University of Mumbai

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विद्याविषयक प्राधिकरणे
सभा आणि सेवा विभाग(ए.ए.एम.एस)
रूम नं. १२८ एम.जी.रोड, फोर्ट,
मुंबई – ४०० ०३२
टेलिफोन नं - ०२२ - ६८३२००३३

(नॅक पुनर्मूल्यांकनाद्वारे ३.६५ (सी.जी.पी.ए.) सह अ++ श्रेणी
विद्यापीठ अनुदान आयोगाद्वारे श्रेणी १ विद्यापीठ वर्जा)

क.वि.प्रा.स.से./आयसीडी/२०२५-२६/३७ दिनांक : २७ मे, २०२५

परिपत्रक:-

सर्व प्राचार्य/संचालक, संलग्नित महाविद्यालये/संस्था, विद्यापीठ शैक्षणिक विभागांचे संचालक/ विभाग प्रमुख यांना कळविण्यात येते की, राष्ट्रीय शैक्षणिक धोरण २०२० च्या अमंलबजावणीच्या अनुषंगाने **शैक्षणिक वर्ष २०२५-२६** पासून **पदवी व पदव्युत्तर अभ्यासक्रम** विद्यापरिषदेच्या दिनांक २८ मार्च २०२५ व २० मे, २०२५ च्या बैठकीमध्ये मंजूर झालेले सर्व अभ्यासक्रम मुंबई विद्यापीठाच्या www.mu.ac.in या संकेत स्थळावर NEP २०२० या टॅब वर उपलब्ध करण्यात आलेले आहेत.

(डॉ. प्रसाद कारंडे)
कुलसचिव

मुंबई – ४०० ०३२
२७ मे, २०२५

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AC – 20/05/2025
Item No. – 6.15 (N)

As Per NEP 2020

University of Mumbai

Syllabus for Major Vertical – 1 & 4 (Scheme – I)		
Name of the Programme – B.Sc. (Chemistry)		
Faculty of Science		
Board of Studies in Chemistry		
U.G. Second Year Programme	**Exit Degree**	**U.G. Diploma in Chemistry**
Semester		**III & IV**
From the Academic Year		**2025-26**

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars
1	**Title of program** **O:_____**	**B.Sc. (Chemistry)**
2	**Exit Degree**	**U.G. Diploma in Chemistry**
3	**Scheme of Examination** **R: _____**	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination
4	**Standards of Passing** **R: _____**	**40%**
5	**Credit Structure** **R: SU - 525 C** **R: SU - 525 D**	**Attached herewith**
6	**Semesters**	**Sem. III & IV**
7	**Program Academic Level**	**5.00**
8	**Pattern**	**Semester**
9	**Status**	**New**
10	**To be implemented from Academic Year**	**2025-26**

Sd/-
Sign of
Dr. Sunil Patil
Coordinator,
Board of Studies in Chemistry

Sd/-
Sign of
Prin. (Dr.) Madhav Rajwade
Offg. Associate Dean,
Faculty of Science and Technology

Sd/-
Sign of
Prof. (Dr.) Shivram Garje
Offg. Dean,
Faculty of Science and Technology

Under Graduate Diploma in Chemistry

Credit Structure (Sem. III & IV)

	R:_____C								
Level	**Semester**	**Major**		**Minor**	**OE**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**OJT, FP, CEP, CC,RP**	**Cum. Cr. / Sem.**	**Degree/ Cum. Cr.**
		Mandatory	**Electives**							
5.0	III	8 **Paper I: S1MJ5**: Progressive Physical and Analytical Chemistry I **Paper II:** Theory **S1MJ6**: Progressive Inorganic and Organic Chemistry I **Practical I: S1MJCHP3**: Chemistry Practical 3 **Practical II: S1**MJCHP4: Chemistry Practical 4		4	2	VSC:2, **VSC** **3:** Soil Analysis	AEC:2	FP: 2 CC:2	22	**UG Diploma 88**
	R:_____D									
	IV	8 **S1MJ7**: Progressive Physical and Analytical Chemistry II **Paper II:** Theory **S1MJ8**: Progressive Inorganic and Organic Chemistry II **Practical I: S1MJCHP5**: Chemistry Practical 5		4	2	SEC:2 Business Skills in Chemistry Synthesis of Nanoparticles	AEC:2	CEP: 2 CC:2	22	

		Practical II: S1MJCHP6: Chemistry Practical 6								
	Cum Cr.	28		10	12	6+6	8+4+2	8+4	88	
Exit option; Award of UG Diploma in Major and Minor with 80-88 credits and an additional 4 credits core NSQF course/ Internship OR Continuewith Major and Minor										

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Community Engagement Project, CC – Co-Curricular, RP – Research Project]

Sem. - III

Vertical – 1
Major

Syllabus
B.Sc. Chemistry
(Sem.- III)

Paper I: S1MJ5: Progressive Physical and Analytical Chemistry I
And
Paper II: S1MJ6: Progressive Inorganic and Organic Chemistry I

Sr. No.	Heading	Particulars
1	**Description the course:** **Including but Not limited to:**	This program is meticulously designed to furnish a fundamental understanding of Chemistry. Through a comprehensive academic curriculum encompassing both theoretical and practical courses, we aspire to not only impart knowledge but also to cultivate interest in the discipline. The Bachelor of Science (B.Sc.) in Chemistry course is structured to equip students with a solid theoretical foundation, practical skills, and critical thinking abilities that are essential to navigate the challenges and opportunities within the diverse fields of the subject. Continuous evaluation of students is conducted through quizzes, class tests, and assignments. Emphasis is placed on conceptual understanding of theoretical frameworks, which is subsequently integrated into practical applications. The B.Sc. (Chemistry) program offers two major subjects, one minor subject, and various elective courses including VSCs, SECs, IKS, AECs, OEs, VEC, and CC. Upon successful completion of the first year of the B.Sc. program, learners will be conferred with a Undergraduate Certificate in Chemistry.
2	**Vertical:**	Major
3	**Type :**	Theory / Practical
4	**Credit**:	2 credits / 4 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	**Hours Allotted:**	30 Hours / 60 Hours
6	**Marks Allotted**:	50 Marks /100 Marks

7 **Course Objectives**:

Physical and Analytical Chemistry

CO 1	To understand and apply the basic concept of Free energy, Chemical potential
CO 2	To understand and apply the principles of electrolyte conductance, transference number.
CO 3	To understand and apply the concept of ideal solutions, partially miscible and immiscible liquid pairs
CO 4	To introduce the scope of Analytical Chemistry and the statistical treatment of data in chemical analysis.
CO 5	To Learn and identify the concepts of standard solutions, primary and secondary standards. Type of titrations and indicators used. Facilitate the learner to make solutions of various concentrations.
CO 6	To introduce instrumental analysis, like the spectrometric technique and the law applied to it.

