and Mechatronic Solutions for Soap Manufacturing Technology from Saponification Systems.
3. Determination of the surface tension of given liquid in the presence of surfactant.
4. Determination of alkali content of soap.
5. Determination of pH of water samples and surfactant (Soap, detergent, Toiletries)
6. Estimation of hardness of water by titration with soap solution.
7. Determination of CMC of various soaps and detergents in market.
8. Comparison of cleansing actions of various commercial soaps and detergents.
9. Preparation of hand sanitizer.
10. Preparation of Soap, Detergents / Surfactants, Cleaners / Cleaning Powder.
11. Preparation of Laundry Care / fabric care / wash.
12. Preparation of Household and Industrial Detergent.
13. Preparation of Liquid Soaps/ Liquid Detergents / Acid Slurry.

**Note:** Minimum 10 experiments should be performed.

**References**

1. Ahluwalia, V.K. and Aggarwal, R. Comprehensive Practical Organic Chemistry, Preparation and Quantitative Analysis, University Press, New Delhi.
2. Sharma, R.K., Sidhwani, I.T., Chaudhari, M.K. (2013), Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi.
3. Vermani, O. P.; Narula, A. K. (2004), Industrial Chemistry, Galgotia Publications Pvt. Ltd., New Delhi.
4. <https://www.aocs.org/stay-informed/aocs-continuing-education-program/soap-fundamentals?SSO=True#brief-history-of-soap-and-soapmaking-processes>
5. Bhatia, S. C. (2004), Chemical Process Industries, Vol. I & II, CBS Publishers, New Delhi.
6. Jain, P. C.; Jain, M. (2013), Engineering Chemistry, Dhanpat Rai & Sons, Delhi.
7. Gopalan, R. Venkappayya, D.; Nagarajan, S. (2004), Engineering Chemistry, Vikas Publications. 5. Sharma, B. K. (1997), Engineering Chemistry, Goel Publishing House, Meerut.

## **B.Sc. SEMESTER – I**

### **BVE1T01: ENVIRONMENTAL SCIENCE**

#### **COURSE OUTCOMES:**

#### **At the end of the course, students shall be able to:**

- Explain the basics of Environmental Science and Atmospheric Science along-with the components of Environment
- Explicate the importance of Environmental Education.
- Elucidate the fundamentals of atmospheric science including formation, depletion and effects of ozone layer and acid rain on environment.
- Describe the various physical and chemical characteristics and properties of Water and Soil
- Understand the Ecology and its allied branches
- Comprehend about Population and Community Ecology
- Study the changes in Population by understanding the concept of Population ecology

#### **Unit-I: Basics of Environmental Science (7.5 Hrs)**

- A. Introduction of Environmental Science: Definition, Types, Classification, Characteristics, Components and principles of environment. Scope and need for environmental science, Multidisciplinary nature of environmental science, Environmental ethics.
- B. Environmental Education: Goals, Objectives and principles of environmental education, formal and non-formal environmental education, environmental programme, importance of environmental education, environmental awareness.
- C. Components of Environment: Atmosphere (Structure and composition), hydrosphere – distribution of water, hydrological cycle, global water balance, lithosphere – Internal structure of Earth, types of rocks, Biosphere- Boundaries of biosphere.

#### **Unit-II: Basics of Atmospheric Science (7.5 Hrs)**

- A. Atmospheric Chemistry: Structure of atmosphere based on temperature, photochemical reaction in the atmosphere, temperature inversion and lapse rate, smog formation, types of smog (sulphur and photochemical smog), adverse effect of smog on human being, aerosol.
- B. Green House Effect: Greenhouse gases, relative contribution and effects of greenhouse effect, control of greenhouse gases. Ozone depletion: chemistry of ozone depletion, Dobson Unit, ozone depleting substances (ODS), ozone hole, consequences of ozone depletion, mitigation measures and international protocols.
- C. Acid Rain: Chemistry of Acid Rain, effect of acid rain on ecosystem, control measures. Precipitation – Forms of precipitation (rain, drizzle, snow, sleet, and hail), types of precipitation (conventional, orographic, and cyclonic).

