JAI HIND COLLEGE

Basantsing Institute of Science & J. T. Lalvani College of Commerce
and Sheila Gopal Raheja College of Management.

Empowered Autonomous

"A" Road, Churchgate, Mumbai - 400 020, India

Affiliated to
University of Mumbai

Bachelor of Science

Program: B.Sc. in Chemistry

Choice Based Credit System (CBCS) under NEP-2020
with effect from the academic year 2023-2024

Syllabus as approved by Statutory Committees

LOCF document

JAI HIND COLLEGE 'A' Road Churchgate Mumbai-20.

PRINCIPAL
JAI HIND COLLEGE

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Preamble

The BSc Programme in Chemistry introduces the students to various aspects of chemistry as a central subject integrating with various other scientific disciplines. It is designed to empower the students to amalgamate their knowledge with other scientific fields and apply it to develop products and processes beneficial to humankind. Chemistry provides indelible solutions with remarkable products we use in everyday life. The programme provides students with thorough knowledge of theoretical and practical chemistry, industrial process and operations, application chemistry and on completion of the course the students attain employable skills. The programme aims to provide in-depth understanding of physical chemistry, inorganic chemistry, organic chemistry, analytical chemistry and drugs and dyes subjects. The course components also enable the students with environmental and sustainable knowledge needed for present times. The curriculum is designed considering the current industry needs in terms of skill sets, demands of emerging technologies, research and business environment. It also endeavours to align the programme structure and course curriculum with student aspirations and industrial expectations. The programme augments the student on intellectual development and academic success.

The programme builds knowledge at fundamental level and slowly builds over three years to the threshold of advance level which help students to further their knowledge through postgraduate and research programmes. The curriculum exposes the students to the recent developments through various integrated components. The ICT tools and virtual laboratory introduced at various semesters provide them a platform to self-experiment and integrate with real time scenarios. The field visits conducted as a part of the programme introduces the students to the industrial environment and its operations. The programme intends to inspire, encourage and develop entrepreneurial skills and inquisitive minds amongst students.

The physical chemistry course emphasises the underlying fundamental theoretical aspects of physical forces and their correlations with tangible attributes. This part of the curriculum provides in-depth understanding on state of matter, thermodynamics, kinetics and various physical properties associated with matter and the correlation with chemical properties, quantum chemistry and spectrometry. The practical course work introduces them to qualitative and quantitative methodologies and determination of physical constants.

Inorganic chemistry exposes the learner to concept building in chemical bonding, study of elements of periodic table, concept of symmetry, complexes and practical skill building in classical methods of analysis.

Organic chemistry engages students with various theory and mechanism of transformations, stereochemistry, industrial and polymer chemistry, heterocyclic chemistry, photochemistry, organometallics, biomolecules and natural products. The practical coursework provides necessary skill in molecular architecture and chemical analysis.

Analytical chemistry provides learners with thorough theoretical insights into qualitative and quantitative methods of chemical analysis, instrumental methodologies, instrumentation theory, quality concepts, ISO, GLP and GMP environments. The practical sessions train the learner with various industry oriented skills required for an analyst.

The elective components unravel the knowledge of dyes, pigments and drug chemistry. The course is designed to provide the student with knowledge on industrially relevant chemical substances, functionalities, their synthesis and isolations.

The BSc chemistry programme provides an opportunity for the learner to develop analytical and logical skills, envisage holistic development and forthcoming for serving the society at large.

Credit Framework

Type of Courses

Sr.No	Course Type	Learner Category
1	**Major**	Chemistry Major
2	**Minor**	Chemistry Minor
3	**OE**	Commerce/Arts Stream
4	**SEC**	Chemistry Major/Minor
5	**VSC**	Chemistry Major/Minor

Number of Courses & Credits

Type of Course	Number offered of each	Credits of each (Theory + practical)
Major/Minor	02	4 (3+1)
OE	02	2
SEC	01	2
VSC	01	2

Semester-wise courses and Credits

Semester	Course Title	Type	Credits per Semester
I	Fundamental of Chemistry-I	Major/Minor	4
I	Practical Coursework in Chemistry-I	Major/Minor	
I/II	Chemical Analysis	SEC	2
I/II	Laboratory Management-I	VSC	2
II	Fundamental of Chemistry-II	Major/Minor	4
II	Practical Coursework in Chemistry-II		
I/II	Products in Everyday Life	OE	2
I/II	Wonder with Molecules	OE	2

Learning Outcome Based Approach:

• **Customized Learning Pathways:-**The goal of a customized learning pathway is to maximize the effectiveness of the learning experience by providing the learner with a structured and personalized roadmap for achieving their objectives.

• **Assessment Precision:** precision is a crucial aspect because it ensures that the assessment results are dependable and truly reflect the knowledge, skills, or attributes being assessed.

• **Skill Development**: Skill development is the process of acquiring or enhancing specific abilities, knowledge, or competencies that enable individuals to perform tasks, solve problems, or achieve specific goals more effectively. Skill development is essential in both personal and professional contexts and plays a crucial role in personal growth, career advancement, and overall life satisfaction.