Inorganic and Organic Chemistry

By the end of this course, students will:

1. Understand types of bonding, valance bond theory and MOT and their applications
2. Imbibed the basic concept of chemistry of boron and silicon compound
3. Understand the mechanisms of nucleophilic substitution reactions in haloalkanes and haloarenes.
4. Explore the influence of structural and environmental factors on reactivity and stereochemistry.
5. Examine the structure, nomenclature, and preparation methods of aldehydes and ketones.
6. Analyze nucleophilic addition reactions and their applications in organic synthesis.
7. Learn key name reactions and transformations.

8 **Course Outcomes**:

Physical and Analytical Chemistry

On completing the course, the learner will be able to:	
OC 1	Explain and apply concept of Free energy, Chemical potential
OC 2	understand the principle of electrolyte conductance, terms associated and experimental technique to determine transport no. of ions
OC 3	Explain the difference of ideal and non-ideal solution, partially and immiscible liquid pairs
OC 4	Understand the importance of Analytical Chemistry and apply statistical tests to the given data or the data generated in the laboratory to comment on error and minimize it.
OC 5	Explain the various terms involved in titrimetric analysis, choose a suitable indicator, standardization and Preparation of standard solutions
OC 6	Describe the function of the different components of a colorimeter and spectrophotometer.

Inorganic and Organic Chemistry

After successful completion, students will be able to:

1. Elucidate the types of bonding and enable them to write the VBT and MOT with respect to examples
2. Explain compounds of boron and silicon
3. Differentiate between SN^1, SN^2, SN^i, and aromatic substitution mechanisms with stereochemical implications.
4. Predict the reactivity of haloalkanes and haloarenes in various nucleophilic substitution contexts.
5. Identify and describe methods of preparing aldehydes and ketones different precursors.
6. Explain mechanisms and outcomes of reactions involving carbonyl compounds.
7. Describe and illustrate the mechanisms of selected name reactions

9. Modules

Semester	Paper	Unit	Description	Credits
III	**Paper I: S1MJ5:** Progressive Physical and Analytical Chemistry I	**I**	**Physical Chemistry** 1.1. Chemical Thermodynamics II 1.2. Electrochemistry 1.3. Solution	**02**
		II	**Analytical Chemistry** 2.1 Scope of Analytical Chemistry and Errors in Analysis with their types 2.2 Classical Methods: Titrimetric Methods of Analysis 2.3 Instrumental Methods-I (Spectrometry)	
	Paper II: S1MJ6: Progressive Inorganic and Organic Chemistry I	**I**	**Inorganic Chemistry** 1.1 Chemical Bonding 1.2 Basic Chemistry of Boron and Silicon	**02**
		II	**Organic Chemistry** 2.1 Reactions and Reactivity of Halo Alkanes and Halo Arenes 2.2 Chemistry of Carbonyl Compounds 2.3 Name Reactions (Mechanism and Applications) – I	
	S1MJCHP3: Chemistry Practical 3	**--**	**Practical Component**	**02**
	S1MJCHP4: Chemistry Practical 4	**--**	**Practical Component**	**02**

Paper I: S1MJ5: Progressive Physical and Analytical Chemistry I

Unit I	**Physical Chemistry**
1.1	**Chemical Thermodynamics-II (5L)** 1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibbs Free Energy, Variation of Gibbs Free Energy with Pressure and Temperature. 1.1.2 Gibbs-Helmholtz equation, Concept of fugacity and activity (Numericals expected). 1.1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature. Gibbs Duhem equation.
1.2	**Electrochemistry (5L)** 1.2.1 Electrolytes: Definition, Strong and Weak electrolytes and their conductance measurement, ions and electrical conductivity by ions. 1.2.2 Kohlrausch law of independent migration of ions. 1.2.3 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts. (Numerical expected). 1.2.4 Transference number and its experimental determination using Moving boundary method. (Numerical expected). Factors affecting transference number.
1.3	**Solutions (5L)** 1.3.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. 1.3.2 Partial miscibility of liquids: Definition, Effect of Temperature, effect of impurity and intermolecular interactions on partial miscibility, Critical solution temperature; Phenol-Water, Triethanolamine – Water and Nicotine – Water systems 1.3.3 Immiscibility of liquids- Nernst distribution law and its applications, solvent extraction.

Unit II	Analytical Chemistry
2.1	**Scope of Analytical Chemistry and Errors in Analysis with their types (5L)** 2.1.1 Important terms and their significance in Analytical Chemistry. Classical and Non-Classical Methods of Analysis; their types and Importance. Applications in various fields- Organic, Pharmaceuticals, Electronics & Environmental analysis. 2.1.2 Errors in Chemical Analysis and their types: i) Determinate Errors ii) Indeterminate Errors. 2.1.3 Classification of determinate errors: i) instrumental errors ii) methodic errors iii) operational errors iv) personal 2.1.4 Methods of minimisation of determinate errors in chemical analysis: Calibration, running of blanks, control determination, independent method of analysis, parallel determination. 2.1.5 Constant and proportionate errors with examples
2.2	**Classical methods: Titrimetric Methods of Analysis (5L)** 2.2.1 Terms involved in Titrimetric analysis. i) Titrant ii) Titrand iii) Equivalence Point iv) Indicator v) End point vi) Titration Error 2.2.2 Types of volumetric analysis with example and indicators i) Neutralisation (Acidimetry, alkalimetry) ii) Redox (Iodometry, Iodimetry) iii) Precipitation iv) Complexometric titrations 2.2.3 Standard solutions and standardisation in Titrimetry (primary and secondary standards) Calculations based on preparation of standard solutions and their dilutions.
2.3	**Instrumental Methods-I (Spectrometry) (5L)** 2.3.1 Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic Light, Polychromatic Light, Wavelength of Maximum Absorbance, Absorptivity and Molar Absorptivity. 2.3.2 Statement and derivation of Beer's Law and Lambert's Law, Combined Mathematical Expression of Beer-Lambert's Law (Numerical based on Beer-Lambert's Law) 2.3.3 Block Diagram for Single Beam Colorimeter (Principle, Construction and Working (Details of Components Expected, i.e. source, Sample Holder, Filter, Detector). Comparison between single Beam Colorimeter and double beam colorimeter. Single beam spectrophotometer (Principle, Construction and Working)