### **Unit-III: Basics of Ecology (7.5 Hrs)**

- A. Ecology: Definition, subdivision and modern branches of ecology, ecology spectrum, scope of ecology. Application and significance of ecology to human beings.
- B. Abiotic Factors: Temperature: effect of temperature on plants and animals, Adaptation to meet extreme temperature. Light: Zonation in marine habitat, effects of light on plants and animals, Microclimate and fire, Shelford law of tolerance, Leibigs law of minimum.
- C. Biotic Factor: Inter specific relationship Positive: Mutualism (symbiosis), commensalism, proto-cooperation Negative: Parasitism, predation, competition, Antibiosis, Neutralism.

### **Unit-IV: Ecosystems and food chain (7.5 Hrs)**

- A. Ecosystem: Definition, structure and function of ecosystem, types of ecosystem: Terrestrial (forest, grassland, desert, cropland), Aquatic (Marine and freshwater)
- B. Food chain: Definition & types: Grazing food chain, detritus food chain, and parasitic food chain, food web in forest and grassland ecosystem. Ecological pyramids (number biomass and energy), energy flow in ecosystem (Y-shaped). Energy flow and the law of thermodynamics.
- C. Biogeochemical Cycles: Definition, classification, gaseous cycle (oxygen, carbon and nitrogen) Sedimentary cycle (phosphorus and sulphur).

### **Reference Books:**

1. Text Book of Environment: K M Agrawal, P.K. Sikdar, and S.C. Deb, Mc'Millan Publication, Mumbai.
2. Man and Environment: M.C. Dash and P.C. Mishra, Mc'Millan Publication, Mumbai.
3. Environmental Science: S.C. Santra, New Central Book Pvt.Ltd, Kolkatta.
4. Environmental Problems and Solution: D.K. Asthana, S.Chand Publication, New Delhi.
5. Environmental Chemistry: S.S. Dara, S.Chand Publication ,New Delhi.
6. Environmental Chemistry: A.K. Dey, New Age International Publishers,2001.
7. A Textbook of Environmental Studies: Dr S.Satyanarayan, Dr S.Zade, Dr S Sitre and Dr

### **P.U. Meshram, Allied Publishers, New Delhi.**

8. Environmental Biology: Biswarup Mukherjee, Tata McGraw-Hill Publishing Company Ltd, New Delhi,1996.
9. Animal Ecology and Distribution of Animals: Veer Bala Rastogi , Rastogi Publication, Meerut (U.P).
10. Ecology and Environment: P.D.Sharma, Rastogi Publication ,Meerut (U.P).
11. Fundamentals of Environmental Biology: S. Arora, Kalyani Publishers.
12. Environmental Biology: P.K.G. Nair, Himalaya Publication.
13. Environmental Biology: K.C. Agrawal, Agro Botanical Publisher ,Bikaner,1994

## Indian Knowledge System (IKS)

### SEM1: VEDIC MATHEMATICS (BIK1T01)

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

1. Improve speed and accuracy in numerical calculations
2. Acquire IQ skills and high-end technical knowledge
3. gain test taking skills & creativity of calculations

UNITS	TOPICS	HOURS
<b>Unit 1</b>	(i) Addition - Subtraction - Combined operations - Beejank (ii) Multiplication methods: Urdhwatiryagbhayam, Nikhilam, Ekanyunen, Ekadhiken, Antyayordashakepi. (iii) Vinculum - Operations. (iv) Awareness of 1 to 5 Vedic sutras as per Shankaracharya Bharthikrishan Teerthji Swamiji's book.	<b>8</b>
<b>Unit 2</b>	(i) Division methods : Nikhilam, Paravartya Yojayet, Dhvajank(ii) GCD and LCM (iii) Expression of GCD in terms of two numbers.	<b>8</b>
<b>Unit 3</b>	(i) Divisibility tests, Osculation & Reverse osculation. (ii) Division Algorithm, Quotient & Remainder. (iii) Duplex method.	<b>7</b>
<b>Unit 4</b>	i) Squares & Square-roots for 6 digit number. (ii) Cubes & Cube-roots for 6 digit number, Contribution of Indian Mathematicians in Arithmetic.	<b>7</b>
	<b>TOTAL</b>	<b>30 HRS</b>