• **Curriculum mapping:** Curriculum mapping is a valuable tool for educational institutions to ensure

coherence and alignment in their programs. It helps educators design effective instruction, improve student learning outcomes, and maintain quality education that aligns with educational standards and objectives.

- **Outcome-centric pedagogy:** Outcome-centric pedagogy, also known as outcome-based education (OBE) or outcomes-based learning, is an educational approach that places a strong emphasis on defining specific learning outcomes or objectives and aligning all aspects of teaching and assessment with these outcomes. The core idea is to focus on what students should know, understand, and be able to do by the end of a course or educational program, rather than just covering content or following traditional teaching methods.
- **Alignment with Industry Demands:** This alignment is crucial for producing a workforce that is well-prepared, skilled, and capable of contributing effectively to the workforce.

Graduate Attributes

The following objectives would be achieved by the programme:

1. To understand and analyze matter, its composition and various forms seen around us in natural and synthetic forms.
2. Capability to express and operate on theoretical concepts of all branches related to chemical sciences and interdisciplinary domains, statistical analysis and data interpretation.
3. Graduated students will be able to build molecules through chemical transformation, characterize it and perform various analyses to deconstruct the constitution of chemical species/matter.
4. On completion, the student will acquire employable skills so as to work in commercial and industrial settings with knowledge of quality management, GMP and GLP standards.
5. The learner will be aware of environmental sustainability and get trained to frame environmentally benign processes and chemical transformations.
6. Skills for in-silico studies, work on virtual and cloud environments and various software platforms.

PROGRAMME OBJECTIVE

Students will be able:

1. To understand fundamental concepts in various branches of chemistry.
2. To appraise the core concepts involved in chemistry.
3. To develop critical thinking &problem-solving skills in core areas of chemistry.
4. To acquire Analytical skills and apply for enhancement of employability.
5. To enhance students in scientific and communication skills by involving in different activities such as Discussion Clubs, Scientific writing, Projects etc.
6. To appraise the importance of chemical science and its application related to environmental and social context as a pursuit of lifelong learning.
7. To develop the ability to design experiments to solve problems related to chemistry and other multidisciplinary areas.
8. To inculcate research aptitude, scientific thinking, and ethical sensibilities.
9. To implement standard safety procedures and techniques commonly used in laboratories, disposal of waste appropriately, safety regulations, and recognize an and minimize hazards in the laboratory.
10. To execute suitable methodologies in order to conduct chemical synthesis, analysis, characterization or other chemical investigation.
11. To apply the principles of green chemistry as a good laboratory practice for the betterment of society.
12. To introduce modern technologies and instrumentations involved in recent developments in research and industries.
13. To select appropriate chemical techniques relevant to academic,industrial, and generic skills and global competencies.
14. To demonstrate laboratory skills in all major laboratory techniques and principles including instrumentation, synthesis, purification, and analysis.
15. Identify problems and generate hypotheses through various laboratory techniques & implement experimental methods to test hypotheses, and interpret the resulting data.

Teaching Learning Process:

Active Learning Strategies:

- Incorporate active learning strategies to engage students.
- This includes group discussions, problem-solving exercises, case studies, and hands-on laboratory experiments.
- Use multimedia and technology to enhance learning, such as interactive simulations and online resources.

Lectures and Demonstrations:

- Plan well-organized lectures with clear explanations of key concepts.
- Use visuals, analogies, and real-world examples to make the content relatable.
- Demonstrations to illustrate chemical reactions and principles.

Laboratory Work:

- Laboratory experiments that align with the course content and provide practical experience.
- Emphasize safety protocols and proper laboratory techniques

Assessment and Feedback:

- Assessment methods, including quizzes, exams, lab reports, and projects, to evaluate student understanding.
- Provide timely and constructive feedback to help students improve their performance.
- Consider formative assessments to gauge student progress throughout the course.

Active Participation:

- Encourage student participation in class discussions and group activities.
- Supportive learning environment where students feel comfortable asking questions and sharing their thoughts.
- Problem-Solving: Emphasize problem-solving skills and analytical thinking.
- Conceptual Understanding: Focus on developing a deep conceptual understanding of chemistry principles, rather than rote memorization.
- Use concept maps and diagrams to visualize relationships between concepts.

Assessment Methods / Evaluation Scheme

ASSESSMENT PATTERN FOR EACH COURSE TYPE WOULD BE AS FOLLOWS:

Assessment pattern of the Major & Minor Courses:

- **For Science** – Each Major/Minor Course of 4 credits will be divided into 3 credits for Theory and 1 credit for Practical. The assessment pattern will be as follows:
  - Theory - 75 marks, Practical – 25 marks
  - The Theory component will comprise of 50 marks as Semester End Examination (SEE) of 2 hours ; and 25 marks Continuous Assessment (CA)
  - The Practical Component will comprise of 25 marks Semester End Examination (SEE) Practical of 1.5 hour; and 25 marks for Continuous Assessment (CA). The latter will consist of 20 marks based on continuous assessment of practical conducted during regular turns and 5 marks for VIVA . Completion of Journal is a requirement to appear for Semester end Practical Exam.
  - Total of Internal Assessment + SEE for practical = 50 marks which will be converted to out of 25