Paper II: S1MJ6: Progressive Inorganic and Organic Chemistry I

Unit I	**Inorganic Chemistry**
1.1	**Chemical Bonding (12L)** 1.1.1 Non directional Bonding (3L) • Ionic Bond: Conditions for the Formation of Ionic Bond and properties • Types of Ionic Crystals • Radius Ratio Rules • Born-Haber Cycle and its Applications 1.1.2 Directional bonding (4L) • VBT, introduction and basic tenets • Concept of homo nuclear diatomic molecule from He_2 to Ne_2 • Bonding in Polyatomic Species: The Role of Hybridization. And types of hybrid orbitals-sp, sp^2, sp^3, sp^3d, sp^3d^2, d^2sp^3, Sp^3d^3 with examples. 1.1.3 Molecular Orbital Theory (5L) • Comparing Atomic Orbitals and Molecular Orbitals. • Linear combination of atomic orbitals to give molecular orbitals LCAO-MO approach fordiatomic homonuclear molecules). • Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2, O^+, O_2^-, O_2^{2-}
1.2	**Basic chemistry of Boron and Silicon (3L)** 1.2.1 Basic chemistry of boron and silicon – electronic configuration, oxidation state and inert pair effect. 1.2.2 Preparation, bonding and applications of diborane, silicon dioxide and silicon tetra chloride.
Unit II	**Organic Chemistry**
2.1	**Reactions And Reactivity of Halo Alkanes and Halo Arenes: (4L)** **2.1.1 Alkyl halides: (2 L)** Nucleophilic substitution reactions: SN^1, SN^2 and SN^i mechanisms with stereo chemical aspects (examples of chiral carbon are expected) Factors affecting nucleophilic substitution reactions: Nature of substrate, nature of solvent, nature of nucleophilic reagent, nature of leaving group. **2.1.2 Aryl halides: (2 L)** Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution: addition-elimination mechanism (SNAr), elimination- addition mechanism (benzyne mechanism) and Cine substitution
2.2	**Chemistry of Carbonyl Compounds: (8 L)** **2.2.1 Recapitulation: (1 L)** Introduction to classes of compounds containing carbonyl group Bonding, structure and reactivity of carbonyl group in aldehyde and ketone. IUPAC nomenclature of aldehydes and ketones. **2.2.2 Methods of Preparation (Mechanisms not expected): (1 L)** Oxidation of primary and secondary alcohol using PCC, $K_2Cr_2O_7$, Wacker process (Using $PdCl_2$), Swern oxidation (oxylyl chloride / DMSO and Et_3N), Jones reagent (CrO_3 in sulfuric acid), Sarett oxidation (CrO_3 in pyridine, selective oxidation of OH group in presence of double bond. (Preparation of cinnamaldehyde is expected) **2.2.3 Nucleophilic Addition Reactions: (2 L)** Mechanism of nucleophilic addition reactions Reactivity of aldehyde and ketone. Example: addition of HCN, $NaHSO_3$, Grignard reagent, alcohol, amines, phenyl hydrazine, 2,4 – DNPH

	2.2.4 Oxidation and Reduction (Mechanisms not expected): (1 L) Reduction to alcohol: Reduction using $LiAlH_4$, $NaBH_4$, MPV reduction, Reduction to hydrocarbon: Clemmensen reduction, Wolff – Kishner reduction Oxidation: Oppenauer oxidation, Baeyer – Villiger oxidation **2.2.5 Active methylene compounds: (3 L)** Introduction and reactivity of active methylene compound and enolate formation, Examples: ethyl acetoacetate, acetyl acetone, malonic ester. Some characteristic reactions of these compounds like salt formation, alkylation. Application of active methylene compounds in name reactions viz: 1) Michael addition 2) Knoevenagel condensation
2.3	**Name Reactions (Mechanism and Applications) – I: (3 L)** **2.3.1** Simmons-Smith reaction **2.3.2** Reformatsky reaction **2.3.3** Reimer-Tiemann reaction **2.3.4** Beckmann rearrangement

S1MJCHP3: Chemistry Practical 3

Physical Chemistry

1 To verify Ostwald's dilution law for weak acid conductometrically.
2 To determine the amount of HCl in the given sample potentiometrically.
3 To determine the critical solution temperature (CST) of phenol -Water system
4 To investigate the reaction between K2S2O8 and KI with equal initial concentrations of the reactants
5 To determine solubility of sparingly soluble salts (any two) conductometrically.
6 To determine λmax and molar extinction coefficient for potassium permanganate solution using a photometer and hence to determine the concentration of potassium permanganate in a given solution.
7 To determine the amount of strong acid present in a given solution by titration with a strong base using a pH meter.
8 To determine the standard reduction potential of Ag|Ag +using Nernst Equation

Analytical Chemistry

1 Tools of Analytical Chemistry-I
   a) Analytical glass wares like burettes, pipettes, Standard flasks, and separating funnels.
   b) Weighing tools such as two pan balance and monopan balance, digital balances:
   c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace,
   d) Drying Devices: Hot Air Oven, Microwave Oven, Desiccators, Vacuum desiccators
   e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photo emissive cells, Photomultiplier tubes
2 Colorimetry: Determination of copper ion in the given solution by calibration curve method
3 pH metry: Determination of buffer capacity of acid buffer and basic buffer.
4 Conductometry: Estimation of given weak acid with strong base by conductometric titration.
5 Estimation of drugs - Estimation of aspirin.
6 Estimation of chloride content in the given saline sample by using silver nitrate.
7 Estimation of Mg content in talcum powder by using standard EDTA solution.
8 Determination of COD of given water sample.

S1MJCHP4: Chemistry Practical 4

Inorganic Chemistry

Inorganic preparation (4):

1) Tri (thiourea) cuprous (I) chloride
2) Tris ethylene diamine Ni (II) thiosulphate
3) Sodium hexa nitro cobaltate (III)
4) Tetraamine copper (II) sulphate

Complexometric titration (2)

1) Estimation of total hardness of water
2) Investigation of the reaction between copper sulphate and sodium hydroxide.

Gravimetric estimation (2)

1) Nickel (II) as Ni(dmg)
2) Barium as $BaCrO_4$

Organic Chemistry

Organic Qualitative Analysis <u>(Minimum 8 compounds to be analysed)</u>

Qualitative analysis of bi-functional organic compounds on the basis of

1. Preliminary examination
2. Solubility / miscibility profile
3. Detection of elements C, H, (O), N, S, X.
4. Detection of functional groups
5. Determination of physical constants (M.P/B. P)

Solid or liquid compounds containing not more than two functional groups from among the following classes may be given for analysis

- **<u>Suggested Compounds</u>**

Carboxylic Acids: Salicylic acid, Acetyl aalicylic acid, o-chloro benzoic acid, o or m or p -nitro benzoic acid, anthranilic Acid

Phenols: o or m or p -nitro Phenol

Amines: o or m or p -nitro aniline or p-toluidine

Mono-functional Compound List:

Aldehydes: Benzaldehyde

Ketones: Benzophenone, acetophenone

Esters: Methyl acetate, Ethyl acetate, Ethyl benzoate

Alcohols: Propanol, butanol, benzyl alcohol

Ethers: Anisole

Amides & anilides: Urea, thiourea, benzamide, acetanilide, benzanilide

Vertical - 4
VSC

Syllabus
B.Sc. (Chemistry)
(Sem.- III)