#### Reference Books:

1. Tirthaji B.K. (1965) Vedic Mathematics, MotilalBanarsidass
2. Bidder G.P. (1856) On Mental Calculation. Minutes of Proceedings, Institution of Civil Engineers (1855-56), 15, 251-280
3. Scripture E.W. (1891) American Journal of Psychology. Vol. IV 1-59
4. Mitchell F.D. (1907) American Journal of Psychology. Vol. XVIII 61-143
5. Aitken A.C. (1954) The Art of Mental Calculation: With Demonstrations. Transactions of the Society of Engineers. 45, 295-309
6. Dow A. (1991) A Unified Approach to Developing Intuition in Mathematics, Scientific Research on the Transcendental Meditation and TM-Sidhi Program Vol 5,3386-3398
7. Williams K.R. (1984) Discover Vedic Mathematics. Vedic Mathematics Research Group
8. Nicholas, Williams, Pickles (1984) Vertically and Crosswise. Inspiration Books

**B.Sc. Semester – II**  
**BCH2T03**  
**Organic Chemistry-2 (Functional group chemistry)**  
**Theory 2 credits + Practical 1 credit**

**Course Outcomes**

*On completion of the course, the student will be able to:*

1. *Understand preparation, properties and reactions of haloalkanes, haloarenes and oxygen containing functional groups.*
2. *Use the synthetic chemistry learnt in this course to do functional group transformations.*
3. *To propose plausible mechanisms for various reactions.*
4. *Suggest synthesis routes for desired product from initial reactant.*
5. *Identify given organic compound by systematic chemical analysis.*
6. *Synthesize derivatives of given organic compound.*

**Unit-I : 7.5h**

**Orientation :** Activating ( $-\text{OH}$ ,  $-\text{NH}_2$ ) and deactivating ( $-\text{Cl}$ ,  $-\text{NO}_2$ ,  $-\text{COOH}$ ) substituents, their orientation and directive influence on further electrophilic substitution, o/p ratio. Methods of formation and chemical reactions of alkyl benzene (Toluene) and biphenyl.

**Alkyl halides :** Nomenclature, classification, methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides  $\text{S}_\text{N}^1$  and  $\text{S}_\text{N}^2$  with energy profile diagrams. Factors affecting  $\text{S}_\text{N}^1$  and  $\text{S}_\text{N}^2$  mechanisms.

**Polyhalogen compounds :** Chloroform and carbon tetrachloride – formation and chemical reactions.

**Nuclear and side chain halogen derivatives of benzene:** Halobenzene and benzyl halide preparation and reactions.

**Unit-II: 7.5h**

**A) Alcohols :** Classification and nomenclature,

**Monohydric alcohols :** Methods of formation by reduction of aldehydes, ketones using  $\text{H}_2/\text{Ni}$ , hydrolysis of alkyl halides, addition of Grignard reagent to aldehydes and ketones. Reactions of alcohol.

**Dihydric alcohols :** Methods of formation, chemical reactions of vicinal glycols, oxidative cleavage ( $\text{Pb}(\text{OAc})_4$  and  $\text{HIO}_4$ ) and Pinacol – pinacolone rearrangement.

**Trihydric alcohols :** Methods of formation, chemical reactions of glycerol.

**B) Phenols :** Structure and bonding, Preparation of phenols from cumene, chlorobenzene (Dows and Raschig process) and diazonium salts. Physical properties and acidic character, Resonance stabilization of phenoxide ion, Reactions of phenols, Electrophilic aromatic substitution, acetylation and carboxylation, Claisen rearrangement, Gatterman synthesis reaction Mechanism of (i) Fries Rearrangement, (ii) Reimer-Tiemann reaction.

**Unit-III: 7.5h**

**Aldehydes and ketones :** Nomenclature and structure of the carbonyl group, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides and ketones from nitriles. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation, Wittig reaction, Mannich reaction, oxidation of aldehydes (by  $\text{KMnO}_4$ , Tollen's reagent and Fehling solution), Baeyer-Villiger oxidation of Ketones, Cannizzaro reaction with mechanism, MPV, Clemmensen, Wolf-Kishner,  $\text{LiAlH}_4$  and  $\text{NaBH}_4$  reductions,

#### Unit-IV: 7.5h

**A) Carboxylic Acids :** Nomenclature, structure and bonding, Physical properties, acidity of carboxylic acids, effect of substituents on acid strengths preparation of carboxylic acids(from G.R. and cyanides), Reactions of carboxylic acids, Hell-Volhard-Zelinsky reactions. Reduction of carboxylic acids, Mechanism of decarboxylation. Methods of formation and chemical reactions of unsaturated monocarboxylic acids (crotonic acid and cinnamic acid).