PATTERN OF SEMESTER END EXAM (SEE) AND CONTINUOUS ASSESSMENT (CA):

- SEE will be **consist of** a mix of long and short answer type questions based on Higher Order Thinking Skills (HOTS) aligned with Bloom's Taxonomy
- A minimum of 2 and a maximum of 5 internal assessments to be carried out during a semester for each course being assessed only on Continuous assessment pattern, of which the best evaluation to be chosen for grades
- One or more, but not limited to the following methods of assessment can be used for internal assessment - MCQ, quiz based, objective type, puzzle, group presentation, group or individual projects, debate, model making, poster making, role play, case studies or any other creative mode of assessment
- The faculty has to share with the students, the rubrics for the format(s) chosen for CA by displaying it in Google classroom/ notice boards/circulars
- Marks obtained by students under continuous assessment to be displayed

- **Assessment for Vocational Skill Course (VSC) and Skill Enhancement Course (SEC) across all streams will be assessed as a Practical component of 50 marks which will be as follows:**

- The Practical component will comprise of 25 marks as Semester End Examination (SEE) of 1.5 hour ; and 25 marks Continuous Assessment (CA); the evaluation pattern to be experiment/ task based/ case study or any other similar

- **Assessment for Open Elective (OE) / Ability Enhancement Course (AEC) across all streams will be assessed on Theory component which will be as follows:**

- The Theory component will comprise of 25 marks as Semester End Examination (SEE) of 1 hour ; and 25 marks Continuous Assessment (CA)

Discipline Specific Core Courses – Major/Minor

Course Code JUSCHE-DSC101/JUSCHE-MIN 101	**Course Title: Fundamentals of Chemistry I**	Credits: 3 Lectures/Week: 3
Course description	**Thermodynamics and States of Matter, Atomic Structure & General Trends of Modern Periodic Table, General Organic Chemistry – I, Chemistry of Aliphatic Hydrocarbons, Chemistry of some functional groups**	
Course Learning objectives	• To understand the fundamental concepts of thermodynamics and the Inter-relationships of variables and their practical applications through problem-solving. • To understand the special features of the quantum mechanical model of an atom and to define an atomic orbital in terms of its quantum numbers. • To correlate the systematic name with the structure of organic compounds. differentiate and rationalize the bond strength, bond dissociation, and therefore, reactivity of different classes of organic compounds.	
Course Outcomes	Learner will be able: • To explain and apply the concepts of thermodynamics in deriving relationship between thermodynamic variables. • To describe the experimental observable by using the quantum mechanical model studied. • To analyze the stability of a given reactive intermediate.	
	THEORY	**(45 lectures)**
Sub Unit	**Unit – I: Thermodynamics and States of Matter**	**15 Lectures**
1	1) Thermodynamics: a) Basic Concepts in Thermodynamics: i) Types of systems, Properties of system, State and state system and types of processes b) Concepts of Heat &Work c) First law of Thermodynamics: i. Internal energy, Enthalpy ii. Heat capacity, Relation between Cp and Cv in gaseous state iii. Joule– Thomson effect d) Second Law of Thermodynamics & Concept of Entropy i. Carnot Cycle-Heat engine ii. Physical significance of entropy	(9L)
2	States of Matter a) Gaseous State: i. Ideal gas behavior and kinetic theory of gases (only postulates) ii. Distribution of molecular speed (Maxwell Boltzmann's plot) b) Liquid State: Liquid-vapour equilibrium (vapour pressure) Surface tension: determination using stalagmometer Viscosity: measurement using Ostwald's viscometer	(6L)

	Unit – II: Atomic Structure & General trends of Modern Periodic Table	**15 lectures**
1	**Historical perspectives of the Atomic Structure** i. Bohr's theory and its limitations ii. Dual behavior of matter and radiation iii. De Broglie's relation iv. Heisenberg's Uncertainty Principle v. Hydrogen atom spectra vi. Need for a new approach to Atomic Structure	(2L)
2	i. Time independent Schrodinger's Equation; meaning of various terms involved ii. Significance of ψ and ψ^2 iii. Schrödinger's equation for hydrogen atom (derivation not required) iv. Radial and angular parts of the hydrogenic wave function (atomic orbital) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbital (Graphical representation only) v. Radial and angular nodes and their significance. vi. Radial distribution functions and concept of the most Probable distance (special reference to 1s and 2s atomic orbital) vii. Significance of quantum numbers viii. Shapes of s, p and d atomic orbital, ix. Calculation of nodes (angular & radial) for the orbitals.	(6L)
3	Aufbau and Pauli exclusion principles, Hund's multiplicity Rule.	(3L)
4	Electronic configurations of the elements, effective nuclear charge.	(2L)
5	Modern Periodic Table: General trends in the modern periodic table	(2L)
	Unit – III: Organic Chemistry- I	**15L**
1	**General Organic Chemistry – I** **a) Nomenclature of polyfunctional organic compounds on the basis of priority order, of the following classes:** i. Aliphatic ii. Alicyclic iii. Aromatic compounds (Overview of nomenclature of alkanes, alkenes, and alkynes. Discuss the nomenclature of functional groups and priority order in detail with examples) **b) Electronic Effects:** i. Inductive Effect ii. Electromeric Effect iii. Resonance (Mesomeric) Effect iv. Hyperconjugative Effect	