Title of Paper: Soil Analysis (S1VSCCH31)

Sr. No.	Heading	Particulars
1	**Description of the course:**	This vocational skill course furnishes students with extensive training in soil analysis techniques that are vital for assessing soil fertility, quality, and suitability for agricultural applications. The syllabus encompasses a broad array of practical experiments, integrating traditional chemical methodologies with contemporary instrumental techniques, thereby ensuring that students acquire both theoretical knowledge and practical proficiency. The course seeks to equip students for careers in agricultural services, environmental management, and laboratory-based soil testing by instructing them on how to evaluate soil parameters that are crucial for sustainable farming and land management.
2	**Vertical :**	Vocational Skill Course (VSC)
3	**Type :**	Practical
4	**Credit**:	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted**:	50 Marks
7	**Course Objectives**: 1. To develop a basic understanding of soil qualities 2. To enhance the ability to use principles of soil chemistry for soil treatment 3. To understand soil quality control in the natural systems 4. To train the students to acquire various practical skills required for soil analysis. 5. To prepare the health card of soil	

8	**Course Outcomes**: **After completing the course, students will be able to-** 1. Identify the quality of soil of the surroundings. 2. Develop the soil quality plan for better crop yield 3. Classify the various samples of soil according to their overall health. 4. Discover the important parameters of soil. 5. Raise awareness within the peoples002E

9	**Modules**:- **Perform the following practical's (Any Ten)** 1. To measure organic matter and moisture content of soil using redox titration. 2. To find Alkalinity of different types of soil sample by acid-base titration. 3. Estimation of water holding capacity of soil by gravimetry. 4.. Measurement of electrical conductivity of the soil sample by using Electrical conductivity meter. 5. Evaluate the Nitrogen content from the soil sample by Kjeldal' method. 6. To estimate bulk density and particle density of the soil sample using specific gravity bottle. 7. Analysis of Sodium content in the given soil sample by flame photometric method 8. Find out the Potassium content in the given soil sample by flame photometric method 9. Find the content of available phosphorous from the soil sample by spectrophotometry 10. Estimation of Calcium and Magnesium by Complexometric titration. 11. Determination of chlorides in the given soil sample by Argentometric titration 12. Measurement of sulphates in the given soil sample by turbidimetry. 13. Measurement of pH of the given soil using calibrated pH meter. 14. Preparation of soil health card and demonstration of soil Analysis Kit
10	**Reference Books:** 1. Soil and air analysis by S.K. Maiti. 2. A comprehensive laboratory manual for Environmental Sciences and Engineering By P.R. Sreemahadevan Pillai. New Age International Publishers. 3 Maiti, S.K. (2002): Chemical analysis of soil, Handbook of methods in Environmental studies A.B.D. Publishers 4. Introduction to soil laboratory manual-J.J.Harset stipes. 5. Introduction to soil science laboratory manual, Palmer and troch-Lowa state. 6. Sarkar, D.; Haldar, A. Physical and Chemical Methods in Soil Analysis, 2nd Ed., New

	Age International (2010). 7. Saha, A. K. Methods of Physical and Chemical Analysis of Soil, Kalyani Publishers (2008).	
11	**Internal Continuous Assessment: 40%**	**External, Semester End Examination 60% Individual Passing in Internal and External Examination**
12	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

Sem. - IV

Vertical – 1
Major

Syllabus
B.Sc. Chemistry
(Sem.- IV)

Paper I: S1MJ7: Progressive Physical and Analytical Chemistry II
And
Paper II: S1MJ8: Progressive Inorganic and Organic Chemistry II

Sr. No.	Heading	Particulars
1	**Description of the course:** **Including but Not limited to:**	This course provides an integrated study of the principles and applications of physical and analytical chemistry. It is designed to build a concrete foundation in the theoretical concepts of chemical systems as well as practical techniques used to analyse them.
2	**Vertical :**	Major
3	**Type :**	Theory / Practical
4	**Credit**:	2 credits / 4 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	**Hours Allotted :**	30 Hours / 60 Hours
6	**Marks Allotted**:	50 Marks/100 Marks
7	**Course Objectives**: **Physical and Analytical Chemistry**	

CO:1	To understand the basic concepts, reaction mechanism and type of complex chemical reactions.
CO:2	To understand the chemical cell and types of electrodes and apply emf data to calculate equilibrium constant and pH of the solution.
CO:3	To understand the Phase Rule and apply it to one and two-component systems.
CO: 4	To learn chromatography and Solvent Extraction as a tool for Separation.
CO: 5	To understand the basic concepts of some instrumental method of analysis.
CO: 6	To learn about the Statistical treatment of analytical data.

Inorganic and Organic Chemistry

By the end of this course, students will:

1. Understand the placement of transition elements in Periodic table and their magnetic properties and qualitative test
2. Imbibed the basic concepts of coordination theory, rules and applications
3. Explore the types of oxides of nitrogen, sulphur and their impact on environment
4. Understand the basic structure, classification, and nomenclature of common heterocyclic compounds.
5. Study the synthesis, reactivity, and substitution patterns of five- and six-membered heterocycles.

6. Analyze conformational behavior and stereochemistry of mono- and disubstituted cyclohexanes.
7. Explore symmetry elements and their role in determining stereochemical outcomes.
8. Understand and apply mechanisms of selected name reactions relevant to synthesis and rearrangements.

8 Course Outcomes:

Physical and Analytical Chemistry

Course Outcomes (OC): On completing the course, the learner will be able to:	
OC 1	Demonstrate an understanding about chemical kinetics, reaction mechanism and complex chemical reaction.
OC 2	Learn chemical cell, distinguish between reversible/ irreversible cells, types of electrode, use of emf data to calculate equilibrium constant and pH of solution.
OC3	Develop a clear understanding of the criteria for phase equilibrium and apply Gibbs Phase Rule to different systems
OC 4	Develop a clear understanding of the principle, technique and application of PC and TLC , Solvent extraction.
OC: 5	Understand the details of working and application of potentiometer, Conductometer and pH-meter

Inorganic and Organic Chemistry

After successful completion, students will be able to:

1. Discern the position of transition elements, properties and qualitative analysis
2. Determine the rules , theories of coordination compounds and their application
3. Expound the types of oxides of nitrogen, Sulphur and their impact on environment
4. Classify and name five- and six-membered heterocyclic compounds containing one heteroatom.
5. Describe and compare synthesis methods and electrophilic substitution reactivity of furan, pyrrole, thiophene, and pyridine.
6. Predict conformational preferences and stereochemical behavior of mono- and disubstituted cyclohexanes.
7. Identify symmetry elements in organic molecules and relate them to optical activity.
8. Explain mechanisms and applications of selected named reactions.

