Bharatiya Vidya Bhavan's

M. M. College of Arts, N.M. Institute of Science, H.R.J. College of Commerce.
(Bhavan's College) Autonomous

(Affiliated to University of Mumbai)

Syllabus for: F.Y.B.Sc.

Program: B.Sc.
Program Code: BH.BSc.

Course Code: BH.USCHEM

Choice Based Credit System (CBCS)
With effect from academic year 2023-2024

PROGRAM OUTCOMES

PO	A learner completing bachelor's degree in science program will be able to acquire the following:
PO1	**Fundamental disciplinary knowledge and/or interdisciplinary approach:** Capable of demonstrating comprehensive knowledge and understanding of one or more other disciplines that form a part of an undergraduate programme of study. This programme helps students in building a solid foundation for further higher studies and research.
PO2	Recall and explain acquired scientific knowledge in a comprehensive manner and apply the skills acquired in their chosen discipline. Interpret scientific ideas and relate its interconnectedness to various fields in science and other disciplines and can also be utilised in modelling and solving real life problems
PO3	**Evaluate scientific ideas critically, analyse problems, explore options for Practical demonstrations, illustrate work plans and execute them, organise data and draw inferences.**
PO4	**Explore and evaluate digital information and use it for knowledge upgradation**: Apply relevant information gathered for analysis and communication using appropriate digital tools.
PO 5	**Environment Awareness:** The course curriculum is designed to teach chemistry students to apply the green routes for the synthesis of chemical compounds and also find out new greener routes for sustainable development. This course also helps students to understand the causes and control measures of environmental pollution. And thereby applying environmentally friendly policies in daily life
PO 6	**Interdisciplinary and Research Skills:** A sense of inquiry and capability for asking relevant/ appropriate questions,.The ability to apply broadly accepted scientific methodologies in their research.
PO7	**Proficiency in Employments:** This programme will help students to enhance their employability for Government jobs, related to science, data analysis jobs, and jobs in various other public and private enterprises.
PO8	**Social awareness:** Chemistry graduates are expected to be more aware about finding green chemical reaction routes for sustainable development. They are expected to maintain good laboratory practices and safety.

PROGRAM SPECIFIC OUTCOMES

PSO	Syllabus
PSO 1	Firm foundations in the fundamentals and application of current chemical and scientific theories.
PSO 2	Ability to design, carry out, record and analyze the results of chemical experiments and are familiar with standard safety practices, equipment, procedures, and techniques common to most working laboratories.
PSO 3	To use modern library searching and retrieval methods to obtain information about a topic, chemical, chemical technique, or an issue relating to chemistry.
PSO 4	Competencies to successfully crack the competitive exams in life sciences
PSO 5	To effectively develop skill for using chemicals, glassware and instruments in a Chemistry laboratory.

PROGRAM OUTLINE FOR F.Y.B.Sc.

level	Sem	Major	Elective	Minor	OE	VSC/SEC	IKS generic/ VEC	OJT/FP/ CEP	Cr/Sem	Degree
4.5 (2023-24)	Sem 1	(3T + 1P)	0	(3T + 1P)	3T + 1P	3T + 1P	IKS 2T VEC (1T+1P)	0	22	44
	Sem2	(3T + 1P)	0	(3T + 1P)	3T + 1P	3T + 1P	IKS 2T+ VEC (1T+1P)	CC2	22	UG certificate

OE : Open Elective

VSC: Vocational Skill courses

SEC: Skill Enhancement Courses

IKS: Indian Knowledge System

VEC: Value Education Courses

Cr : Credit

PROGRAM OUTLINE

YEAR	SEMESTER	COURSE TYPE	COURSE CODE	COURSE TITLE	CREDITS
FYBSc	I	MAJOR	BH.USCHEM.Maj101	GENERAL CHEMISTRY I	03
		Practical	BH.USCHEM.MajP101	PRACTICAL	01
FYBSc	I	MINOR	BH.USCHEM.Min101	BASIC CHEMISTRY I	03
		Practical	BH.USCHEM.MinP101	PRACTICAL	01
FYBSc	I	IKS	BH.USCHEM.IKS101	Introduction to Indian Knowledge system	02
FYBSc	I	OPEN ELECTIVE	BH.USCHEM.OE101	CHEMISTRY IN EVERYDAY LIFE I	03
		Practical	BH.USCHEM.OEP101	PRACTICAL	01
FYBSc	I	VOCATIONAL /SKILL DEVELOPMENT COURSE	BH.USCHEM.vSEC101	INDUSTRIAL CHEMISTRY -1	03
		Practical	BH.USCHEM.vESCP101	PRACTICAL	01
FYBSc	I	VALUE ADDED COURSE	BH.USCHEM.VEC101	Effects of synthetic chemicals on Environment	01
		Practical	BH.USCHEM.VECP101	PRACTICAL	01
FYBSc	II	MAJOR	BH.USCHEM.Maj201	GENERAL CHEMISTRY II	03
		Practical	BH.USCHEM.MajP201	PRACTICAL	01
FYBSc	II	MINOR	BH.USCHEM.Min201	BASIC CHEMISTRY II	03
		Practical	BH.USCHEM.MinP201	PRACTICAL	01
FYBSc	II	OPEN ELECTIVE	BH.USCHEM.OE201	CHEMISTRY IN EVERYDAY LIFE II	03
		Practical	BH.USCHEM.OEP201	PRACTICAL	01
FYBSc	II	VOCATIONAL /SKILL DEVELOPMENT COURSE	BH.USCHEM.vSEC201	INDUSTRIAL CHEMISTRY -II	03
		Practical	BH.USCHEM.vESCP201	Practical	01
FYBSc	II	VALUE ADDED COURSE	BH.USCHEM.VEC201	Sustainable use of synthetic chemicals	01
		Practical	BH.USCHEM.VECP101	Practical	01

DETAILED SYLLABUS
SEMESTER I & II

PREAMBLE

The present syllabus aims at developing knowledge, skills, and interest of the learner in the subject of Chemistry. The faculty is expected to use their knowledge, experience and skills to develop interest in learners towards the subject of Chemistry. The classroom course and laboratory work are designed taking into consideration the needs and competence level of the students. The course is flexible enough to allow experimentation on the part of individual faculty. The ultimate aim of this course is to ensure that learners develop basic knowledge and skill sets in the subject of chemistry.