2	**Chemistry of Aliphatic Hydrocarbons:** **a) Alkanes:** i. Sources of alkanes – Petroleum, natural gas, LPG, CNG, Catalytic hydrogenation (general discussion). Preparation of alkanes: By reduction of haloalkanes – using Zn/HCl, HI in the presence of red phosphorus, catalytic reduction, Wurtz reaction, Kolbe's synthesis. (Mechanism not expected) ii. Physical Properties – Discussion on physical state, Density, Boiling point, Melting point iii. Use of alkanes in brief. **b) Alkenes:** Preparation- from dehydrohalogenation of haloakanes (Saytzeff rule), dehydration of alcohols. ii. Reactions: By hydration, addition of $KMnO_4$ and Br_2 (test for unsaturation); addition of HX (Markownikoff's& anti-Markownikoff's addition),ozonolysis. (Mechanism not expected) iii. Physical properties: Physical state, boiling points and melting points (self-study) iv. Uses of alkenes – (self-study) **c) Alkynes (1L)** i. Preparation- From CaC_2 (discuss applications in fruit ripening), Dehydrohalogenation of vicinal dihalides, reaction of metal acetylides with primary alkyl halides. ii. Reactions: From the addition of water, addition of bromine & and alkaline $KMnO_4$, ozonolysis & oxidation. iii. Acidic nature of ethyne (discuss). iv. Physical properties – (Self-study) v. Uses – (Self-study)	

3	**Chemistry of some functional groups** a) **Alcohols** i. Preparation- Industrial preparation (fermentation), using Grignard reagent, using hydride reducing agents ii. Reactions- with sodium, HX (Lucas test), esterification, oxidation (the distinction between primary, secondary, and tertiary alcohols) b) **Ethers** i. Preparation- Williamson's synthesis ii. Reactions- cleavage of ethers with HI iii. Uses- ethers as solvents (THF, diethyl ether) in organic synthesis c) **Haloalkanes** i. Nucleophilic substitution: SN1 & SN2 (Mechanism and Stereochemistry to be discussed) ii. Factors affecting nucleophilic substitution: Substrate, Solvent, Reagent, Leaving group	
Course Code JUSCHE-DSCPR101/JUSCHE-MINPR101	**CHEMISTRY PRACTICAL**	**Credit: 1** **Total: 30 hours**
	Practical Coursework in Chemistry-I	
	a. 1. Introduction to chemistry Lab and Safety measures SOP and safety measures in the laboratory. 2. Introduction to primary and secondary standard solutions. 3. Preparation of standard solutions and finding the exact normality of NaOH solution by titrating it against a primary standard. 4. To determine endergonic/exergonic salts through enthalpy of dissolution. 5. To determine the relative viscosity of aqueous solutions at room temperature using Ostwald's Viscometer. 6. To determine the surface tension of a given liquid using a stalagmometer. 7. To study the trends in the periodicity of a modern periodic table by plotting a graph of the given values on a graph paper and concluding based on the observation. 8. Organic Spotting up to element detection. (minimum4)	

	Evaluation Scheme Mention assessment pattern **Theory paper**:75 marks CA-25 marks SEE- 50 marks theory Practicals - 25 marks(25 internals + 25 SEE =50/2)	
References	**Unit I:** 1. Bhal, A, Bahl B.S, Tuli, G.D, Essential of Physical Chemistry, S. Chand Publication. 2. Puri, B. R., Sharma, L.R., Pathania, M.S., Physical Chemistry, (45th Ed.), Vishal Publish Co. 3. Glasston& Lewis, Principles of Physical Chemistry 4. Atkins P. W., and Paula J. De, Physical Chemistry, 10th ed., Oxford University, 12 press(2014) 5. Levine, I.N., Physical Chemistry, (6thEd.2010), Tata McGraw Hill **Unit II:** 1. Lee, J.D. Concise Inorganic Chemistry, (1991),ELBS 2. Douglas, B.E. and McDaniel, D.H.,(1970),Concepts Models of Inorganic Chemistry 3. Prakash,S.,Tuli, G.D., Basu, S.K., Madan, R.D., Advanced Inorganic Chemistry, Volume I 4. Day, M.C. and Selbin, J.,(1962),Theoretical Inorganic Chemistry, ACS Publications 5. James E. Huheey, Inorganic Chemistry,(1983),Harper & Row Publishers, Asia 6. Shriver, D.F., P.W. Atkins, C.H. Lang ford,3rd edition, Inorganic Chemistry, Oxford University Press . **Unit III:** 1. Morrison, R.T.; Boyd, R.N. (2012) Organic Chemistry. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2. Finar, I.L. (2012) Organic Chemistry (Volume1 Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 3. Solomons, T.W.G. (2009) Organic Chemistry. John Wiley & Sons, Inc. 4. Kalsi, P.S. (2005) Stereochemistry Conformation and Mechanism New Age International 5. Ahluwalia, V.K.; Parashar, R.K. (2006) Organic Reaction Mechanisms, Narosa. Publishing House. 6. Mukherji; Singh; Kapoor (2002) Reaction Mechanisms in Organic Chemistry, McMillan 7. Madam, R. L.; Simplified Course in Organic Chemistry, S. Chand & Company Ltd, 2001	