9 Modules

Semester	Paper	Unit	Description	Credits
IV	**Paper I: S1MJ7:** Progressive Physical and Analytical Chemistry II	**I**	**Physical Chemistry** 1.1. Chemical Kinetics II 1.2. Electrochemistry II 1.3. Phase Equilibria	**02**
		II	**Analytical Chemistry** 2.1 Methods of Separation 2.2 Instrumental Methods-II 2.3 Statistical Treatment of Analytical Data	
	Paper II: S1MJ8: Progressive Physical and Analytical Chemistry II	**I**	**Inorganic Chemistry** 1.1 Comparative chemistry of transition metals 1.2 Coordination chemistry 1.3 Study of oxides, volatile oxides and oxo acids	**02**

		II	**Organic Chemistry** 2.1 Heterocyclic Compounds 2.2 Stereochemistry of mono and disubstituted cyclohexanes 2.3 Name Reactions (Mechanism and Applications) – II	
	S1MJCHP5: Chemistry Practical 5		**Practical Component**	**02**
	S1MJCHP6: Chemistry Practical 6		**Practical Component**	**02**

Paper I: S1MJ7: Progressive Physical and Analytical Chemistry II

Unit I	**Physical Chemistry**
1.1	**Chemical Kinetics-II (5L)** 1.1.1 Introduction to reaction mechanism (concept of elementary steps, intermediates, and the overall reaction mechanism with an example of Thermal chain reactions: H_2 and Br_2 reaction. 1.1.2 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected)
1.2	**Electrochemistry-II (5L)** 1.2.1 Electrochemical cells, Nernst equation and its importance in generating electricity through chemical reactions. Types of electrochemical cells - Reversible and irreversible cells (Definition, example, characteristics) 1.2.2 Types of electrodes, Standard electrode potential, Electrochemical series. 1.2.3 Calculation of equilibrium constant and pH measurement using quinhydrone electrode, from EMF data. (Numericals to be solved wherever necessary)
1.3	**Phase Equilibria (5L)** 1.3.1 Introduction to Phase equilibria, Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule. 1.3.2 Phase diagrams of one-component systems (water and sulphur). 1.3.3 Two-component systems involving eutectics – Condensed Phase rule, Definition of eutectic Phase diagram of Lead-Silver system.
Unit II	**Analytical Chemistry**
2.1	**Methods of Separation (5L)** 2.1.1. Types of separation methods Based on volatility – Distillation (definition, types and example) Based on electrical effects – Electrophoresis (definition, principle and applications) 2.1.2. Chromatography – General idea of paper chromatography and thin layer chromatography (principle, technique and applications) 2.1.3. Solvent Extraction – Introduction, Nernst Distribution Law, Distribution Ratio. Single-step and multistep extraction, Percentage extraction for single-step and multistep extraction. Batch Extraction (Simple separating technique -diagram and process) (Numerical problems expected on 2.1.3)
2.2	**Instrumental Methods-II (6L)** 2.2.1 Potentiometry – Principle, role of reference and indicator electrodes, Graphical Methods of detection of end points. (first derivative and second derivative methods) 2.2.2 pH metry – Principle, construction and working of the glass electrode. 2.2.3 Conductometry – Conductivity cell: Construction. Principle, application in neutralization titration with respect to strong acid–strong base, strong acid – weak base, strong base – weak acid.
2.3	**Statistical Treatment of Analytical Data (4L)** 2.3.1 Normal error curve or Gaussian distribution curve: Equation and important features

	of Gaussian distribution curve. Gaussian error curve and precision and accuracy. 2.3.2 Linear Regression analysis between two variables: Obtaining equation of the best fitting line for line passing through origin and for line not passing through origin using: i) method of averages ii) method of least squares [Numerical problems expected on 2.3.2]

Paper II: S1MJ8: Progressive Inorganic and Organic Chemistry II

Unit I	**Inorganic Chemistry**
1.1	**Comparative chemistry of transition metals (4L)** 1.1.1 Position of transition elements in periodic table, occurrence (ores and minerals), oxidation state and transition elements 1.1.2 Magnetic properties of transition metal compounds. Origin of magnetism (Spin & Spin-Orbital) 1.1.3 Qualitative tests for transition metal ions (Cr, Mn, Fe, Co, Ni, and Cu)
1.2	**Coordination chemistry (7L)** 1.2.1 Introduction to coordination compounds, basic terms and nomenclature, types of ligands 1.2.2 Isomerism (stereoisomerism of coordination compounds no. 6) 1.2.3 Theories of coordination compounds (Werner's Theory), Effective atomic number rule, Eighteen electron rule. 1.2.4 VBT for sp^3d^2 and d^2sp^3 hybridization , inner and outer orbital , Complexes, limitation of VBT 1.2.5 Applications of coordination compounds
1.3	**Study of oxides, volatile oxides and oxo acids (4L)** 1.3.1 Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4 1.3.2 Volatile oxides and oxo acids of sulphuric acid and nitric acid 1.3.3 Uses and environment aspects of sulphuric acid and nitric acid with respect to acid rain and photochemical smog respectively.
Unit II	**Organic Chemistry**
2.1	**Heterocyclic Compounds: (6 L)** **2.1.1 Introduction: (1 L)** Introduction, classification, nomenclature of 5 and 6-membered heterocycles containing one heteroatom **2.1.2 Five membered heterocycles (Furan, Pyrrole and Thiophene): (3 L)** Synthesis of furan, pyrrole and thiophene (Paal-Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), thiophene (Hantzsch synthesis), Reactivity of furan, pyrrole and thiophene towards electrophilic substitution on the basis of stability of intermediate. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier- Haack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, ring opening reaction. Pyrrole: Acidity and basicity of pyrrole, comparison of basicity of pyrrole, pyrrolidine and pyridine. **2.1.3 Six membered heterocycles (Pyridine): (2 L)** Hantzsch synthesis pyridine. Reactivity of pyridine towards electrophilic and nucleophilic substitution on the basis of electron distribution. Pyridine: Basicity, sulphonation of pyridine (with and without catalyst), (Chichibabin reaction)

2.2	**Stereochemistry of mono and disubstituted cyclohexanes (6L)** **2.2.1 Conformational analysis (2 L)** Monosubstituted cyclohexanes: methyl cyclohexane, tert-butylcyclohexane. Disubstituted cyclohexanes: 1,2-dimethylcyclohexane, 1-tert-butyl-4-methylcyclohexane, **2.2.2 Cis-trans isomerism in disubstituted cyclohexanes: (1 L)** 1-chloro-2-methylcyclohexane, 1,3-dimethylcyclohexane **2.2.3 Elements of Symmetry: (1L)** Mirror plane symmetry, inversion center, rotation -reflection (alternating) axis **2.2.4 Stereochemical Consequences: (2L)** Cis-1,2-dimethylcyclohexane, cis-1,3-dimethylcyclohexane-optically inactive (presence of plane of symmetry), trans-1,2-dimethylcyclohexane-optically active. **Note: Gauche-butane interaction to be discussed.**
2.3	**Name Reactions (Mechanism and Applications) – II: (3 L)** **2.3.1 Darzens reaction** **2.3.2 Wittig reaction** **2.3.3 McMurry reaction** **2.3.4 Wagner-Meerwein rearrangement**