**Dicarboxylic acids :** Methods of formation and effect of heat and dehydrating agents. (Succinic acid, Phthalic acid).

**B) Carboxylic acid derivatives :** Structure and nomenclature of acid chlorides, esters, amides and acid anhydrides. Interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, Chemical reactions, Mechanism of esterification and hydrolysis (acidic and basic).

#### Organic Chemistry Practical (1 credit)

Complete analysis of simple organic compound involving following steps:

1. Preliminary examination
2. Detection of elements
3. Detection of functional group
4. Determination of melting point/ boiling point.
5. Preparation of derivative and its melting point/ boiling point.
6. Performance of specific test, if any.

**Note:** At least eight compounds should be analyzed.

#### Reference books

1. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Janice Smith, Organic Chemistry, 7th Edition, McGraw Hill with solution manual
4. Bruice, P. Y. Organic Chemistry, 6th Edition, Pearson Education with solution manual
5. Francis A. Carey, Robert M. Giuliano Organic Chemistry, 8th Edition McGraw Hill with solution manual
6. Marc Loudon, Jim Parise 7th Edition, W. H. Freeman with solution manual
7. David Klein Organic Chemistry, John Wiley & Sons Inc with solution manual
8. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), Intermediate for Organic Synthesis, I. K. International.
9. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016), Organic Chemistry, 12th Edition, Wiley.
10. Chandra, R. ; Singh, S.; Singh, A. (2019), Organic reactions and their nomenclature, Arcler Press.
11. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education.
12. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012), Vogel's Textbook of Practical Organic Chemistry, Pearson.
13. Ahluwalia, V.K.; Aggarwal, R.(2004), Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press.

**B.Sc. Semester – II**  
**BCH2T04**  
**Physical Chemistry-1 (Thermodynamics, gaseous and liquid states)**  
**Theory 2 credits + Practical 1 credit**

**Course Outcomes**

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

1. *Solve fundamental mathematical function based problems in chemistry.*
2. *Understand the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties.*
3. *Derive the expressions of  $\Delta U$ ,  $\Delta H$ ,  $\Delta S$ ,  $\Delta G$ ,  $\Delta A$  for ideal gases under different conditions.*
4. *Evaluate thermodynamics of various physical and chemical processes.*
5. *Analyse and explain properties of ideal gas, real gas and liquids.*
6. *Evaluate thermodynamic constants through calorimetric studies.*
7. *Use various properties of liquids for determination of their concentration and composition.*

**Unit-I : 7.5h**

**Mathematical concepts and Introduction to Thermodynamics**

**(A) Mathematical concepts for Chemists:** Logarithmic relations, Curve sketching, Linear graphs calculation of slopes, Differentiation of functions like  $kx$ ,  $e^x$ ,  $x^n$ ,  $\sin x$ ,  $\log x$ , etc., Maxima and Minima, Partial differentiation, Integration of useful/relevant functions, Permutations and combinations (introductory), Factorials, Concept of units with reference to C.G.S. and S.I. units, Inter-conversion of units.

**(B) Introduction to Thermodynamics:** Definitions of some common thermodynamic terms: system, surrounding, etc. Types of system (closed, open and isolated), Homogeneous and heterogeneous systems, intensive and extensive properties, thermodynamic processes (isothermal, adiabatic, isobaric, isochoric, cyclic, reversible and irreversible) State function and path functions and their differentiation, concept of heat and work.

**Unit-II: 7.5h**

**Fundamentals of Thermodynamics and Thermochemistry**

**(A)** Statements of first law of thermodynamics, definition of internal energy and enthalpy, heat capacity, heat capacity at constant volume and at constant pressure, Joule-Thomson experiment, Joule-Thomson coefficient and inversion temperature, calculations of  $w$ ,  $q$ ,  $E$  and  $H$  for expansion of gases for isothermal and adiabatic conditions for reversible process.

**(B)** Thermochemistry : Standard states, standard enthalpy of formation, enthalpy of combustion, enthalpy of solution, enthalpy of dilution, enthalpy of neutralization, enthalpy of ionization, Hess's law of constant heat of summation and its applications, Heat of reaction, relation between heat of reaction at constant volume and constant pressure. Average bond energy, bond dissociation energy and its calculations from thermochemical data. Numerical problems.

