R.P. Gogate College of Arts & Science
&
R.V. Jogalekar College of Commerce
(Autonomous)
Ratnagiri

Syllabus for

F.Y. B.Sc.

(Chemistry)

Semester I and II

Under Choice Based Credit System (CBCS)

As Per framework of NEP 2020

With effect from the academic Year- 2023-2024

Revised Scheme of Examination
Faculty of Science
(Under-graduate Programme)
Choice Based Credit System (CBCS)
Scheme of Examination

Bachelor of Science (B.Sc.) Programme

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks and by conducting the Semester End Examinations with 60% marks. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
02	Assignment / seminar / class test / worksheets	10
03	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 03 questions each of 15 marks on each unit and one question of 15 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Performance Grading:

Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	0 (Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+ (Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+ (Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C (Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

B.Sc. Programme

Under Choice Based Credit System (CBCS)
Course Structure (Autonomous)
First Year BSc

Semester I	Credits	No of Lectures (1Hr)	Semester II	Credits	No of Lectures (1Hr)
Physical and Inorganic Chemistry I	**02**	30	Physical and Inorganic Chemistry II	**02**	**30**
Organic and Inorganic Chemistry I	**02**	30	Organic and Inorganic Chemistry II	**02**	**30**
Chemistry Practical I	**02**	60	Chemistry Practical II	**02**	**60**
Laboratory Skills in Chemical sciences	**02**	60	Skills in Chemical Analysis I	**02**	**60**

SEMESTER I

Course Code	Unit	Topic	No of Lectures (1Hr)	L/ per week (1Hr)	Credits
USCH101	I	Chemical Thermodynamics	7	2	2
		Chemical Calculations	3		
	II	Chemical Kinetics	6		
		Liquid State	4		
	III	Atomic Structure	4		
		Periodic table and Periodicity	6		
USCH102	I	Basics of Organic Chemistry	10	2	2
	II	Stereochemistry I	10		
	III	Comparative chemistry of Main Group Elements	10		
USCH103		Chemistry Practical	60	4	2
USCH104		Vocational Skill Course: Laboratory Skills in Chemical sciences	60	4	2

SEMESTER II

Course Code	Unit	Topic	No of Lectures (1Hr)	L/ per week (1Hr)	Credits
USCH201	I	Gaseous State	3	2	2
		Electrochemistry-I	3		
		Chemical Equilibria and Thermodynamic Parameters	4		
	II	Ionic Equilibria	6		
		Molecular Spectroscopy	4		
	III	Concept of Qualitative Analysis	6		
		Acid Base Theories	4		
USCH202	I	Chemistry of Aliphatic Hydrocarbons	6	2	2
	II	Stereochemistry I	2		
		Aromatic Hydrocarbons	8		
	III	Chemical Bond and Reactivity	10		
USCH203		Chemistry Practical	60	4	2
USCH204		Skill Enhancement Course: Skills in Chemical Analysis I	60	4	2

Name of Programme	B.Sc.
Level	UG
No of Semesters	I and II
Year of Implementation	2023-24
Programme Specific Outcomes (PSO)	1. Acquire the fundamental knowledge of the main branches of chemistry viz. Physical, Inorganic, and Organic 2. Identify and separate components of organic or inorganic origin and will also be able to analyze them by making use of the modern instrumental methods learned. 3. Inculcate the skills useful in chemistry laboratory. 4. Acquire and explore essential skills to succeed in various chemical industries. 5. Appreciate the central role of chemistry in our society and use this as a basis for ethical behavior in issues facing chemists including an understanding of safe handling of chemicals, environmental issues and key issues facing our society in terms of energy, health and medicine.
Relevance of PSO's to the local, regional, national, and global developmental needs (200 words)	The Bachelor of Science in Chemistry programme equips the candidate with knowledge, general competence, and analytical skills on an advanced level, needed in industry, consulting, education, and research and public and private administration. On completion of the programme, the learner will be able to: 1. Identify, formulate and analyze scientific problems and reach concrete solutions for societal benefits using various principles of chemical sciences. 2. Introduce the concepts useful for industries viz. Pharmaceutical, dyes, bulk chemical 3. Monitor and assess regional environmental issues and industry process effectively.