Bloom's Taxonomy in Evaluation Scheme

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	10	8	7	25
II	12	8	5	25
III	8	6	11	25
TOTAL MARKS PER OBJECTIVE	30	22	23	75
% WEIGHTAGE	40	30	30	100

Course Code JUSCHE-DSC201/ JUSCHE-MIN201	Course Title: Fundamentals of Chemistry II	Credits: 3 Lectures/Week: 3
Course description	**Chemical Kinetics, Chemical Bonding and Molecular Structure, stereo-electronic effects, stereochemistry of simple organic compounds.**	
Learning objectives	• To understand the kinetics of various reactions: parameters involved, determination of order by various methodologies and practical applications. • To understand the formation of chemical bonds, the rules governing them, their types, and the spatial arrangements leading to various molecular symmetries. • To apply the different parameters of stereo-electronic effects inorganic reactions.	
Course Outcomes	• To interpret experimental results for determination of reaction order. • To explain students will be having a clear understanding of the formation of bonds between various types of atoms thereby leading to the formation of various molecular entities, their geometrical arrangements, and the rules governing them. • To account for acidity and basicity in organic compounds based on stereo-electronic effects	
	THEORY	**45L**
Sub Unit	**Unit – I: Chemical Kinetics**	**15L**
1.	Rate of Reaction i. Definition and measurement of rate constant ii. Order of reaction iii. Molecularity of reaction iv. Integrated rate equation for zero, first and second order reactions (only a=b)	**(6L)**
2.	Determination of Order of Reaction i. Integration method ii. Graphical method iii. Halftime method iv. Ostwald's Isolation method	**(4L)**

3.	Arrhenius equation i. Effect of temperature on reaction rates ii. Energy of activation	(2L)
4.	Types of Complex Chemical Reactions i. Reversible ii. Consecutive iii. Parallel iv. Thermal chain reaction (only examples: no derivation)	(2L)
5.	Catalysis i. General features of a catalyst ii. Classification iii. Examples of catalyzed reactions (Numerical expected)	(1L)
	Unit – II: Chemical Bonding and Molecular Structure	**15L**
1.	Chemical bond i) Introduction ii) Octet Rule	(2L)
2.	Ionic Bonding i. General characteristics of ionic bonding ii. Polarizing power and polarizability iii. Fajan's rules, ionic character in covalent compounds	(4L)
3.	Covalent bonding i. VB Approach: Shapes of some inorganic molecules Lewis Dot structure, Sidgwick and Powell Theory, the shape of ions on the basis of VSEPR theory for ABn type molecules with and without lone pair of electrons(examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and Octahedral arrangements). ii. Concept of resonance and resonating structures in various compounds. iii. Applications and limitations of VSEPR theory iv. Isoelectronic principles.	(9L)
	Unit – III: Organic Chemistry	**15L**
1.	**Stereo-chemical Modeling:** **a) 2D models** i. Projection Formula: Wedge-Dot, Fischer, Newmann, Sawhorse ii. Interconversions of projection formula **b) 3D models: Ball-stick & space fill models**	(2L)

2.	**Conformation:** **a) Conformational analysis of alkanes** i. Ethane ii. Propane iii. n-Butane	**(3L)**
3.	**Configuration:** **a) Geometrical isomerism in alkenes** i. Stereochemical descriptor: cis/trans; E/Z b) Optical isomerism i. Chirality, asymmetry, stereogenicity ii. Enantiomers, diastereomers &meso isomers iii. Compounds with multiple stereogenic centers- number of possible stereoisomers iv. Configurational descriptor for compounds not containing more than 2 stereogenic centers (D/L; erythro/threo; synanti; R/S)	**(6L)**
4.	**Optical activity:** i. Plane Polarized Light ii. Polarimeter iii. Specific rotation iv. Racemic mixture (external compensation) v. Resolution (methods of resolution not expected) vi. Optical purity (calculation of ee)	**(4L)**
Course Code JUSCHE-DSCPR201/ JUSCHEMINPR201	**Practical** **Practical Course work in Chemistry-II**	**Credit: 1** **30 Hours**
1.	1) To determine the rate constant & order for hydrolysis of ester using HCl as a catalyst 2) To study the base catalyzed hydrolysis (saponification) of ethyl acetate and to evaluate rate constant 3) To determine the strength of carbonate and bicarbonate present in a mixture by titration with standard acid solution using phenolphthalein and methyl orange indicators. 4) Purification using recrystallisation technique (Water soluble compound) 5) Purification using recrystallisation technique (Alcohol soluble compound) 6) To study the number of electrons transferred by iodometric titration of potassium dichromate against sodium thiosulphate. 7) Standardization of commercial sample of HCl using borax. 8) To determine the strength of commercial sample of vinegar.	