SEMESTER I

Programme: F.Y.B.Sc.	**Semester: I**
MAJOR (3+1 credits) **(Theory + Practical)** **Course: GENERAL CHEMISTRY (45L)**	**Course Code:** **BH.USCHEM.Maj101**

Teaching Scheme			
Lecture (Periods per week)	**Practical (Periods per week per batch)**	**Tutorial (Periods per week per batch)**	**Credits (Theory +Practical)**
3	1	-	4

Course Objectives: After successfully completing this course, students will be able to:

CO1: identify and signify the basic terms used in thermodynamics.
CO2: apply laws of thermodynamics to various systems.
CO3: derive an expression for the first law of thermodynamics for different processes.
CO4: understanding of the laws of thermodynamics and their applications.
CO5: assess thermodynamic application using enthalpy, entropy and free energy.

Unit	**Syllabus**	**Periods**
I	**Physical Chemistry** **1.0 Chemical Thermodynamics (10 L)** 1.1 Basic of thermodynamics : Intensive and extensive properties, 1.2 State functions and path functions,	**15L**

	1.3 Zeroth law of thermodynamics 1.4 First law of thermodynamics: concept of heat (q), work (w), internal energy (U), statement of first law, enthalpy, 1.5 Relation between heat capacities, sign conventions, calculations of heat (q), work (w), internal energy (U), and enthalpy (H) (Numericals expected) 1.6 Thermochemistry: Heats of reactions, standard states, enthalpy of formation of molecules, enthalpy of combustion and its applications, calculation of bond energy, **2.0 Molecular Spectroscopy:** 2.1 Definitions of wavelength, frequency, wave number (Numericals expected). 2.2 Electromagnetic radiation, electromagnetic spectrum, Planck's equation, interaction of electromagnetic radiation with matter: Absorption, 2.3 Emission, scattering, fluorescence, electronic, vibrational and rotational Transitions, 2.4 Beer-Lambert's law (Numericals expected**)**	
II	**Inorganic Chemistry** **1. Periodic table (6L)** 1.1. Long form of periodic table. 1.2. Classification of elements as Main group, Transition and Inner transition elements. 1.3. Periodicity in the following properties: Atomic Size, Electron gain enthalpy, Ionization enthalpy, effective nuclear charge (Slater Rule), electronegativity: Pauling method (Numerical problems expected). **2.0.Atomic structure (9L)** (Qualitative treatment only; it is expected that the learner knows the mathematical statements and understands their physical significance after completing this topic. No derivations of the mathematical equations required) 2.1 Historical perspectives of the atomic structure; Rutherford's Atomic Model, 2.2. Bohr's theory, its limitations and the atomic spectrum of hydrogen atom. Structure of Hydrogen atom. 2.3. Atomic orbitals i) Hydro genic energy levels ii) Shells, subshells and orbitals	**15L**

	iii) Electron spin iv) Radial shapes of orbitals 2.4.Effective nuclear charge 2.5 Aufbau principle	
III	**Organic Chemistry** **1.0 Classification and Nomenclature of Organic Compounds:** 1.1.Review of basic rules of IUPAC nomenclature. Nomenclature of mono and bi-functional aliphatic compounds on the basis of priority order of the following classes of compounds: alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles and amines; including their cyclic analogues. **1.2.Bonding and Structure of organic compounds:** Hybridization: sp3, sp2, sp hybridization of carbon and nitrogen; sp3 and sp2 hybridizations of oxygen in Organic compounds (alcohol, ether, aldehyde, ketone, carboxylic acid, ester, cyanide, amine and amide) Overlap of atomic orbitals: Overlaps of atomic orbitals to form sigma and pi bonds, shapes of organic molecules. Influence of hybridization on bond properties (as applicable to ethane, ethene, and ethyne). **1.3 Fundamentals of organic reaction mechanism:** **Electronic Effects:** Inductive, electrometric, resonance and mesomeric effects, hyper conjugation and their applications; Dipole moment; Organic acids and bases; their relative strengths. **Bond fission:** Hemolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles; Nucleophilicity and basicity; **Types (primary, secondary, tertiary, allyl, benzyl), shape and their relative stability of reactive intermediates:** Carbocations, Carbanions and Free radicals. **Introduction to types of organic reactions:** Addition, Elimination and Substitution Reaction. (With one example of each).	**15 L**
	TOTAL	**45 L**

Reference Books:

Physical Chemistry

1. K.L. Kapoor, A Textbook of Physical Chemistry, Macmillan (2000)
2. Atkins P.W. and Paula J.de, Atkin's Physical Chemistry, 10th Ed., Oxford University 12 Press (2014).

3. Engel T. and Reid P., Physical Chemistry, 3rd Ed., Pearson

4. Peter A. and Paula J. de., Physical Chemistry, 10th Ed., Oxford University Press (2014).

5. 3000 solved problems in chemistry: Schaum's outline series

6. Modern Physical Organic Chemistry, Eric V. Anslyn , Dennis A. Dougherty

7. Levine I.N., Physical Chemistry, 6th Ed., Tata Mc Graw Hill (2010).

8. Banwell C.N., Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill (1994).

9. Ball D.W., Physical Chemistry, Thomson Press, India (2007).

10. Advanced Physical Chemistry by Gurdeep Raj

11. McQuarrie D.A. and Simon J.D., Molecular Thermodynamics, Viva Books Pvt. Ltd., New Delhi (2004).

Inorganic Chemistry

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.

2. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

3. Advanced Inorganic Chemistry, 6th Edition, F. Albert Cotton, Geoffrey Wilkinson, Carlos A.Murillo, Manfred Bochmann.

4. Inorganic Chemistry: Principles of Structure and Reactivity by James E. Huheey (Author), Ellen A. Keiter (Author), Richard L. Keiter (Author)

5. Inorganic Chemistry James E. House · Academic Press (2013)

6. Principles of Inorganic Chemistry, B.R. Puri, L.R. Sharma, K.C. Kalia

7. Basic Concepts of Inorganic Chemistry by D. N. Singh, Pearson

8. A Logical Approach To Modern Inorganic Chemistry by Jagdamba Singh.

Organic Chemistry

1. Textbook of Organic Chemistry by V K Ahluwalia , Rakesh K Parashar .

2. Reaction Mechanisms in Organic Chemistry by Ray Mukul C

3. Organic Chemistry by Paula Yurkanis Bruic

4. Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren

5. Advanced Organic Chemistry: Part A: Structure and Mechanisms Textbook by Francis A.Carey and Richard J.

6. Solomons' Organic Chemistry, Global Ed by T W Graham Solomons and Craig B Fryhland Scott A Snyder, John Wiley.

7. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012
8. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
9. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
10. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
11. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
12. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning.