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	Physical and Inorganic Chemistry I
Course Code	USCH101
Class	F.Y.B.Sc. (Chemistry)
Semester	I
No of Credits	02
Nature	Theory
Type	Major / Minor
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	Restructuring of syllabus has been done to ensure a smooth and logical flow of content throughout the curriculum. It also facilitates the logical progression of subjects which allows learners to build their understanding of subject progressively and systematically to grasp contents more effectively. The course equips learners with the basic understanding of chemical thermodynamics, chemical calculations, chemical kinetics, atomic structure, and periodic table and periodicity. In addition to above, the syllabus also focuses on practical. Problem-solving exercises that require learner to apply these theories and basic concepts to real world scenarios. Chemical thermodynamics helps in understanding the energetics of chemical reaction and phase changes. Learner can apply it for process optimization in industries such as petrochemical where efficiency and cost effectiveness are crucial. Chemical kinetics involves study of rates of reaction and factors that influence them. Graduates with proficiency in this field demonstrates strong problem solving skills which are valued in R and D in chemical industry. By Understanding concept relating to concentration learner can able to calculate molality, molarity, normality and use this concepts to prepare solutions of specific concentration Interpreting periodic table requires critical thinking and analytical skills. Learner can able to predict elemental properties, chemical properties etc. from the periodic table.

Nomenclature: Physical and Inorganic Chemistry I

Course Outcomes:

On successful completion of this course learners will be able to:

CO1 Understand the basics of thermodynamic properties.
CO2 Prepare solutions of different concentrations from solid and liquid analyte.
CO3 Analyze the rate and orders of reactions by using different methods.
CO4 Explain Surface tension and its impact on liquid behavior including capillary action.
CO5 Differentiate various liquid crystal phases such as Nematic, Smectic and Cholesteric phases.
CO5 Explore the historical development of atomic models.
CO6 Explore the trends in elemental properties within specific group or families of elements such as main group elements, transition and inner transition metals.

Curriculum:

Unit	Title	Learning Points	No of Lectures (in Hrs)
I	**Chemical Thermodynamics**	**Thermodynamic terms:** System, surrounding, boundaries, types of system, Intensive and Extensive properties, State functions and path functions, Thermodynamic processes. **First law of thermodynamics:** Concept of heat (q), work (w), internal energy (U), enthalpy, heat capacity, relation between heat capacities, sign conventions, calculations of heat, work, internal energy and enthalpy(H). (Numerical problems expected where ever necessary)	**7 L**
	Chemical Calculations	Methods of expressing concentration of solutions: Normality, Molarity, Formality, Mole fractions, Weight ratio, Volume ratio, Weight to volume ratio, ppm, ppb, millimoles, milliequivalents, Preparation of solutions. (Numerical problems expected wherever necessary)	**3L**

II	**Chemical Kinetics** **Liquid State**	Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, Integrated rate equation of first order and Second order reactions (with equal initial concentration of reactants) Determination of order of reaction by a) Integration method b) Graphical method c) Differential method d) Half time method, Effect of temperature on rate of reaction (J J Hood Theory) (Numerical problems expected wherever necessary). **Surface Tension** Introduction, methods of determination of surface tension by drop number method. **Viscosity:** Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer. **Liquid crystals**: Introduction, Classification and structure of thermo tropic phases (Nematic, Smectic and Cholesteric phases), applications of liquid crystals. (Numerical problems expected wherever necessary).	**6L** **4L**
III	**Atomic structure** **Periodic Table and periodicity**	**Historical perspectives of the atomic structure;** J. J. Thomson Model, Rutherford's Atomic Model-alpha particle scattering experiment, Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Structure of hydrogen atom. **Hydrogen atoms:** 1. Simple principles of quantum mechanics 2. Atomic orbitals i) Hydrogenic energy levels ii) Shells, subshells and orbitals iii) Electron spin Aufbau principle, Hund's rule of maximum multiplicity and Pauli exclusion principle. **Long form of Periodic Table;** Classification for elements as main group, transition and inner transition elements. **Periodicity in the following properties:** Atomic and ionic size, electron gain enthalpy, ionization enthalpy, effective nuclear charge (Slater's rule), electronegativity, Pauling and Mullikan methods. (Numerical problems expected, where ever applicable.)	**4L** **6L**