Semester IV Practical
S1MJCHP5: Chemistry Practical 5

Physical Chemistry

1) To determine standard EMF and the standard free energy change of Daniel cell potentiometrically.
2) To determine the amount of HCl and CH3COOH in a mixture by conductometric titration with sodium hydroxide solution.
3) Determination of energy of activation of acid-catalyzed hydrolysis of methyl acetate.
4) To determine the amount of Fe (III) present in the given solution by using Salicylic acid by colorimetric titration (Static Method) {$\lambda = 525$ nm}
5) To determine acidic and basic dissociation constants of amino acid hence to calculate isoelectric point.
6) Determination of partition coefficient of I2 between organic solvent and H_2O.
7) To determine ΔG^0 and equilibrium constant for cell reaction in the cell set up with copper and silver electrodes.
8) To determine the Solubility product and solubility of AgCl potentiometrically using chemical cell.

Analytical Chemistry

1) Tools in analytical chemistry-II
    a. Filtration Flasks, Funnels, Separating Funnels, Distillation apparatus, Vacuum Distillation assembly, Centrifuge machine, Electrophoresis apparatus.
    b. Development chamber for chromatography
    c. Electrodes like Reference Electrodes and Indicator Electrodes (with respect to care and maintenance).
    d. Conductivity cell (with respect to care and maintenance).
    e. Combined Glass electrode (with respect to care and maintenance).
    f. Types of Salt Bridges and preparation of any one or use of salt bridge, its effect on the potential of a given electrode/cell.
2) Paper Chromatography: - Separation of Cation Fe (III), Ni (II) and Cu (II) in a sample
3) Solvent Extraction: - Separation of a solute between two immiscible solvents to determine the distribution ratio and/or extraction efficiency. (Solutes could be as their aqueous solutions and the organic solvent ethyl acetate) Suggested solute for the distribution study: Fe (III) in aqueous solutions. (The learner is expected to learn the technique of solvent extraction by using a separating funnel, method to estimate the concentrations of the solute distributed in the two immiscible phases, determination of the extraction efficiency)
4) Spectrophotometry: To determine the concentration of chromium (VI) in the given solution as dichromate by the least squares method spectrophotometrically.
5) Potentiometry: - Estimation of Fe (II) in the given solution by titration against K2Cr2O7.
6) Estimation of copper by EDTA method using fast sulphone black F indicator.
7) Determination of hydrogen peroxide in terms of i) volume strength ii) grams per litre.
8) Titration of sodium thiosulphate with potassium dichromate (to study transfer of electrons)

Semester IV Practical

S1MJCHP6

Inorganic Chemistry

1. **Identification of cations – (minimum 5)**
   Identification of cations in a given mixture and analytical separation of mixture
   [from a mixture containing not more than two of the following; Pb(II), Ba(II), Ca(II), Sr(II), Cu(II), Cd(II), Mg(II), Zn(II), Fe(II), Fe(III), Ni(II), Co(II), Al(III), Cr(III)]
2. **Volumetric Analysis / Redox titration**
   Estimation of the amount of Iron present in the given ferric alum solution
3. **Iodometric titration**
   Estimation of Cu(II) by using sodium thiosulphate
4. Determine the amount of sodium carbonate and sodium hydroxide present together in the given solution.

Organic Chemistry

Short organic preparation and their purification: <u>(Minimum 8 compounds to be prepared)</u>
Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report 1) Theoretical yield, 2) Percentage yield and 3) Melting point of the purified product

Preparation of:

1. Cyclohexanone oxime from cyclohexanone.
2. Glucosazone from dextrose or fructose
3. Tribromoaniline from aniline.
4. β-Naphthylbenzoate from β-naphthol
5. m-Dinitrobenzene from nitrobenzene
6. Acetanilide from aniline
7. p-Bromoacetanilide from acetanilide
8. Iodoform from acetone
9. Phthalic anhydride from phthalic acid by sublimation

10. Reference Books:

Physical Chemistry

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).
2. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
3. Keith J. Laidler & John H. Meiser, Physical Chemistry, 2nd Ed. (2004)
4. Puri B. R., Sharma L. R. & Pathania M. S. Principles of Physical Chemistry, Vishal Publishing Company, 2008
5. Ball, D. W. Physical Chemistry Thomson Press, India (2007).
6. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
7. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
8. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
9. Levine, I .N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
10. Laboratory Experiments in Chemistry I & II, University Practical Book of Chemistry, University of Mumbai.
11. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).
12. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
13. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
14. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003)

Analytical Chemistry

1. Analytical Chemistry, Gary D. Christan, Purnendu Dasgupta, 7th Edition, Wiley.
2. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch, 10th edition.
3. Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R.Crouch, 7th edition.
4. Basic Concepts of Analytical Chemistry, S.M. Khopkar, 3rd Edition, New academic sciences.
5. Modern Analytical Chemistry, David Harvey,2nd edition, 2009.

Inorganic Chemistry

Transition Metal and Coordination Chemistry

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, 2013-2014.
2. W. W. Porterfield, Inorganic Chemistry-A Unified Approach, 2nd Ed., Academic Press, 1993.
3. B. W. Pfennig, Principles of Inorganic Chemistry, Wiley, 2015.
4. C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry, Pearson Education Limited, 2nd Edition 2005.
5. J. Huheey, F. A. Keiter and R. I. Keiter, Inorganic Chemistry–Principles of Structure and Reactivity, 4th Ed., Harper Collins, 1993.
6. R. L. Dekock and H.B.Gray, Chemical Structure and Bonding, The Benjamin Cummings Publishing Company, 1989.
7. G. Miessler and D. Tarr, Inorganic Chemistry, 3rd Ed., Pearson Education, 2004.
8. R. Sarkar, General and Inorganic Chemistry, Books & Allied (P) Ltd., 2001.
9. C. M. Day and J. Selbin, Theoretical Inorganic Chemistry, Affiliated East West Press Pvt. Ltd., 1985.
10. G. A. Jeffrey, An Introduction to Hydrogen Bonding, Oxford University Press, Inc., 1997.
11. D. Banerjea ,Coordination Chemistry Tata McGraw Hill,1993.

Study of oxides, volatile oxides and oxo acids

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, 2013-2014.

2. B. W. Pfennig, Principles of Inorganic Chemistry, Wiley, 2015.
3. Andrew Barron, Chemistry of the Main Group Elements, Middas Green Innovations, 2020.
4. R. Sarkar, General and Inorganic Chemistry, Books & Allied (P) Ltd., 2001.