	Evaluation Scheme Theory paper:75 marks CA-25 marks Internal SEE- 50 marks theory Practical - 25 marks(25 marks internals+25 marks SEE practical examination = 50/2)
References:	**Unit I:** 1.Bhal, A, Bahl B.S, Tuli, G.D, Essential of Physical Chemistry, S. Chand Publication. 2. Puri, B. R., Sharma, L.R., Pathania, M.S., Physical Chemistry, (45th Ed.), Vishal Publish Co. 3. Glasston&Lewis, Principles of Physical Chemistry 4. Atkins P. W., and Paula J. De, Physical Chemistry, 10th ed., Oxford University, 12 press(2014) 5. Levine, I.N., Physical Chemistry, (6thEd.2010), Tata McGraw Hill **Unit II:** 1. Lee, J.D. Concise Inorganic Chemistry, (1991),ELBS 2. Douglas, B.E. and McDaniel, D.H.,(1970),Concepts Models of Inorganic Chemistry 3. Prakash,S.,Tuli, G.D., Basu, S.K., Madan, R.D., Advanced Inorganic Chemistry, Volume I 4. Day, M.C. and Selbin, J.,(1962),Theoretical Inorganic Chemistry, ACS Publications 5. James E. Huheey, Inorganic Chemistry,(1983),Harper & Row Publishers, Asia 6. Shriver, D.F., P.W. Atkins, C.H. Lang ford,3rd edition, Inorganic Chemistry, Oxford University Press. **Unit III:** 1. Morrison, R.T.; Boyd, R.N. (2012) Organic Chemistry. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 2. Finar, I.L. (2012) Organic Chemistry (Volume1 Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 3. Solomons, T.W.G. (2009) Organic Chemistry. John Wiley & Sons, Inc. 4. Kalsi, P.S. (2005) Stereochemistry Conformation and Mechanism New Age International 5. Ahluwalia, V.K.; Parashar, R.K. (2006) Organic Reaction Mechanisms, Narosa. Publishing House. 6. Mukherji; Singh; Kapoor (2002) Reaction Mechanisms in Organic Chemistry, McMillan 7. Madam, R. L.; Simplified Course in Organic Chemistry, S. Chand & Company Ltd, 2001

Bloom's Taxonomy in Evaluation Scheme

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	10	8	7	25
II	10	8	7	25
III	10	7	8	25
TOTAL MARKS PER OBJECTIVE	30	23	22	75
% WEIGHTAGE	40	30	30	100

VOCATIONAL SKILLS ELECTIVE COURSE

Course Code JUSCHE-VSC101/ JUSCHE-VSC201	Laboratory Management I	Credits: 2 60 hours
Course description	**Laboratory management, chemical storage, and preparation of reagents, Laboratory Safety, Waste management and Green Practices**	
Learning objectives	• To Understand the basics of laboratory management, chemical storage, and preparation of reagents. • To acquire knowledge of quality concepts, the role of lab equipments in quality data acquisition, storage of data, and maintenance of records. • To understand the upkeeping of the laboratory, the operation of lab equipment, and their calibration. To know the safety in the laboratory, how to maintain SHE and green practices.	
Course Outcomes	• To prepare the standard reagents and solutions, knowledge of storage and disposal of chemicals. • To explain the handling of various instruments, their calibration, and upkeeping to avoid downtime. To discuss green practices, RRR concepts, practicing SHE/EHS (Safety, Health & Environment), first aid and waste disposal.	
Sub Unit	**Unit – I: Laboratory Management I**	
1.	Introduction to quality & quality management.	**(1L)**
2.	Facilities and Safety of Laboratory (Book: LQMS handbook)	**(1L)**
3.	Chemicals, Classification & Storage (CAS numbers, MSDS, Labeling, sample management)	**(2L)**
4.	Preparation of standard solutions (primary and secondary standards, dilutions, Normality, Molarity, Molality, w/v, and v/v)	**(2L)**
5.	Classical methods, Instrumental methods,and advanced analytical methods 1. Introduction to Instrumentation 2. Calibration of Potentiometer,Conductometer and pH meter	**(1L)**
6.	Calibrations - Glassware, pH meter, Potentiometer & Conductometer	**(1L)**
7.	Preparation of Indicators Preparation of Buffer	**(1L)**
8.	First aid	**(1L)**
9.	Lab design - Geographic or spatial organization	**(2L)**
10.	Waste Management and Green Practices Disposal of chemicals	**(2L)**
11.	Documents, Records & Lab Notebooks	**(1L)**