References:

Physical Chemistry

1. Concise Graduate Chemistry – I, II, III and IV, University Textbook of Chemistry, University of Mumbai.
2. Atkins, P.W.and Paula, J. de Atkin's Physical Chemistry 10th Ed. Oxford University Press (2014).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Keith J. Laidler and John H. Meiser, Physical Chemistry, 2nd Ed. (2004)
5. Puri B.R., Sharma L.R.and Pathania M.S. Principles of Physical Chemistry, Vishal Publishing Company, 2008
6. Ball, D.W. Physical Chemistry Thomson Press, India (2007).
7. Mortimer, R.G. Physical Chemistry3rdEd.Elsevier: NOIDA, UP (2009).
8. Engel, T. and Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
9. Mc Quarrie, D.A. and Simon, J.D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
10. Levine, I.N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010)

Inorganic Chemistry

1. Concise Graduate Chemistry–I, II, III and IV, University Text Book of Chemistry, University of Mumbai.
2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
3. Douglas, B E and Mc Daniel, D.H. Concepts and Models of Inorganic Chemistry, Oxford,1970
4. Atkins, P.W.and Paula, J. Physical Chemistry,10thEd.,Oxford University Press,2014.Day,M.C.and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications,1962.
5. Rodger, G. E. Inorganic and Solid State Chemistry, Cengage Learning India

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Evaluation Pattern:

A) Continuous Evaluation (40%) : 20 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
02	Assignment / seminar / class test / worksheets	10
03	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	10

40 marks of CIE will be converted into 20 Marks.

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
3. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.

   Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I, II, III	15 (5 Marks each unit)
2	I	15
3	II	15
4	III	15

60 marks of SEE will be converted into 30 Marks.

CIE	SEE	Total Marks
20	30	50

Name of the Course	Organic and Inorganic Chemistry I
Course Code	USCH102
Class	F.Y.B.Sc. (Chemistry)
Semester	I
No of Credits	02
Nature	Theory
Type	Major / Minor
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	Restructuring of syllabus has been done to ensure a smooth and logical flow of content throughout the curriculum. It also facilitates the logical progression of subjects which allows learners to build their understanding of subject progressively and systematically to grasp contents more effectively. The course equips learners with the understanding of basic organic chemistry, stereochemistry, and comparative chemistry of main group elements In addition to above, the syllabus also focuses on practical Problem-solving exercises that require learner to apply these theories and basic concepts to real world scenarios. Knowledge of IUPAC nomenclature is crucial learner seeking employment in chemistry related fields especially in industry like pharmaceuticals, polymer and fine chemical etc. This helps learner to identify, classify and communicate the chemical compounds they work with. Understanding organic reaction mechanism enables chemist to design optimize synthetic route which is crucial for chemical manufacturing, drug development. Learner with this expertise suitable by research institution Stereochemistry deals with the three dimensional arrangement of atoms in molecule. Which significantly affects the properties and measurements Acquiring Knowledge stereochemistry learner can contribute to drug design, synthesis and optimization in pharmaceutical industry.

Nomenclature: Organic and Inorganic Chemistry II

Course Out comes: On successful completion of this course learners will be able to:

CO1 Understand the IUPAC nomenclature system of organic compounds.
CO2 Assign the correct IUPAC name to the organic compounds and write the structure from their IUPAC names.
CO3 Explain Basic terms in organic chemistry and hybridization of carbon oxygen and nitrogen.
CO4 Understand the advanced concepts in stereochemistry.
CO5 Distinguish between chiral and achiral molecules.
CO6 Draw and interpret Fischer, Newman and Sawhorse projection formulae
CO7 Differentiate between basic, amphoteric and acidic oxides and hydroxides of Group I and Group II elements.
CO8 Explore the common oxidation state exhibited by main group element and understand how these oxidation states influence their chemical behavior and compound formation.
CO9 Explain the chemical reaction involved in formation of photochemical smog.