Inorganic Practical

1. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. A. I. Vogel, Quantitative Inorganic Analysis, 5th Edn Longman Scientific and Technical, 1989.
3. J. D. Woolins, Inorganic Experiments. Hohn Wiley and Sons, 2010
4. G. Raj, Advanced Practical Inorganic Chemistry. Goel Publication, 2010
5. J. E. House, Inorganic chemistry, Academic press, 2nd edition, 2013.
6. G. N. Mukherjee, Advanced Experiments in Inorganic Chemistry., U. N. Dhur & Sons Pvt. Ltd. 2010.
7. G. Christian, Analytical Chemistry, John Wiley, New York 4th edition 1986.

Organic Chemistry

1. Acheson, R. H. (**1976**). *An Introduction to the Chemistry of Heterocyclic Compounds* (3rd ed.). John Wiley & Sons.
2. Gilchrist, T. L. (**1997**). *Heterocyclic Chemistry* (3rd ed.). Pearson Education.
3. Joule, J. A., & Mills, K. (**2010**). *Heterocyclic Chemistry* (5th ed.). Wiley-Blackwell.
4. Parashar, R. K. (**2010**). *Heterocyclic Chemistry*. Ane Books India.
5. Bansal, R. K. (**2022**). *Heterocyclic Chemistry* (7th ed.). New Age International Private Limited.
6. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers- Oxford University Press
7. Stereochemistry of Organic Compounds, Ernest Eliel, Samual Wilen, A Wiley-Inter-science Publication
8. Organic Chemistry, G. Marc Loudon (4th Edition) Oxford University Press
9. Stereochemistry of Organic Compounds, Principles and Applications, D. Nasipuri, 4th Edition, New Academic Science
10. Heterocyclic Cyclic, Shrikrishna Tupare, String Production

Vertical - 4

SEC

Syllabus
B.Sc. (Chemistry)
(Sem.- IV)

Title of Paper : Business Skills in Chemistry (S1SECCH41)

Sr. No.	Heading	Particulars
1	**Description of the course :** **Including but Not limited to :**	To equip chemistry students with the practical knowledge for the preparation of personal hygiene and cosmetic products. The course is useful for the students to learn laboratory skills for preparation of thee products, survey and general analysis of such products.
2	**Vertical :**	Skill Enhancement Course (SEC)
3	**Type :**	Practical
4	**Credit**:	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted**:	50 Marks
7	**Course Objectives**:	

1.	To introduce students to the fundamental techniques of formulating everyday cosmetic and personal care products.
2.	To develop hands-on laboratory skills in the preparation of various cosmetic formulations.
3.	To impart knowledge on quality assessment techniques such as solubility testing, moisture analysis, viscosity, pH measurement, and foaming ability.
4.	To enable learners to analyze the physicochemical properties of cosmetic products using instrumental and classical methods.
5.	To provide experience in interpreting cosmetic product labels, ingredient functionalities, and regulatory compliance.
6.	To foster comparative and critical thinking skills by analyzing and benchmarking various commercial cosmetic brands.

8 **Course Outcomes**:

CO 1.	Formulate various cosmetic products using standard laboratory protocols.
CO 2.	Perform chemical and physical analyses of cosmetic products.
CO 3.	Compare foaming abilities of shampoo brands using experimental methods.
CO 4.	Determine active ingredient concentrations and interpret efficacy.
CO 5.	Conduct surveys on product labels and ingredient lists.
CO 6.	Evaluate and compare product performance across brands.

9 Modules:

Semester	Module	Description	Hours	Credits
IV	**Unit I**	Preparation	6 (Sessions) * 4 (hours) = 24	**02**
	Unit II	Analysis	6 (Sessions) * 4 (hours) = 24	
	Unit III	Surveys	3 (Sessions) * 4 (hours) = 12	
			Total = 60 Hours	

Unit	Description	Hours
I	Preparations (Any 6) 1.1. To prepare the Talcum Powder. 1.2. To prepare the Bath Soap. 1.3. To prepare the Shampoo. 1.4. To prepare the Nail Polish. 1.5. To prepare the Nail Polish Remover. 1.6. To prepare Hand Wash. 1.7. To prepare Hand Sanitizer. 1.8. To prepare Hand Cream. 1.9. To prepare Body Lotion 1.10. To prepare after Shave Lotion.	4Hours each practical 6 * 4 = 24
II	Analysis 2.1. To determine the amount of matter insoluble in boiling water of the given material. 2.2. To determine the moisture, volatility and to test the solubility of the color in the given material. 2.3. To study the comparative foaming ability of the various Shampoo brands using Cylinder Shake Method. 2.4. To measure the pH of the sample of a cosmetic products using pH meter. 2.5. To determine the relative viscosity of a given liquid product using Ostwald Viscometer. 2.6. To determine the concentration of Thioglycolic acid in a given Depilatories.	4 Hours each practical 6 * 4 = 24
III	Surveys 3.1. To carry out the survey of given cosmetic product's label. 3.2. To carry out the study of ingredients in given cosmetic products. 3.3. To determine and compare the melting points of the Lipstick of various brands using slip melting point method.	4 Hours each practical 3 * 4 = 12

10 Reference Books:

1) Barel, A. O.; Paye, M.; Maibach, H. I. (2014), Handbook of Cosmetic Science and Techology, CRC Press.

2) Garud, A.; Sharma, P. K.; Garud, N. (2012), Text Book of Cosmetics, Pragati Prakashan.

3) Gupta, P. K.; Gupta, S. K. (2011), Pharmaceutics and Cosmetics, Pragati Prakashan

4) Butler, H. (2000), Poucher's Perfumes, Cosmetics and Soap, Springer

5) Kumari, R. (2018), Chemistry of Cosmetics, Prestige Publisher.

6) Formulation Guide for cosmetics; The Nisshin Oillio Group, Ltd.