Practicals	
Sr. No.	**Aim of the Practical**
	1. To prepare 0.1 N succinic acid and standardize NaOH solution of two different concentrations. 2. To determine the rate constant for the hydrolysis of ester using HCl as a catalyst. 3. To determine enthalpy of dissolution of salt (like KNO3). 4. Commercial Analysis of (any two): (a) Mineral acid. (b) Organic acid. 5. Titration using double indicators: Analysis of solution of Na2CO3 and NaHCO3. 6. Gravimetric analysis (a) To determine the percentage purity of a sample of BaSO4, containing NH4Cl. (b) To determine the percentage purity of a sample of ZnO containing ZnCO3. 7. ORGANIC CHEMISTRY 1) Purification of organic compounds by recrystallization with suitable solvent. (Provide 1) and determine the melting points of purified compounds. 8. Synthesis of Nanoparticles.

Reference Books:
Chemistry Laboratory

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).

2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).

3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).

4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001).

5. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.

6. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

7. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

8. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,

9. Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996

10. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani , A. Chhikara

11. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS.

Programme: F.Y.B.Sc.	Semester: I
Minor (3+1 credits) **(Theory + Practical)** **Course: BASIC CHEMISTRY-I (45 L)**	**Course Code:** **BH.USCHEM.Min101**

Teaching Scheme			
Lecture (Periods per week)	**Practical (Periods per week per batch)**	**Tutorial (Periods per week per batch)**	**Credits (Theory +Practical)**
3	**1**	**-**	**4**

Course Objectives: After successfully completing this course, students will be able to:

CO1: represent the rate law of the elementary and chain reaction.
CO2: understanding of the theories for the determination of the rate of the reactions.
CO3: understanding of the kinetics of the explosive photochemical and unimolecular reactions.
CO4: understanding of the laws of thermodynamics and their applications.
CO5: learn basic concepts of stereochemistry.
CO6**:** understand various terminologies in stereochemistry.
CO7: understand the structure, reactivity and stability of organic molecules including conformation and stereochemistry.
CO8: explore basic chemistry of S and P block elements.

Unit	Syllabus	Periods
I	**Physical Chemistry** **1.0 Chemical Kinetics: (8 L)** 1.1 Rate of reaction, rate constant, measurement of reaction rates, 1.2 order and molecularity of reaction, 1.3 integrated rate equation of first and second order reactions (with equal initial concentration of reactants) (Numericals expected) 1.4 Determination of order of reaction by (a) Integration method (b) Graphical method (c)Ostwald's isolation method (d) Half time method (Numericals expected) **2.2 Liquid State: (7 L)** 2.1 Surface Tension : Introduction, methods of determination of surface tension by drop number method (Numericals expected) 2.2 Viscosity: Introduction, coefficient of viscosity, determination of viscosity by Ostwald viscometer (Numericals expected) 2.3 Refractive index: Introduction, molar refraction and polarizability, 2.4 Liquid crystals: Introduction, classification and structure of thermotropic phases (Nematic, smectic and cholesteric phases), applications of liquid crystals.	**15L**

II	**Inorganic Chemistry** **1.0 Comparative chemistry of Main Group Elements (15 L)** 1.1 Metallic and non-metallic nature 1.2 Oxidation states and electronegativity 1.3 Anomalous behaviour of second period elements. 1.4 Allotropy, catenation and diagonal relationship. 1.5 Comparative chemistry of carbides, nitrides, oxides and hydroxides of group I and group II elements. 1.6 Some important compounds- $NaHCO_3$, Na_2CO_3, NaCl, NaOH, CaO, $CaCO_3$.	**15L**
III	**Organic Chemistry** **1.0 Stereochemistry I (15 L)** 1.1.Fischer Projection, Newman and Sawhorse Projection formulae (of erythro, threo isomers of tartaric acid and 2,3 dichlorobutane) and their interconversions. 1.2.Geometrical isomerism in alkene and cycloalkanes: cis–trans and syn-anti Isomers E/Z notations with C.I.P rules. 1.3. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Diasteroisomers. Molecules with two similar and dissimilar chiral-centers, Di stereoisomers, meso structures, racemic mixture. 1.4. Relative and absolute configuration: D/L and R/S designations. 1.5.Conformation analysis of alkanes (ethane and n-butane); Relative Stability with Energy diagrams.	**15L**
	TOTAL	**45L**
	Reference Books: **Physical Chemistry** 1. K.L. Kapoor, A Textbook of Physical Chemistry, Macmillan (2000) 2. Atkins P.W. and Paula J.de, Atkin's Physical Chemistry, 10th Ed., Oxford University 12 Press (2014). 3. Engel T. and Reid P., Physical Chemistry, 3rd Ed., Pearson 4. Peter A. and Paula J. de., Physical Chemistry, 10th Ed., Oxford University Press (2014). 5. 3000 solved problems in chemistry: Schaum's outline series 6. Modern Physical Organic Chemistry, Eric V. Anslyn , Dennis A. Dougherty 7. Levine I.N., Physical Chemistry, 6th Ed., Tata Mc Graw Hill (2010).	

8. Banwell C.N., Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill (1994).

9. Ball D.W., Physical Chemistry, Thomson Press, India (2007).

10. McQuarrie D.A. and Simon J.D., Molecular Thermodynamics, Viva Books Pvt. Ltd., New Delhi (2004).

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3. Advanced Inorganic Chemistry, 6th Edition, F. Albert Cotton, Geoffrey Wilkinson, Carlos A.Murillo, Manfred Bochmann.

4. Inorganic Chemistry: Principles of Structure and Reactivity by James E. Huheey (Author), Ellen A. Keiter (Author), Richard L. Keiter (Author)

5. Inorganic Chemistry James E. House · Academic Press (2013)

6. Principles of Inorganic Chemistry,B.R. Puri, L.R. Sharma, K.C. Kalia

7. Basic Concepts of Inorganic Chemistry by D. N. Singh, Pearson

8. A Logical Approach to Modern Inorganic Chemistry by Jagdamba Singh

9. Modern Inorganic Chemistry 3rd Edition, Authored by Dr. R. D. Madan

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3. Organic Chemistry by Paula Yurkanis Bruic

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7. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012

8. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd.(Pearson Education).

9. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).

10. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley:

	London, 1994. 11. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005. 12. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning.	

Practicals	
Sr. No.	**Aim of the Practical**
1	Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2	Estimation of oxalic acid by titrating it with KMnO4.
3	pH measurements a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter and by using indicator papers.
4	ORGANIC CHEMISTRY (1) Purification of any two organic compounds by recrystallization, selecting suitable solvent. (provide 1) (a) Solvent for recrystallization. (b) Mass and the melting points of purified compounds
5	Titration using double indicators: Analysis of solution of Na2CO3 and NaHCO3.

Reference Books:

Chemistry Laboratory

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).

2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).

3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).

4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001).

5. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.

6. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).

7. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

8. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,

9. Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996

10. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani , A. Chhikara

11. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS.

Programme: F.Y.B.Sc.	**Semester: I**

Ancient Chemistry (2 credits) **THEORY** **Course: Indian knowledge System (30L)**	**Course Code:** **BH.USCHEM.IKS101**

Teaching Scheme			
Lecture (Periods per week)	**Practical (Periods per week per batch)**	**Tutorial (Periods per week per batch)**	**Credits (Theory +Practical)**
2	**-**	**-**	**-**

Course Objectives: After successfully completing this course, students will be able to:

CO 1: develop an overview of rich Indian legacy in chemistry (from ancient perspective).
CO 2: understand the contribution of Indian alchemists.

Unit	**Syllabus**	**Periods**
I	1.0 Introduction to Indian Knowledge system I 1.1 Survey of IKS Domains: A broad overview of disciplines included in the IKS, and historical developments 1.2 Sources of IKS knowledge, classification of IKS texts, a survey of available primary texts, translated primary texts, and secondary resource materials. Differences between a sutra, bhashya, karika, and vertika texts. Fourteen/eighteen vidyasathanas, tantrayukti 1.3 Vocabulary of IKS: Introduction of Panchamahabhutas, concept of a sutra, introduction to the concepts of non-translatable (Ex. Dharma, punya, aatma, karma, yagna, Shakti, varna, jaati.	**15 L**
II	1.0 History of Indian chemistry -1 1.1 Ancient to Pre-British Era 1.2 Alchemist, Chemist 1.3 Metallurgy 1.4 Ayurveda 1.5 Textiles, etc.	**15 L**
	TOTAL	**30 L**
	References: 1. History of Chemistry in ancient and Medieval India: Incorporating the History of Hindu Chemistry by Acharya Prafulla Chandra Ray (Author) 2. A History of Hindu Chemistry: from the Earliest Times to the Middle of the Sixteenth Century A.D. by P. C. Ray (Author) 3. Ancient Indian Chemistry Dr. Iragavarapu Suryanarayana 4. Land Control And Social Structure In Indian History (Second Edition) Robert Eric Frykenberg 5. Indian Politics and Society since Independence by Bidyut Chakrabarty	

Programme: F.Y.B.Sc.	**Semester: I**

Open Elective (OE) (3+ 1) **THEORY + PRACTICAL** **Course: CHEMISTRY IN EVERYDAY LIFE I (45L)**	**Course Code:** BH.USCHEM.OE101

Teaching Scheme			
Lecture (Periods per week)	**Practical (Periods per week per batch)**	**Tutorial (Periods per week per batch)**	**Credits (Theory +Practical)**
3	1	-	4

Course Objectives: After successfully completing this course, students will be able to:

CO1: provide basic knowledge and understanding of essential chemical and analytical Principles. CO2: understand basic analytical techniques and Practical aspects.
CO2: create, select and apply knowledge, resources in a multidisciplinary environment.

CO4: learn experimentally the quantitative estimation of various ions in the given Samples.
CO5**:** understand the causes and control measures of environmental pollution and thereby Applying environmentally friendly policies in daily life.
CO6: apply their knowledge in estimation of radicals in soil, water etc.
CO7: understand the composition of soil and measurement of important parameters of soil.

Unit	**Syllabus**	**Periods**
I	**1.0 Importance of Pharma-Chemistry in living systems** **1.1:**Introduction & Importance of Metal ions in living systems (1L) 1.2:Role of Metal ions in living systems wrt elements,sources, ailments & diseases caused by metal ions.(4L) **1.3:Medicines (7L)** I. Antacids 2.Analgesic 3.Antibiotics 4.Antimicrobial/Antibacterials 5.Antiinflamamatory 6.Antiallergics	**15 L**

	7.Anticancers **1.4:Nutritional chemistry in Diet (3 L)** Sources & Role of proteins, carbohydrates, fats, vitamins and minerals.	
II	**Fundamental of pH (6L)** 1.1 Concept of pH and pH measurement. **2.0 Analysis of soil: (3L)** 2.1 Composition of soil. 2.2 Determination of pH of soil samples. **3.0 Analysis of water: (6 L)** 3.1 Definition of pure water, sources responsible for contaminating water 3.2 acidity and alkalinity of a water sample. 3.3 Determination of dissolved oxygen (DO) of a water sample.	**15 L**
III	**1.0 New age chemistry in our daily life** 1.1 Quality concepts (03) 1.2 Safety in Laboratory (04) 1.3 Expiry of medicines (01) 1.4Artificial ripening (04) 1.5 Desiccants (01) 1.6 Alkaline water intake (02)	**15 L**
	TOTAL	**45L**

Practicals	
Sr. No.	**Aim of the Practical**
	Practicals
1	Lab Techniques
2	pH measurements a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass Electrode) using pH-meter.
3	Determination of Chemical Oxygen Demand (COD).

4	Determination of Biological Oxygen Demand (BOD).
5	Preparation of buffer solutions: (i) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide.
6	Analysis of soil components (By Classical method/Instruments).
7	To synthesis aspirin by acetylation of salicylic acid.

	Reference Books:
	Chemistry Laboratory

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).

2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).

3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).

4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001).

5. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.

6. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

7. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

8. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,

9. Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996

10. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani , A. Chhikara

11. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS.

Programme: F.Y.B.Sc.	Semester: I
Vocational/Skill enhancement course (VSEC) (3+1) THEORY + PRACTICAL **Course: Industrial Chemistry-1 (45 L)**	**Course Code: BH.USCHEM.vSEC101**

Teaching Scheme			
Lecture (Periods per week)	**Practical (Periods per week per batch)**	**Tutorial (Periods per week per batch)**	**Credits (Theory + Practical)**
3	1	-	4

Course Objectives: After successfully completing this course, students will be able to:

CO1: understand the basic chemical concepts, basic analytical techniques and Practical aspects of Classical chemical analysis.
CO2: prepare the solution of the desired concentration and the desired volume.
CO3: solve the problems related to chemical analysis and interpret analytical results.
CO4: prepare for high level coursework.
CO5: acquire knowledge and skill and develop analytical approach for problem solving.
CO6: create, select and apply knowledge, resources in a multidisciplinary environment.
CO7: Gain proficiency in logical deduction skill through written problem and laboratory work.
CO8: learn experimentally the quantitative estimation of samples.
CO9: implement experimental methods to test their hypotheses, analyze and interpret the resulting Data.