12.	• Introduction of glassware • Calibration of glassware • Preparation of Salt bridge	
	Evaluation Scheme:Total 50 marks **CA** (internal)25 marks **SEE:** 25 marks practical examination for1.5hour	
References	1. Vogels Textbook of quantitative chemical analysis 2. Quality Assurance in Analytical Chemistry - Elizabeth Prichard 3. WHO Handbook of Good Laboratory Practice 4. Industrial Hygiene & Chemical Safety – Fulekar 5. Safety & Hazards Management in Chemical Industries - M N Vyas 6.Modern Analytical Chemistry - David Harvey 7.A Practical Book on Calibration of Analytical Instruments - Jain, Saini & Trivedi	

SKILL ENHANCEMENT ELECTIVE COURSES

Course Code JUSCHE-SEC101/ JUSCHE-SEC201	SEC **COURSE TITLE: Chemical Analysis**	**Credits: 2** 60 hours
Course description	**Concept of Qualitative Analysis, Introduction to S and P block elements, Ionic Equilibria, Gravimetric analysis**	
Learning objectives	• To apply the concept of the solubility product and pH of the medium tothe precipitation of ionic compounds. • To correlate the chemical properties of elements with their position in the periodic table • To explain the concept of ionic equilibria, pH, theory of ionic products, and theory of acids and bases. • To discuss the concept of the theory of indicators, solubility product &and their practical applications.	
Learning outcomes	• To explain the chemical properties of elements based on parameters with predictable trends across periods and groups in the periodic table. • To observe and perform in the laboratory the semi-micro analysis with the concept of solubility product.	
	Qualitative & Quantitative Analysis & Properties of S and P block elements, ionic equilibria	
1.	**Concept of Theory and Practical Aspects of Qualitative Analysis:** i) Testing of Gaseous Evolutes ii) Role in qualitative analyses: Papers impregnated with reagents (Starch iodide, potassium dichromate, lead acetate, dimethylglyoxime, and oxime reagents) iii) Precipitation equilibria iv) Solubility product v) Common ion effect vi) Uncommon ions vii) Oxidation states viii) Buffer action ix) Complexing agents for precipitation of ionic compounds. Its application in the Semimicro Analysis of Cations (Ba^{+2}, Sr^{+2},Ca^{+2},K^{+} ,Al^{+3}, NH_4^{+} ,Mg^{+2}) and Anions(CO_3^{-2}, NO_3^{-}, SO_4^{-2}, Cl^{-} , Br^{-} , F^{-} , I^{-}).	**5L**

2.	Introduction to the chemical properties of S and P block elements both theory and practical approach : i) Study the general Chemical properties of s block elements: Reaction with oxygen, water, hydrogen, nitrogen, Action of Carbonates and Bicarbonates of these elements. ii) Compounds of s block elements: Hydrides, oxides, super oxides, nitrates, sulphates. iii) Uses of s block elements. iv) Study the general Chemical properties of p block elements: Reaction with air, acids &alkalies; Reactivity towards halogens, water, oxygen v) Uses of p block elements. Theory of indicators: acid base, self, external & internal. e.g) The estimation of Fe(II) by titration against potassium dichromate using internal (diphenylamine/N-phenylanthranilic acid) indicators. (Self Learning)	**5L**
3.	Strong, moderate, and weak electrolytes practical analysis: i. Ionization constant and ionic product of water Buffer solution, buffer capacity, and buffer action iii. Henderson's equation for acidic and basic buffer iv. Applications of buffer in biochemical processes Hydrolysis of salts: Hydrolysis constant, degree of hydrolysis. (For Example) To study the number of transferred electrons of KMnO4 in acidic,basic and neutral mediums. Constructing the titration curves and choice of the indicator for acid-base titrations.	**3L**
4.	Introduction to gravimetric analysis & its application: i)Volatilization method. 1.To determine the percentage purity of sample $BaSO_4$& NH_4Cl. 2. To determine the percentage purity of ZnO containing $ZnCO_3$. ii) Precipitation method.	**2L**
	Evaluation Scheme: Total 50 marks **CA (internal)25 marks** **SEE: 25 marks practical examination for 1.5hour**	

References:	1. Shriver, D.F. and Atkins, P.W.(1999),Inorganic Chemistry, 3 rdEd., Oxford University Press. 2. Jolly, W.L.,(1993), Modern in organic chemistry, McGraw Hill Book Co. 3. Douglas, B.E. and McDaniel, H. Concepts and models in inorganic chemistry,(1994),3rd Ed., John Wiley & Sons, Inc., New York 4. Huheey, J.E.,(1993), Inorganic Chemistry, Prentice Hall. 5. Lee, J.D.(1993),Concise Inorganic Chemistry, ELBS