Curriculum:

Unit	Title	Learning Points	No. of lectures (in Hrs)
I	**Basics of Organic Chemistry**	**Classification and Nomenclature of Organic Compounds:** **Nomenclature of mono and bi functional aliphatic compounds on the basis of priority order of the following classes of compounds**: Alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid, derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitrile and amines and their cyclic analogues	**3L**
		Bonding and Structure of organic compounds: **Hybridization**: sp^3,sp^2,sp hybridization of carbon and nitrogen; sp^3 and sp^2 hybridization of oxygen in Organic compounds. **Overlap of atomic orbitals:** Overlaps of atomic orbitals to form sigma and pi bonds, shapes of organic molecules. **Shapes of molecules;** Influence of hybridization on bond properties (as applicable to ethane, ethene, and ethyne).	**3L**
		Fundamentals of organic reaction mechanism: **Basic terms and concepts**: Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles. Inductive, electromeric, resonance and mesmeric effects, hyper conjugation and their applications. Types (Primary, secondary, tertary allyl benzene), shape and their relative stability of the following reactive intermediates i) Carbocation ii) Carbanion iii) Free radical Introduction to type of organic reactions: addition, elimination and substitution reaction (with one example each)	**4L**

II	**Stereochemistry I**	Projection formulae: Flying Wedge projection, Fischer Projection, Newman and Sawhorse Projection formulae (of erythro, threo isomers of tartaric acid and 2,3-dichlorobutane) and their interconversions; **Geometrical isomerism in alkene and cycloalkanes**: cis–trans and syn-anti isomerism E/Z notations with C.I.P rules. **Optical Isomerism:** Optical Activity, Specific Rotation, Chirality/ Asymmetry, Enantiomers, Molecules with two similar and dissimilar chiral-centres, Diastereo isomers, meso structures, racemic mixture and resolution (methods of resolution not expected). **Relative and absolute configuration**: D/L and R/S designations.	**10L**
III	**Comparative chemistry of Main Group Elements**	Metallic and non-metallic nature, oxidation states, electronegativity, anomalous behavior of second period elements, allotropy, catenation, diagonal relationship. Comparative chemistry of oxides and hydroxides of group I and group II elements.Some important compounds- **$NaHCO_3$,Na_2CO_3,CaO, $CaCO_3$**;oxides of carbon, oxides of Sulphur and Nitrogen with respect to environmental aspects like greenhouse effect, photochemical smog and acid rain.	**10L**

References:

Organic Chemistry

1. Concise Graduate Chemistry–I, II, III and IV, University Text Book of Chemistry, University of Mumbai.
2. Morrison, R.T .and Boyd, R.N. Organic Chemistry ,Dorling Kindersley (India) Pv t Ltd.(Pearson Education).2012
3. Finar, I.L. Organic Chemistry (Volume1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
4. Finar, I .L. Organic Chemistry (Volume2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
5. Eliel, E.L. and Wilen, S. H. Stereochemistry of Organic Compounds,Wiley:London,1994
6. Kalsi, P.S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
7. Mc Murry, J.E. Fundamentals of Organic Chemistry,7thEd.Cengage Learning India Edition, 2013
8. Paula Y Bruice, Organic Chemistry,7thEd,Pearsoneducation,Asia.2014
9. Graham Solomon, Fryhle, Dnyder, Organic Chemistry, Wiley publication.12th Ed,2016
10. Bahland Bahl, Advanced Organic chemistry by S. Chandpublication.2010
11. Peter Sykes. Guidebook to the mechanism in Organic chemistry,6th edition
12. D. Nasipuri. Stereochemistry of Organic Compounds, Principles and Applications, Second Edition

Inorganic Chemistry

1. Concise Graduate Chemistry–I, II, III and IV, University Text Book of Chemistry, University of Mumbai.
2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
3. Douglas, B E and Mc Daniel, D.H. Concepts and Models of Inorganic Chemistry,Oxford,1970
4. Atkins, P.W.and Paula, J. Physical Chemistry,10thEd.,Oxford University Press,2014.Day,M.C.and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications,1962.
5. Rodger, G. E. Inorganic and Solid-State Chemistry, Cengage Learning India

Evaluation Pattern:

A) Continuous Evaluation (40%) : 20 Marks

Sr. No.	**Particulars**	**Marks**
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
02	Assignment / seminar / class test / worksheets	10
03	Active participation in routine class instructional deliveries and Overall conduct as a responsible learner.	10

40 marks of CIE will be converted into 20 Marks

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
3. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.
4. Question Number one consists of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

.Question Number	Unit	Marks
1	I, II, III	15 (5 Marks each unit)
2	I	15
3	II	15
4	III	15

60 marks of SEE will be converted into 30 Marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	Chemistry Practical I
Course Code	USCH103
Class	F.Y.B.Sc. (Chemistry)
Semester	I
No of Credits	02
Nature	Practical
Type	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	Restructuring of syllabus has been done to ensure a smooth and logical flow of content throughout the curriculum. It also facilitates the logical progression of subjects which allows learners to build their understanding of subject progressively and systematically and to grasp contents more effectively. The curriculum also demonstrates how principles apply to real world scenarios. After completion of this course, learners will develop the laboratory skills like safety, handling of chemicals, equipment like digital balance, and preparation of standard solution. These skills are essential in academics as well as in industry. Learners learn safety precautions taken during handling chemicals, Basic experimental techniques and measurement skills including skills of independent investigation of chemistry related problems Organic spotting/ characterization skill is valuable analytical technique used for qualitative and compound identification. By gaining these skills learner can enhance his employability in chemical analysis role or consider entrepreneurial ventures in analytical services.

Practical I
Course Code: USCH103
Course Outcomes:
After successful completion of this course learners are able to

CO1 Take precautionary measures while handling chemicals.
CO2 Handle Electronic Balance and other lab equipment carefully.

CO3 Prepare standard solutions of desired concentration that required in the laboratory
CO4 Standardize different solutions using suitable primary standard.
CO5 Estimate percentage composition of mixture gravimetrically.
CO6 Purify organic compounds using suitable solvent.
CO7 Draw structure of organic compound using Chemsketch software.
Curriculum:

Group	Title	Learning points	No. of Hours
Group A	**Skill Experiments**	1 Introduction to chemistry lab, safety rules, precautions. 2. Introduction to lab apparatus and handling. 3. Preparation of molar and normal solutions. (Any 4) i) NaOH,ii) KOH iii) Succinic acid, iii) Oxalic acid iv) $K_2Cr_2O_7$ v) Iodine vi) $Na_2S_2O_3$ 4. To prepare 0.1N Succinic acid and standardize the NaOH solution of different concentrations. 5. To draw chemical structure of organic molecule using chemdraw/ chemsketch.	**20**
Group B	**Physical and Inorganic Experiments**	1) To determine enthalpy of dissolution of salt (KNO_3) 2) Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature (Any two solutions 3) To determine the rate constant for the hydrolysis of ester using HCl as Catalyst. 4) To determine the percent purity of sample of $BaSO_4$ containingNH_4Cl 5) To determine the percent purity of ZnO containing $ZnCO_3$.	**20**
Group C	**Inorganic and Organic Experiments**	1) Purification of organic compounds by recrystallization selecting suitable solvent (minimum 2 organic compounds to be given) (Learners are expected to report a)Solvent for recrystallization b) Percentage Yield and the melting points of the purified compound.	**20**

		3. Basic principles of Organic compound characterization (minimum 4 Solid organic compounds) (Learners should perform Preliminary Tests, Solubility Test, obtain melting point and recrystallize the compound with given solvent)	

References:

Physical Chemistry

1) Laboratory Experiments in Chemistry I and II, University Practical Book of Chemistry, University of Mumbai.
2) Athawale, V. D. and Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).
3) Khosla, B.D.; Garg, V.C. and Gulati, A. Senior Practical Physical Chemistry, R .Chand and Co.: New Delhi (2011).
4) Garland, C.W.; Nibler, J.W. and Shoemaker, D.P. *Experiments in Physical Chemistry 8th Ed*.; Mc Graw-Hill: New York (2003).
5) Halpern, A.M. and Mc Bane, G.C. *Experimental Physical Chemistry 3rd Ed.;* W.H .Freeman and Co: New York (2003).