Unit	Syllabus	Periods
I	**Industrial Inorganic-Analytical Chemistry (15 L)** **1.0. Classical Methods of Analysis. (9L)** 1.1. Introduction to Analytical Chemistry and Chemical analysis. 1.2 Titrimetric Methods: Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry. 1.3. The Conditions suitable for Titrimetry. 1.4. Classification of reaction in titrimetric analysis: Neutralization reaction, complex formation reaction, precipitation reaction, oxidation-reduction reaction. 1.5. Standard solutions (Primary and Secondary standards in Titrimetric analysis). 1.6. End point and Equivalence point 1.7. Preparation of indicator solutions: -Methyl orange, Methyl red, Phenolphthalein, Methyl yellow.	**15L**

	2.Chemical Calculations (6L) 2.1. Methods of expressing concentration of solutions: Normality, molality, molarity, formality, mole fractions, weight ratio, ppm, ppb. 2.2. Inter-conversion between different concentration units. 2.3. Concept of millimoles, milliequivalents (Numericals expected).	
II	**1. Industrial Environmental Chemistry (Water Pollution)**: 1.1. Multidisciplinary nature of environmental studies, scope and importance. 1.2. Definition, causes, types, effects and control measures of water Pollution. 1.3. Sources of Water pollution - Domestic, Industrial, and Agricultural, commercial. 1.4. Types of Water Pollutants - Biological, Chemical, Physical agents and radioactive materials. 1.5. Effects of Water Pollution - effects of Soaps and detergents, effects of oil spills and marine pollution. 1.6. Treatment of water pollution - preprimary, primary, secondary and tertiary treatment. 1.3. Public awareness and Role of an individual in prevention of pollution and Pollution case studies with reference to water pollution. 1.4. Environment Protection Act: a) Water Prevention and Control of Pollution).	**15 L**
III	**Industrial Organic Chemistry** 1.0 FUEL CHEMISTRY 1.1. Review of energy sources (renewable and non-renewable). 1.2. Classification of fuels and their calorific value. 1.3. Coal: Uses of coal (fuel and nonfuel) in various industries. 1.4. Coal gas, producer gas and water gas composition and uses. N Fractionation of coal tar, uses of coal tar bases chemicals. 1.5. Coal gasification: (Hydro gasification and Catalytic gasification), 1.6. Coal liquefaction and Solvent Refining.	**15 L**
	TOTAL	**45 L**

Practicals	
Sr. No.	**Aim of the Practical**
1	Analytical tools
2	Calibration of Glassware and instruments.
3	Preparation of different concentration of solution
4	Estimation of Ca from calcium supplementary tablet by complexometric titration
5	Estimation of selectively Cu (II) from brass alloy by iodometrically.

References :

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).

2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).

3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).

4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001).

5. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

6. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

7. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

8. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G.,

9. Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996

10. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani , A. Chhikara

11. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS.

Programme: F.Y.B.Sc.	Semester: I
Value Education Courses (1+ 1) **THEORY + PRACTICALS** **Course:** Effects of synthetic chemicals on Environment **(15 L)**	**Course Code: BH.USCHEM.VEC101**

Teaching Scheme

Lecture (Periods per week)	Practical (Periods per week per batch)	Tutorial (Periods per week per batch)	Credits (Theory + Practical)
1	1	-	2

Course Objectives: After successfully completing this course, students will be able to:

CO 1: categories the different types of separation methods under physical , chemical , mechanical methods.

CO 2: develop simple separation schemes.

CO 3: apply the most suitable method for the detection of the resolved components. .

CO4: Understand Basic requirements of fermentation process.

Unit	Syllabus	Periods
I	**1.0 Effects of synthetic chemicals on Environment** 1.1 Introduction about the Synthetic Chemicals 1.2 Classification of Synthetic Chemicals 1.3 Atmospheric pollution due to some Synthetic Chemicals 1.4 Case studies	**15 L**
	TOTAL	**15L**

Practical

Sr. No.	Aim of the Practical	
1	Commercial Analysis of Water Samples	
2	To determine the percentage purity of a sample of ZnO containing ZnCO3.	
3	Determination of Chemical Oxygen Demand (COD).	

4	Determination of Biological Oxygen Demand (BOD).	

	References :
	1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011). 2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003). 3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003). 4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001). 5. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009. 6. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009) 7. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012) 8. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., 9. Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996 10. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani , A. Chhikara 11. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS.

SEMESTER II

Programme: F.Y.B.Sc.	Semester: II
Major (45L) (3+1 credits) **(Theory + Practical)** **Course: General Chemistry-II (45 L)**	**Course Code: BH.USCHEM.Maj201**

Teaching Scheme

Lecture (Periods per week)	Practical (Periods per week per batch)	Tutorial (Periods per week per batch)	Credits(Theory +Practical)
3	1	-	4

Pre-requisites:

Course Objectives: After successfully completing this course, students will be able to:

CO1: apply thermodynamic principles to physical and chemical processes.
CO2: understanding the laws of thermodynamics and their applications.
CO3: learn basic concepts of aliphatic and aromatic hydrocarbons
CO4: understand the structure, reactivity and stability of organic molecules including conformation.
CO5: understand the reactions mechanisms.
CO6: gain the knowledge about different reagent papers and their use in chemistry.
CO7: learn about various aspects to know acidic and basic nature of compounds.
CO8: To apply gas laws in various real-life situations.

Unit	Syllabus	Periods
I	**Physical Chemistry (15 L)** **1. Chemical Equilibria and Thermodynamic Parameters: (8L)** 1.1 Reversible and irreversible reactions, law of mass action, dynamic equilibria, 1.2 equilibrium constant, (Kc and Kp), relationship between Kc and Kp, Le Chatelier's principle, factors affecting chemical equilibrium (Numericals expected) 1.3 Statement of second law of thermodynamics, concepts of entropy and free energy, 1.4 Spontaneity and physical significance of free energy, thermodynamic derivation of equilibrium constant (Numericals expected) **2.0. Gaseous State: (7L)** 2.1 Ideal gas laws, kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (qualitative discussion), 2.2 ideal gases, real gases, compressibility factor, Boyle's temperature (Numericals expected).	**15L**