**Unit- III: 7.5h**

**Gaseous State**

**(A)** Postulates of kinetic theory of gases, derivation of kinetic gas equation, deduction of various gas laws from kinetic gas equation (Boyle's law, Charles's law, Avogadro's law, Graham's law, Dalton's law. Qualitative discussion of the Maxwell-Boltzmann distribution of molecular velocities. Effect of temperature on molecular velocities. Different types of molecular velocities (most probable, R.M.S. and average and expressions for them), their inter relationships. Definitions of collision diameter, collision number, mean free path.

**(B)** Ideal gas and real gases, behavior of real gases, deviations from ideal behavior, explanation of the terms - Compressibility factors and Boyle temperature. Causes of deviation from ideal behaviors. Vander Waal's equation of state, explanation of behaviour of real gases on the basis of van der Waal equation. Andrew's

experiment on critical phenomenon of CO<sub>2</sub>. Continuity of states. The isotherms of Van der Waals equation, Relation between critical constants and Van der Waals constants. Reduced equation of state and law of corresponding states. Numerical problems.

#### Unit- IV: 7.5h

##### Liquid State

(A) Intermolecular forces, structure of liquids (a qualitative description), structural differences between solids, liquids and gases, liquid crystals, Classification, structure of Nematic and Cholesteric phases, Thermography, liquid crystal display and seven segment cell.

(B) Properties of liquid :

i) Surface tension : Explanation, methods of determination, Capillary rise method and drop number method, Parachor value and its application.

ii) Viscosity : Explanation, coefficient of viscosity, Effect of temperature on Viscosity, relative viscosity, specific viscosity and intrinsic viscosity and reduced viscosity. Method of determination by Ostwald viscometer.

iii) Refractive index : specific refraction, molar refractions and chemical constitution. Method of determination by Abbe's Refractometer. Numerical problems.

##### Physical Chemistry Practical (1 credit)

1. To determine the heat of solution of potassium nitrate calorimetrically
2. To determine heat of ionization of acetic acid calorimetrically.
3. To determine solubility of benzoic acid at different temperatures and hence to determine heat of solution of benzoic acid.
4. Determination of relative viscosity of unknown liquid by Ostwald viscometer.
5. To determine the percentage composition of given binary mixture (Ethanol-water) by viscosity method.
6. Determination of surface tension of a given liquid by drop number method (Stalagmometer method)
7. To compare cleansing power of two samples of detergent.
8. To determine parachor value of -CH<sub>2</sub> group by surface tension method.
9. To determine refractive index, specific and molar refraction of given liquid by Abbe's refractometer.

**Note:** At least eight experiments should be performed.

##### Reference books

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.
4. Kapoor, K.L.(2013), A Textbook of Physical Chemistry, Vol 3, 3rd Edition, McGraw Hill Education.
5. McQuarrie, D. A.; Simon, J. D. (2004),Molecular Thermodynamics, Viva Books Pvt. Ltd. Levine, I.N.(2010),Physical Chemistry, Tata Mc Graw Hill.
6. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A.; Will, S.(2011),Commonly asked Questions in Thermodynamics. CRC Press.
7. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015),Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.
8. Kapoor, K.L. (2019),A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education.
9. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003),Experiments in Physical Chemistry, 8<sup>th</sup> Edition, McGraw-Hill, New York.

**B.Sc. Semester – II**  
**Vocational Skill Course (VSC)**  
**BVS2P03: Drug synthesis and analysis**  
**Practical 2 credits**

**Course Outcomes**

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

- 1. A foundational understanding of the principles and concepts of medicinal chemistry, including drug design and development.*
- 2. Gaining practical experience in common laboratory techniques used in medicinal chemistry, such as synthesis and purification.*
- 3. Ability to design and perform experiments to test the effectiveness of potential drug candidates, including assays.*
- 4. Develop an understanding of the Physico-Chemical properties of drugs through fundamentals of volumetric analytical skills.*

**List of Experiments**

**(A) Synthesis of pharmaceuticals**

- 1. Paracetamol from p-nitro phenol
- 2. Benzocaine from p-nitro benzoic acid
- 3. Acetanilide from aniline
- 4. Diphenylhydantoin from Benzoin.
- 5. Diclofenac sodium from aniline.
- 6. Aspirin from Salicylic acid.
- 7. Methyl Salicylate from Salicylic Acid.