Inorganic Chemistry

1) Laboratory Experiments in Chemistry I and II, University Practical Book of Chemistry, University of Mumbai.
2) Mendham, J.A. I. Vogel's *Quantitative Chemical Analysis 6thEd.* Pearson, 2009.

Organic Chemistry

1) Laboratory Experiments in Chemistry I and II, University Practical Book of Chemistry, University of Mumbai.
2) Mann, F.G. and Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
3) Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5thEd. Pearson (2012).
4) Vogel,A.I.,Tatchell,A.R.,Furnis,B.S.,Hannaford,A.J.andSmith,P.W.G.,Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

Evaluation Pattern: Practical Total Marks: 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Group	Title	Method	Marks
1.	B	Physical and Inorganic experiments	Experiment performance as per the practical slip	25
2.	C	Inorganic and Organic experiments	Experiment performance as per the practical slip	25
		Viva Voce and journal		10
Total				**60**

Marks in SEE practical examination will be converted into 30 marks.

CIE / Internal	SEE	Total
20	**30**	**50**

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	Laboratory Skills in Chemical sciences
Course Code	USCH104
Class	F.Y.B.Sc. (Chemistry)
Semester	I
No of Credits	02
Nature	Practical (VSC)
Type	Vocational Skill Course
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	Restructuring of syllabus has been done to ensure a smooth and logical flow of content throughout the curriculum. It also facilitates the logical progression of subjects which allows learners to build their understanding of subject progressively and systematically and to grasp contents more effectively. The curriculum is so designed that it offers hands-on approach to learn the subject. VSC in chemistry demands for a skilled workforce in various industries such as pharmaceuticals, fine chemicals, food processing, by providing trained individual .VSC in chemistry equips students with practical and specialized skills required by industry. By Acquiring such skills a learner will be more suitable for industry

Practical II
Course Code: USCH104
Course Outcomes:
After successful completion of this course learners are able to

CO1	Take precautionary measures while handling chemicals
CO2	Handle Electronic Balance and other lab equipment carefully.
CO3	Prepare standard solutions of desired concentration that required in the laboratory
CO4	Standardize different solutions using suitable primary standard
CO5	Characterize organic compounds.
CO6	Draw structure of organic compound using Chemsketch software

Curriculum:

Group	Title	Learning points	No. of Hours
Group A	**Skill Experiments** •	1 Introduction to chemistry lab, safety rules, precautions. 2. Introduction to lab apparatus and handling. 3. Preparation of molar and normal solutions.(Any 4) i) NaOH,ii) KOH iii) Succinic acid, iii) Oxalic acid iv) $K_2Cr_2O_7$ v) Iodine vi) $Na_2S_2O_3$ 4. To prepare 0.1N Succinic acid and standardize the NaOH solution of different concentrations. 5. To draw chemical structure of organic molecule using chemdraw/ chemsketch..	**20**
Group B	**Physical and Inorganic Experiments**	1) Commercial analysis of mineral acids. 2) Commercial analysis of organic acids. 3) Titration using double indicator: analysis of solution of Na_2CO_3 and $NaHCO_3$. 4) Determination of optical activity of compounds using polarimeter. 5) To determine the percent purity of ZnO containing $ZnCO_3$.	**20**
Group C	**Inorganic - Organic Experiments**	Purification of organic compounds by recrystallization selecting suitable solvent (minimum 2organic compounds to be given) Learners are expected to report a) Solvent for recrystallization. b) Percentage Yield and the melting points of the purified compound.) Basic principles of Organic compound characterization (minimum 4 Solid organic compounds) (Learners should perform Preliminary Tests, Solubility	**20**

		Test, obtain melting point and recrystallize the compound with given solvent)	

References:

1) Laboratory Experiments in Chemistry I and II, University Practical Book of Chemistry, University of Mumbai.
2) Athawale, V.D. and Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).
3) Khosla, B. D.; Garg, V. C. and Gulati, A. *Senior Practical Physical Chemistry*, R. Chand and Co.: New Delhi (2011).
4) Laboratory Experiments in Chemistry I and II, University Practical Book of Chemistry, University of Mumbai.
5) Vogel, A. I., Tatchell, A. R. Furnis, B. S., Hanna ford, A.J.and Smith, P.W. G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
6) Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed., Pearson*, 2009.