	2.3 Deviation from ideal gas laws, reasons for deviation from ideal gas laws. 2.4 Van der Waals equation of state	
II	**Inorganic Chemistry (15 L)** **1. Concept of Qualitative analysis : (8L)** 11. Introduction and different types of qualitative analysis. 1.2. Role of reagent paper in qualitative analysis 1.3. Preparation and use of different reagent papers: starch iodide paper, potassium dichromate paper, lead acetate paper, dimethylglyoxime and oxine paper. 1.4. Various terms used in analysis: Precipitation equilibrium, common ion effect, uncommon ion effect, buffer solution, complexing agent (numerical problems expected). **2. Acid-base theories (7L)** 2.1.Appreciation of various concepts due to (a) Arrhenius theory, (b) Lowry-Bronsted theory, (c) Lewis theory, (d) Lux-Flood Concept. (e) Solvent solute system 2.2.. Pearson's classification of acids and bases and his principles of HSAB	**15L**
III	**Organic Chemistry (15 L)** **1.0.Chemistry of Aliphatic Hydrocarbons (8L)** **1.1.** Formation of Alkanes: Wurtz, Wurtz – Fittig reaction and decarboxylation of fatty acids 1.2.Formation of unsaturated compounds (alkenes and alkynes) using elimination reaction with mechanism E1, E2 and E1cb 1.3. Reactions of alkanes: Halogenation of alkanes with mechanism 1.4. Reaction of alkenes: Hydration, electrophilic addition, Ozonolysis, 1,2 and 1,4 addition and Diel-Alder reaction 1.5. Reaction of alkynes: Acidity of terminal alkynes, Hydration to form carbonyl compounds, Alkylation of terminal alkynes. **2.0. Chemistry of Aromatic Hydrocarbons(07L)** 2. 1 Aromatic compounds and their characteristics	**15L**

	2.2Aromaticity , Huckel's rule for different aromatic compounds 2.3 Huckel's rule for Non benzenoid compounds and hetero cyclic aromatic compounds. 2.4 Antiaromaticity 2.5 Electrophilic substitution reactions: Nitration, sulphonation (mechanism expected). 2.6. Friedel crafts Reaction: Alkylation and acylation reactions (Mechanism expected).	
	TOTAL	**45 L**

Reference Books:

Physical Chemistry

1. K.L. Kapoor, A Textbook of Physical Chemistry, Macmillan (2000)
2. Atkins P.W. and Paula J.de, Atkin's Physical Chemistry, 10th Ed., Oxford University 12 Press (2014).
3. Engel T. and Reid P., Physical Chemistry, 3rd Ed., Pearson
4. Peter A. and Paula J. de. Physical Chemistry, 10th Ed., Oxford University Press (2014).
5. 3000 solved problems in chemistry: schaum's outline series
6. Modern Physical Organic Chemistry, Eric V. Anslyn , Dennis A. Dougherty
7. Levine I.N., Physical Chemistry, 6th Ed., Tata Mc Graw Hill (2010).
8. Banwell C.N., Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill (1994).
9. Ball D.W., Physical Chemistry, Thomson Press, India (2007).
10. Advanced Physical Chemistry by Gurdeep Raj
11. McQuarrie D.A. and Simon J.D., Molecular Thermodynamics, Viva Books Pvt. Ltd., New Delhi (2004).

Inorganic Chemistry

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
3. Advanced Inorganic Chemistry, 6th Edition, F. Albert Cotton, Geoffrey Wilkinson, Carlos A.Murillo, Manfred Bochmann.
4. Inorganic Chemistry: Principles of Structure and Reactivity by James E. Huheey (Author), Ellen A. Keiter (Author), Richard L. Keiter (Author)
5. Inorganic Chemistry James E. House · Academic Press (2013)
6. Principles of Inorganic Chemistry,B.R. Puri, L.R. Sharma, K.C. Kalia

7. Basic Concepts Of Inorganic Chemistry by D. N. Singh, Pearson

8. A Logical Approach To Modern Inorganic Chemistry by Jagdamba Singh

9. Modern Inorganic Chemistry 3rd Edition, Authored By Dr. R. D. Madan

Organic Chemistry

1. Textbook of Organic Chemistry by V K Ahluwalia, Rakesh K Parashar.

2. Reaction Mechanisms in Organic Chemistry by Ray Mukul C

3. Organic Chemistry by Paula Yurkanis Bruic

4. Organic Chemistry by Jonathan Clayden, Nick Greeves, and Stuart Warren

5. Advanced Organic Chemistry: Part A: Structure and Mechanisms Textbook by Francis A. Carey and Richard J.

6. Solomons' Organic Chemistry, Global Ed by T W Graham Solomons and Craig B Fryhland Scott A Snyder, John Wiley.

7. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012

8. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd.(Pearson Education).

9. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).

10. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.

11. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.

12. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning

Practicals	
Sr. No.	**Aim of the Practical**
1	To determine the rate constant for saponification reaction between ethyl acetate and NaOH.
2	To prepare various compositions of buffer solutions of different pH using sodium acetate and acetic acid solution and determine their pH values by using a pH meter.
3	To determine concentration of a given sample of $KMnO_4$ by colorimetric method (learners are expected to determine $\lambda_{max)}$ and plot calibration curve.

4	To standardize commercial samples of HCl using borax and to write material safety data (MSD) of the chemical involved.
5	Qualitative analysis (at least 4 mixture to be analyzed): Semimicro Inorganic Qualitative analysis of a sample containing two cations and two anions. Cations (from amongst) : Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2},Cd^{2+}, Fe^{2+}, Ni^{2+}, Mn^{2+},Mg^{2+} , Al^{3+}, Cr^{3+} , K^{+} , NH^{+}_{4}. Anions (from amongst): CO_3^{2-}, S^{2-},SO_3^{2-},SO_4^{2-},NO_2^{-},NO_3^{-},PO_4^{3-},Cl^{-},Br^{-} ,I^{-}.
6	Redox titration : 6) To determine the percentage of copper (II) present in a given sample by titration against a standard aqueous solution of sodium thiosulphate (iodometry titration).
7	7) ORGANIC CHEMISTRY a) Characterization of organic compounds containing C, H, (O), N, S, X elements. (minimum 6 compounds)

Programme: F.Y.B.Sc.	Semester: II
Minor (3+1 credits) **(Theory + Practical)** **Course: BASIC CHEMISTRY-II (45L)**	**Course Code:** **BH.USCHEM.Min201**

Teaching Scheme

Lecture (Periods per week)	Practical (Periods per week per batch)	Tutorial (Periods per week per batch)	Credits (Theory +Practical)
3	1	-	4

Course Objectives: After successfully completing this course, students will be able to:

CO1: write the expressions for equilibrium constants.
CO2: elaborate chemistry of ideal and non-ideal solutions and apply the concept of phase equilibrium in various systems.
CO3: explore electrochemical aspects of dilute solution.
CO4: investigate lattice structure of solids.
CO5: understand the basic concepts and terms in solid state chemistry.
CO6: understand different types of bonding in compounds.
CO7: making student aware of definition of oxidation, reduction, oxidizing agent and reducing agents according to classical electronic concepts, oxidation number concepts.
CO7:understand the structure, reactivity and stability of organic molecules including conformation and stereochemistry