	7) US Patent, 4,735,798 Apr. 5, 1988.	
12	**Internal Continuous Assessment: 40%**	**External, Semester End Examination 60% Individual Passing in Internal and External Examination**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

Syllabus
B.Sc. (Chemistry)
(Sem.- IV)

Title of Paper: Synthesis of Nanoparticles (S1SECCH42)

Sr No	Heading	Particulars
1	**Description of the Course**	This course aims to provide chemistry students with practical knowledge and laboratory skills in the preparation and analysis of nanoparticles (NPs). This course provides hands-on experience in the preparation, analysis, and application of nanoparticles (NPs) for various practical purposes. The course also covers the survey and general analysis of such products, equipping students with the essential techniques for understanding and creating innovative products in the industry.
2	**Vertical**	Skill Enhancement Course
3	**Type**	Practical based
4	**Credits**	2 Credits
5	**Hours Allotted**	60 Hours (15 Practical of 4 Hours duration)
6	**Marks Allotted**	50 Marks
7	**Course Objectives**	
	1.	Introduce students to the basic concepts of nanoscience, including nanoscale materials, properties, and applications.
	2.	Explore chemical, physical, and biological methods for nanoparticle synthesis.
	3.	Highlight eco-friendly and sustainable methods for synthesizing nanoparticles using plant extracts, microorganisms, and biomaterials.
	4.	Introduce students to techniques such as UV-Vis spectroscopy, Dynamic Light Scattering (DLS), X-ray Diffraction (XRD), and Scanning Electron Microscopy (SEM) for analyzing nanoparticles.
	5.	Discuss real-world applications such as water purification and catalysis.
	6.	Encourage students to develop laboratory skills for synthesizing and characterizing nanoparticles.
	7.	Discuss emerging trends and future scope in nanotechnology.
8	**Course Outcomes (CO):**	
	CO 1.	Explain the fundamental principles of nanoscience, the nanoscale effect, and the importance of nanoparticles in various domains.
	CO 2.	Explain the fundamental principles of nanoscience, the nanoscale effect, and the importance of nanoparticles in various domains.
	CO 3.	Utilize characterization tools such as UV-Vis spectroscopy, Dynamic Light Scattering (DLS), X-ray Diffraction (XRD), and Scanning Electron Microscopy (SEM) to analyze the properties of synthesized nanoparticles.
	CO 4.	Follow laboratory safety protocols for nanoparticle synthesis and handling.
	CO 5.	Conduct hands-on experiments to synthesize and characterize nanoparticles, enhancing laboratory and analytical skills.
	CO 6.	Integrate knowledge from chemistry, physics, and biology to explore emerging trends in nanotechnology.

9. Modules

Semester	Module	Description	Hours	Credits
IV	**Unit I**	Preparation	6 (Sessions) * 4 (hours) = 24	**02**
	Unit II	Analysis	6 (Sessions) * 4 (hours) = 24	
	Unit III	Surveys	3 (Sessions) * 4 (hours) = 12	
			Total = 60 Hours	

Unit	Description	Hours
I	Preparations (Any 6) 1.1. To prepare ZnO nanoparticles using sol gel method. 1.2. To remove methylene blue dye using ZnO nanoparticles. 1.3. To study the effect of particle size on optical properties of ZnO NPs. 1.4. To study the photocatalytic degradation of methylene blue dye using TiO_2 nanoparticles under UV light. 1.5. To encapsulate TiO_2 nanoparticles within a chitosan biopolymer matrix and study their stability.	4 Hours each practical 6 * 4 = 24
II	Analysis 2.1. To analyze the weight loss of ZnO nanoparticles as a function of temperature and determine their thermal stability using TGA data. 2.2. To determine the size of ZnO NPs using Debye-Scherrer formula using XRD data. 2.3. To identify the ZnO crystal structures of materials using X-ray diffraction (XRD) spectra. 1.4. To compare the UV absorption of regular sunscreen and nano-based sunscreen using a UV lamp.	4 Hours each practical 6 * 4 = 24
III	Surveys 3.1. To study different synthesis methods for nanoparticles and compare their efficiency and applications. 3.2. To find the toxicity, environmental impact, and safe handling practices for ZnO and TiO_2 nanoparticles. 3.3. To explore the use of nanoparticles in drug delivery and evaluate their advantages in medicine. 3.4. To investigate how nanoparticles are used in improving the efficiency of solar cells. 3.5. To explore the role of ZnO & TiO_2 nanoparticles in cosmetics and personal care products.	4 Hours each practical 3 * 4 = 12

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QUESTION PAPER PATTERN
(External and Internal)

Evaluation Pattern for Major Theory Course

MAJOR: 8 Credits

Semester III

Theory/Practical	Credits	No. of Hours	Marks
Theory: **Paper I: S1MJ5:** Progressive Physical and Analytical Chemistry I	2	30	50
Theory: **Paper II: S1MJ6:** Progressive Inorganic and Organic Chemistry	2	30	50
Practical: **S1MJCHP3:** Chemistry Practical 3	2	60	50
Practical: **S1MJCHP4:** Chemistry Practical 4	2	60	50

Semester IV

Theory/Practical	Credits	No. of Hours	Marks
Theory: **Paper I: S1MJ7:** Progressive Physical and Analytical Chemistry I	2	30	50
Theory: **Paper II: S1MJ7:** Progressive Inorganic and Organic Chemistry	2	30	50
Practical: **S1MJCHP5:** Chemistry Practical 5	2	60	50
Practical: **S1MJCHP6:** Chemistry Practical 6	2	60	50

Evaluation Pattern for Semester III and IV:

Theory Paper

Internal Continuous Assessment: 40% (20 Marks)	Semester End Examination: 60% (30 Marks)	Duration for End semester examination
Continuous Evaluation through: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.	As per paper pattern	1 h

Paper Pattern for 30 marks :

30 Marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of **one hour** duration.
2. Theory question paper pattern:
   a. There shall be **02** questions each of **15 marks** on each unit
   b. All questions shall be compulsory with internal choice within the questions.

Question	Particulars	Marks	Questions Based on
Q.1	A) Objective Questions 06 out of 10	06	Unit I
	B) Subjective Questions 03 out of 05	09	
Q.2	A) Objective Questions 06 out of 10	06	Unit II
	B) Subjective Questions 03 out of 05	09	
	Total	**30**	**---**

Evaluation Pattern for Major Practical Course

Internal Continuous Assessment: 40% (20 Marks)	Semester End Examination: 60% (30 Marks)	Duration for End semester examination
Viva/ assignment/ objective question test (15 Marks), Overall performance (5 Marks) = 20 Marks	One experiment (25 marks for experiment and 5 Marks for Journal = 30 Marks)	3 h 30 minutes

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Examination Pattern for Vocational Skill Courses (VSC) and Skill Enhancement Courses (SEC)

Practical	Credit	No. of Hours	Marks
	02	60	50

Internal Continuous Assessment: 40% (20 Marks)	**Practical Examination: 60% (30 Marks)**
Continuous Evaluation through: Presentation, project, creative writing, Industrial Visit report submission (at least 1) (10 Marks) and Survey Reports (any two) (10 Marks)	**Practical Journal: 05 Marks** **Practical on Unit I or Unit II: 25 Marks**
Individual Passing in Internal and External Examination	

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 - 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Sd/-
Sign of
Dr. Sunil Patil
Coordinator,
Board of Studies in Chemistry

Sd/-
Sign of
Prin. (Dr.) Madhav Rajwade
Offg. Associate Dean,
Faculty of Science and Technology

Sd/-
Sign of
Prof. (Dr.) Shivram Garje
Offg. Dean,
Faculty of Science and Technology