**(B) Estimation of pharmaceuticals**

- 1. Estimation of vitamin B<sub>12</sub> in commercial tablet.
- 2. Estimation of vitamin C in commercial tablet.
- 3. Estimation of alkali in antacid tablet.
- 4. Estimation of paracetamol in commercial tablet.
- 5. Estimation of aspirin in commercial tablet.
- 6. Estimation of Ibuprofen.
- 7. Estimation of Fe in hematinic tablet.

**Note:** Minimum 10 experiments should be performed.

**References:**

1. Patrick, G. (2017), Introduction to Medicinal Chemistry, Oxford University Press.
2. Singh H.; Kapoor V.K. (1996), Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan.
3. Foye, W.O.; Lemke, T. L.; William, D.A. (1995), Principles of Medicinal Chemistry, B.I. Waverly Pvt. Ltd.
4. Kjonaas, R.A.; Williams, P.E.; Counce, D.A.; Crawley, L.R. Synthesis of Ibuprofen. J. Chem. Educ., 2011, 88 (6), pp 825–828 DOI: 10.1021/ed100892p.
5. Marsh, D.G.; Jacobs, D.L.; Veening, H. Analysis of commercial vitamin C tablets by iodometric and coulometric titrimetry. J. Chem. Educ., 1973, 50 (9), p 626. DOI: 10.1021/ed050p626
6. Kar, Ashutosh (2005), Textbook of Medicinal Chemistry, New Age International.
7. Eric Marsault and Mark L. Peterson (2017), Practical Medicinal Chemistry with Macrocycles, Wiley.
8. D. Sriram and P. Yogeswari (2010), Medicinal Chemistry, Pearson.

## **SEM 2 : CONSTITUTION OF INDIA (BVE2T02)**

### **Syllabus**

#### **UNIT – I:**

- Historical Background to the Framing of the Indian Constitution: General Idea about the Constituent Assembly of India.

#### **UNIT – II**

- Preamble – Nature and key concepts/Constitutional values, Socialism, Secularism, Democracy, Justice, Liberty, Equality and Fraternity
- Salient Features of the Constitution of India

#### **UNIT – III**

- General study about the kinds, nature and importance of; Fundamental Rights, Directive Principles of State Policy and Fundamental Duties.

#### **UNIT –IV**

Introduction of the Constitutional Institutions and Authorities;

- Central Legislature and Executive (Parliament of India, President of India and Council of Ministers)
- State Legislature and Executive (State legislative Assemblies, Governors and Council of Ministers)
- Higher Judiciary (Supreme Court of India and High Courts)

## Indian Knowledge System (IKS)

### SEM2: INDIAN ASTRONOMY (BIK2T02)

**Course Outcomes:** This course will enable the students to understand that

- 1.** It is possible to create a map of the intellectual growth of a culture using astronomy as a probe.
- 2.** The growth of Indian astronomy occurs in distinct stages analogous to phase transitions of the evolution of cultures
- 3.** Indian Astronomy therefore provides an excellent window to the past dramatic transitions.

UNITS	TOPICS	HOURS
<b>Unit 1</b>	Astronomy in Prehistoric Era, Astronomy in Vedic Era, Vedang Jyotish, Astronomical References In Religious Scriptures, Astronomies of the West	<b>8</b>
<b>Unit 2</b>	Arya Bhatta, Panch Siddhantika of Varahamihira, Surya Siddhanta Varahamihira to Bhaskar Acharya-II, Siddhant Shiromani of Bhaskar Acharya-II, Bhaskar Acharya-II to Jai Singh, Jai Singh and his Observatories.	<b>8</b>
<b>Unit 3</b>	After Jai Singh, Interaction with the Astronomies of the World, Modern Era Astronomy , Our Universe, Cosmology	<b>7</b>
<b>Unit 4</b>	Panchang Horoscope and Astrology , Siddhantas, Karnas and Koshtakas, Observational Instruments of Indian Astronomy	<b>7</b>
	<b>TOTAL</b>	<b>30 HRS</b>

#### Reference Books:

1. The Story Of Astronomy In India, Chander Mohan, Pothi.com
2. Indian Astronomy: An Introduction. Front Cover · S. Balachandra Rao. Universities Press, 2000
3. Astronomy in India: A Historical Perspective, Thanu Padmanabhan, Springer Science & Business Media
4. Hindu Astronomy, W. Brennand, Alpha Editions
5. Origin and Growth of Astronomy in India,  
<https://www.tifr.res.in/~archaeo/FOP/FOP%20pdf%20of%20ppt/Vahia%20Origin%20of%20Astronomy.pdf>