Unit	syllabus	Periods
I	**Physical Chemistry (15 L)** **1.0 Ionic Equilibria: (9 L)** 1.1 Strong, moderate and weak electrolytes, 1.2 degree of ionization, factors affecting degree of ionization, 1.3Ionization constant and ionic product of water, ionization of weak acids and Bases. 1.4 pH scale, common ion effect, 1.5 dissociation constants of mono-, di- and triprotic acid 1.6 Numericals based on pH & pOH 1.7 Buffers: Introduction, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected). 2.0 **Solid State Chemistry (6 L)**	**15L**

	2.1 Types of solids, crystal lattice, lattice points, unit cell, space lattice and lattice plane, 2.2 laws of crystallography: Law of constancy of interfacial angle, law of symmetry and law of rational indices (Numericals expected) 2.3 Types of cubic lattice- Simple cubic lattice, Face centered and Body centered cubic lattice.	
II	**Inorganic Chemistry (15 L)** **1.0.Chemical Bonding (8L)** 1.1. Types of chemical bond 1.2 Comparison between ionic and covalent bonds 1.3 Polarizability(Fajan's Rule) and shapes of molecules 1.4 Lewis dot structure and Sidgwick Powell Theory 1.5 VSEPR theory for Ab_n type molecules with and without lone pair of electrons 1.6 Isoelectronic principles, applications and limitations of VSEPR theory. **2.0. Oxidation Reduction Chemistry (7L)** **2**.1. Reduction potentials 2.2. Redox potentials: half reactions; balancing redox equations. 2.3. Redox stability in water. i) Latimer and Frost Diagrams. ii) pH dependence of redox potentials. 2.4. Applications of redox chemistry. i) Extraction of elements: (example: isolation of copper by auto reduction). 2.5. Redox reagents in Volumetric analysis: a) I2; b) KMnO4.	**15L**
III	**Organic Chemistry** **Stereochemistry-II:** 2.1 Cycloalkanes and Conformational Analysis: Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy. 2.2Aromatic Hydrocarbons: Aromaticity: Hückel's rule anti-aromaticity, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples.	**15L**

	Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft alkylation/acylation with their mechanism. Hammond's postulate, Directing effects of the groups.	
	TOTAL	**45 L**

Reference Books:

Physical Chemistry

1. K.L. Kapoor, A Textbook of Physical Chemistry, Macmillan (2000)
2. Atkins P.W. and Paula J.de, Atkin's Physical Chemistry, 10th Ed., Oxford University 12 Press (2014).
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9. Ball D.W., Physical Chemistry, Thomson Press, India (2007).
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11. McQuarrie D.A. and Simon J.D., Molecular Thermodynamics, Viva Books Pvt. Ltd., New Delhi (2004).

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5. Inorganic Chemistry James E. House · Academic Press (2013)
6. Principles of Inorganic Chemistry,B.R. Puri, L.R. Sharma, K.C. Kalia
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6. Solomons & 39; Organic Chemistry, Global Ed by T W Graham Solomons and Craig B Fryhland Scott A Snyder, John Wiley.

7. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012

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10. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.

11. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.

12. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning

Practicals	
Sr. No.	**Aim of the Practical**
	1) To determine the rate constant for saponification reaction between ethyl acetate and NaOH. 2) To prepare various composition of buffer solution of different pH using sodium acetate and acetic acid solution and determine their pH values by using pH meter. 3) To determine concentration of a given sample of $KMnO_4$ by colorimetric method (learners are expected to determine $\lambda_{max)}$ and plot calibration curve. 4) To standardize commercial samples of HCL using borax and to write material safety data (MSD) of the chemical involved. 5) To determine the percentage of copper (II) present in a given sample by titration against a standard aqueous solution of sodium thiosulphate (iodometry titration). 6) ORGANIC CHEMISTRY a) Characterization of organic compounds containing C, H, (O), N, S, X elements. (Minimum 6 compounds).

Programme: F.Y.B.Sc.	Semester: II
OPEN ELECTIVE (3+1) **THEORY+ PRACTICAL** **Course: Basic Analytical and environmental Chemistry (45L)**	**Course Code: BH.USCHEM.OE201**

Teaching Scheme

Lecture (Periods per week)	Practical (Periods per week per batch)	Tutorial (Periods per week per batch)	Credits (Theory +Practical)
3	1	-	4

Course Objectives: After successfully completing this course, students will be able to:

CO1: learn fundamental concepts of potentiometry and conductometry.

CO2: learn experimentally the quantitative analysis of known and unknown compounds.

CO3: find green chemical reaction routes for sustainable development and apply the green routes for the synthesis of chemical compounds

CO4: find new greener routes for sustainable development

CO5: learn Practically to handle pH meter, potentiometer and conductometer.

Unit	Syllabus	Periods
I	**1.0 Analysis of food products:** 1.1 Nutritional value of foods, 1.2 Idea about food processing and food preservatives and adulteration. 1.3 Identification of adulterants in some common food items like coffee powder, asafetida, chilli powder, turmeric powder, coriander powder and pulses. 1.4 Analysis of preservatives and colouring matter.	**15 L**
II	**Industrial Environmental Chemistry (15 L)** 1.0 GREEN METHODS IN CHEMISTRY 1.1 Introduction: Definitions of Green Chemistry. 1.1 Brief introduction of twelve principles of Green Chemistry, with examples, special emphasis on atom economy, reducing toxicity, 1.2 Green solvents, Green Chemistry and catalysis and alternative sources of energy. 1.3 Green energy and sustainability 1.4 The following Real world Cases in Green Chemistry should be discussed:	**15 L**

	Surfactants for carbon dioxide – Replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments. 1.5 Designing of environmentally safe marine antifoulant	
III	**1.0 New Age Chemistry in Daily Life- 2** 1.1 Rain water harvesting (4 L) 1.2Purification of drinking water (2 L) 1.3 Greening education (2 L) 1.4 Importance of organic food (2 L) 1.5 Organic fertilizer vs. synthetic fertilizer and related case studies (5 L)	**15 L**
	TOTAL	**45 L**

Practicals	
Sr. No.	**Aim of the Practical**
1	Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
2	Study of some of the common bio-indicators of pollution.
3	Estimation of SPM in air samples.
4	Preparation of borax / boric acid.
5	Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
6	Measurement of dissolved CO2 in water samples.
7	Titration of a mixture of weak acid and strong acid with strong alkali by conductometry.
8	Preparation of bioplastic from banana and potato.
9	To determine the relative strength of monochloro acetic acid and acetic acid conductometrically
10	To study the saponification of ethyl acetate conductometrically.