OPEN ELECTIVE COURSES

Course Code SCHE-OE101/201	Course Title: Products in Everyday life	Credits: 2 Lectures/week: 2
Course description	Plastics and polymers, Cleansing agent and Cosmetics	
Learning objectives	1) To create awareness about the application of polymer in day to day life. 2) To emphasize the importance of sustainable polymers and the role of students in reducing environmental impact through responsible polymer use. 3) To understand about the different types of cleansing agents and cosmetics available in the market	
Course Outcomes	4) To explain the practical application of polymers in day-to-day life. 5) To explore recycling and sustainable practices to mitigate the environmental impact of polymer. 6) To describe the effectiveness of cleansing agents and cosmetics in day-to-day life.	
	THEORY	**Credits: 2 Total Lectures: 30**
Sub Unit	**Unit – I: Plastics and polymers**	**15L**
	Plastics and Polymers: Introduction to polymers, types of polymers. Plastic in daily use: HDPE, LDPE, PVC, PET, PP. Environmental Hazards of Plastics. Recycling of plastics International universal recycling codes and symbols for identification. Biodegradable plastics. Job opportunities and relevant companies	
	Unit – II: Cleansing agent and Cosmetics	**15L**
1.	Chemistry of Cleansing agents, Soaps, detergents, and Common detergent chemicals, soap-making	**7L**
2.	Chemistry of Cosmetics: Basic concepts-composition and classification of creams-sunscreen and suntan lotions deodorants, talcum powder, lipsticks, oils, face creams, skin products, dental cosmetics, hair dyes, shaving cream, shampoo. Analysis of the cosmetics (Demo) Job opportunities and relevant companies.	**8L**
	Evaluation Scheme TOTAL - 50 marks SEE(theory) - 25 marks (1 hr exam) CA –25 marks	
References:	1. Collin Bard, Chemistry in your life, W. H. Freeman and Company • New York. 2. G.D.Gem Mathew, Chemistry in everyday life, 1st edition, Vishal Publishing Co.	

OPEN ELECTIVE COURSES

Course Code JUSCHE-OE101/201	Course Title: Products in Everyday life	Credits: 2 Lectures/week: 2
Course description	Plastics and polymers, Cleansing agent and Cosmetics	
Learning objectives	1) To create awareness about the application of polymer in day to day life. 2) To emphasize the importance of sustainable polymers and the role of students in reducing environmental impact through responsible polymer use. 3) To understand about the different types of cleansing agents and cosmetics available in the market	
Course Outcomes	4) To explain the practical application of polymers in day-to-day life. 5) To explore recycling and sustainable practices to mitigate the environmental impact of polymer. 6) To describe the effectiveness of cleansing agents and cosmetics in day-to-day life.	
	THEORY	**Credits: 2 Total Lectures: 30**
Sub Unit	**Unit – I: Plastics and polymers**	**15L**
	Plastics and Polymers: Introduction to polymers, types of polymers. Plastic in daily use: HDPE, LDPE, PVC, PET, PP. Environmental Hazards of Plastics. Recycling of plastics International universal recycling codes and symbols for identification. Biodegradable plastics. Job opportunities and relevant companies	
	Unit – II: Cleansing agent and Cosmetics	**15L**
1.	Chemistry of Cleansing agents, Soaps, detergents, and Common detergent chemicals, soap-making	7L
2.	Chemistry of Cosmetics: Basic concepts-composition and classification of creams-sunscreen and suntan lotions deodorants, talcum powder, lipsticks, oils, face creams, skin products, dental cosmetics, hair dyes, shaving cream, shampoo. Analysis of the cosmetics (Demo) Job opportunities and relevant companies.	8L
	Evaluation JUSCHEme TOTAL - 50 marks SEE(theory) - 25 marks (1 hr exam) CA –25 marks	
References:	1. Collin Bard, Chemistry in your life, W. H. Freeman and Company • New York. 2. G.D.Gem Mathew, Chemistry in everyday life, 1st edition, Vishal Publishing Co.	

Course Code JUSCHE-OE102/202	Course Title: Wonder with molecules	Credits: 2 Lectures/week: 02
Learning objectives	• To familiarize students with the chemical compounds responsible for flavor in various foods and beverages. • To identify the major chemical elements and compounds the make up the human body.	
Course Outcomes	• To discuss knowledge of flavor chemistry. • To explain the chemical composition of the human body and its relevance to biological functions.	
	THEORY	**(30L)**
Sub Unit	**Unit – I: Flavor Chemistry**	**15L**
1	Periodic table, Organic compounds we eat, drink, and smell: carboxylic acid, aldehydes and ketones, esters, and alcohols. Food additives, classification of food additives, functional role of different additives, safety issues. Job opportunities and relevant companies	
	Unit – II: Chemicals in our bodies	**15L**
1.	Elements in the human body, Essential, Non-essential elements, Criteria of essentiality. Job opportunities and relevant companies	
	Evaluation Scheme: 50 Marks:25 SEE & 25 marks Internals	
References:	1. Collin Bard, Chemistry in your life, W. H. Freeman and Company • New York. G.D.Gem Mathew, Chemistry in everyday life, 1st edition, Vishal Publishing Co.	

Bloom's Taxonomy in the Evaluation JUSCHEme

UNIT	KNOWLEDGE	UNDERSTANDING	APPLICATION	TOTAL MARKS
I	05	07	08	20
II	05	05	10	20
III	05	06	09	20
TOTAL MARKS PER OBJECTIVE	15	18	27	60
% WEIGHTAGE	25	30	45	100

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