	References:
	1. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter

	15, pp. 345-381. 2. A.I. Vogel. “Textbook of Quantitative Inorganic Analysis,” Longman, London (1961). 3. R.V. Dilts. “Analytical Chemistry. Methods of Separation,” van Nostrand, N.Y. (1974). 4. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B.BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi 5. G.H. Morrison and H. Freiser , Solvent extraction in analytical chemistry 6. P. G. Swell and B. Clarke, Chromatographic separations , Analytical chemistry by open Learning , John Wiley and sons, 1987 7. Modern Analytical Chemistry , David Harvey (page numbers 596 -606) 8. Modern Analytical Chemistry , David Harvey (page numbers 215 -217) 9 Skoog et al. “Fundamentals of Analytical chemistry & quot; Cengage Learning, Eight Edition, chapter 13, 14 and 15 10 Day and Underwood, “Quantitative analysis & quot; prentice hall 1991, chapter3 11 S.M. Khopkar, “ Basic Concepts of Analytical Chemistry”, IInd Edition NewAge International Publisher. 12 Gary D. Christan,” Analytical Chemistry”, VIth Edition, Wiley Students Edition, Chapter No 8,9,10.

Programme: F.Y. B.Sc.	Semester: II
Vocational/Skill enhancement course (VSEC) (3+1) **THEORY + PRACTICAL** **Course: Industrial Chemistry-2 (45 L)**	**Course Code: BH.USCHEM.vSEC201**

Teaching Scheme

Lecture (Periods per week)	Practical (Periods per week per batch)	Tutorial (Periods per week per batch)	Credits (Theory +Practical)
3	1	-	4

Course Objectives: After successfully completing this course, students will be able to:

CO1: understand basic terms and important parameters gravimetric analysis.

CO2: apply their gained knowledge in estimation of metal ions in given unknown samples.
CO3: know about various sources of organic compounds.
CO4: Understand mechanism used in unit processes in industry.

Unit	Syllabus	Periods
I	**Industrial Inorganic and Analytical Chemistry** **Gravimetric analysis (15 L)** 1.1. Introduction in gravimetric analysis 1.2. Precipitation methods 1.3. Conditions of precipitation 1.4. Purity of precipitate 1.5. Digestion 1.6. Washing of precipitate 1.7. Ignition of precipitate: Thermogravimetric method of analysis 1.8.Applications: Determination of Aluminium as the 8-hydroxyquinolate. Determination of Barium as sulphate. Determination of Nickel by using dimethylglyoxime reagent.	15 L

II	**Industrial Organic Chemistry** **1.0 Sources of organic compounds (8 L)** (a) Non Renewable: Coal, Petroleum (b) Renewable: Biomass, Biofuels 1.2 Coal : Structure and types of coal, Destructive distillation of coal, Coal tar refining, coal liquefaction (coal to liquid), coal gasification, Synthesis gas (syn gas), Hydropyrolysis. 1.3 Natural gas: Composition, Conversion of methane, higher alkanes, synthetic diesel (gas to liquid), methanol, aromatic compounds, and Natural gas hydrates: occurrence, structure. 1.4 Biofuels: Methanol, Ethanol, biodiesel, synthetic diesel. **2.0.Unit processes in organic chemistry (4 L)** 2.1 Nitration: Mechanism, Industrial preparation of Nitrobenzene, m-dinitrobenzene. 2.2. Sulphonation: Mechanism, Industrial preparation of DDB and DDBS (Detergent). 2.3 Nitration Mechanism 2.4 Sulphonation **3.0 Unit Operation (3 L)** 3.1. Introduction 3.2. Fractional distillation 3.3. Azeotropic distillation	**15L**
III	**Industrial Environmental Chemistry** **1.1. Air Pollution:** 1.1.1 Major regions of the atmosphere. 1.1.2. Chemical and photochemical reactions in atmosphere. 1.1.3. Air pollutants: types, sources, particle size and chemical nature; 1.1.4. Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, 1.1.5. Effects of air pollution on living organisms and vegetation. 1.1.6. Public awareness and Role of an individual in prevention of pollution and Pollution case studies with reference to water pollution. 1.1.7. Environment Protection Act: a) Water (Prevention and Control of Pollution) Act.	**15 L**
	TOTAL	**45 L**

References

1. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp. 345-381.

2. A.I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman, London (1961).

3. R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).

4. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B.BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi

5. G.H. Morrison and H. Freiser , Solvent extraction in analytical chemistry

6. P. G. Swell and B. Clarke, Chromatographic separations , Analytical chemistry by open Learning , John Wiley and sons, 1987

7. Modern Analytical Chemistry , David Harvey (page numbers 596 -606)

8. Modern Analytical Chemistry , David Harvey (page numbers 215 -217)

9 Skoog et al. "Fundamentals of Analytical chemistry & quot; Cengage Learning, Eight Edition, chapter 13, 14 and 15

10 Day and Underwood, "Quantitative analysis & quot; prentice hall 1991, chapter3

11 S.M. Khopkar, " Basic Concepts of Analytical Chemistry", IInd Edition NewAge International Publisher.

12 Gary D. Christan," Analytical Chemistry", VIth Edition, Wiley Students Edition, Chapter No 8,9,10.

Practicals

Sr. No.	Aim of the Practical
1	Determination of Aluminium as the 8-hydroxyquinolate.
2	Gravimetric estimation of Nickel as Ni – DMG.
3	To determine the saponification value of an oil/fat.
4	To determine the iodine value of an oil/fat
5	To synthesis aspirin by acetylation of salicylic acid
6	Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
7	Preparation of borax / boric acid.
8	Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.

Programme: B.Sc.	Semester: II
Value Education Courses (1+1) **THEORY + PRACTICALS** **Course: Sustainable use of synthetic chemicals (15L)**	**Course Code: BH.USCHEM.VEC201**

Teaching Scheme			
Lecture (Periods per week)	**Practical (Periods per week per batch)**	**Tutorial (Periods per week per batch)**	**Credits (Theory + Practical)**
1	**1**	**-**	**2**

Unit	Syllabus	Periods
I	**1.0 Sustainable use of synthetic chemicals (10 L)** 1.1 Basic Concepts of Sustainable Chemistry 1.2 Essentials of sustainable chemistry 1.3 Role of chemistry in sustainability 1.4 Case studies **2.0 Introduction to Green Chemistry (5 L)**	**15 L**
	TOTAL	**15L**

Practicals		
Sr. No.	**Aim of the Practical**	**15L**
1	Preparation of bio-plastic from banana and potato.	
2	Measurement of dissolved CO2 in water samples.	
3	Estimation of SPM in air samples.	
4	Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.	
5	Preparation of propene by two methods can be studied a. Triethylamine ion + OH- → propene + trimethylpropene + water H2SO4/heat b. I-propanol → Propene + water	