Evaluation Pattern: Practical Total Marks: 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Group	Title	Method	Marks
1.	B	Physical and Inorganic experiments	Experiment performance as per the practical slip	25
2.	C	Inorganic and Organic experiments	Experiment performance as per the practical slip	25
		Viva Voce and Journal		10
Total				**60**

Marks in SEE practical examination will be converted into 30 marks.

CIE	SEE Exam	Total
20	**30**	**50**

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	Physical Inorganic Chemistry II
Course Code	USCH201
Class	F.Y.B.Sc. (Chemistry)
Semester	II
No of Credits	02
Nature	Theory
Type	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	Restructuring of syllabus has been done to ensure a smooth and logical flow of content throughout the curriculum. It also facilitates the logical progression of subjects which allows learners to build their understanding of subject progressively and systematically to grasp contents more effectively. The course equips learners with the basic understanding of gaseous state, electrochemistry, chemical and ionic equilibria, molecular spectroscopy,, concepts of qualitative analysis In addition to above, the syllabus also focuses on practical Problem-solving exercises that require learner to apply these theories and basic concepts to real world scenarios. Chemical thermodynamics helps in understanding the energetics of chemical reaction and phase changes. Learner can apply it for process optimization in industries such as petrochemical where efficiency and cost effectiveness are crucial. Measurement of conductivity enhances various skills, including laboratory technique, data analysis. And instrumental operation. The study of conductivity measurement is essential for those seeking employment in industries that deals with electrolyte such as the production of batteries, fuel cells.

Nomenclature: Physical and Inorganic Chemistry II

Course Outcomes:
After successful completion of this course learners are able to

CO1	Explain Distribution of velocities with the help Maxwell's and Boltzmann's law.
CO2	Differentiate between ideal and non-ideal solutions.
CO3	Understand basic terms of electrochemistry like conductance, equivalent conductance.
CO4	Discuss Variation of molar conductance with concentration of strong and weak electrolyte.
CO5	Explain Second law of thermodynamics.
CO6	Relate equilibrium constants (Kc and Kp).
CO7	Derive Henderson equation for acidic and basic buffer.
CO8	Discuss Beer-Lamberts law.
CO9	Study Role of Papers impregnated with Reagents in qualitative analysis.
CO10	Apply Arrhenius theory to acid and base.

Curriculum:

Unit	Title	Learning Points	No. of Lectures (in hrs.)
I	**Gaseous State**	Kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (Qualitative discussion), Ideal gas laws, Deviation from ideal gas laws, Ideal and real gases, Reasons for deviation from ideal gas laws, Compressibility factor, Boyle's temperature, van der Waals equation of state. (Numerical problems expected wherever necessary)	**3L**
	Electrochemistry-I	Conductance, specific conductance, equivalent conductance, molar conductance, Variation of molar conductance with concentration of strong and weak electrolyte. (Numerical problems expected wherever necessary)	**3L**
	Chemical Equilibria and Thermodynamic Parameters	Second law of thermodynamics, concept of entropy, Physical significance of entropy, Concept of free energy, Helmholtz and Gibbs free energy, Variation of free energy with temperature and pressure, Spontaneity and Physical significance of free energy Reversible and irreversible reactions, equilibrium constants (Kc and Kp), relationship between Kc and Kp. (Numerical problems expected wherever necessary)	**4L**
II	**Ionic Equilibria**	Degree of ionization, factors affecting degree of ionization, Ionization constant and ionic product of water, Ionization of weak acids and bases, Dissociation constants of mono-, di-and tri-protic acids.	**6L**

		pH scale, Buffer solutions, types of buffers, Derivation of Henderson equation for acidic and basic buffers, Buffer action, buffer capacity (Numerical problems expected, wherever necessary)	
	Molecular Spectroscopy	Electromagnetic radiation, electromagnetic spectrum, Planck's equation, Interaction of electromagnetic radiation with matter; Absorption, Emission, Scattering, Electronic, Vibrational and Rotational transitions, Beer-Lamberts law. Deviation from Beer-Lamberts law. (Numerical problems expected, wherever necessary)	**4L**
III	**Concept of Qualitative Analysis**	Testing of Gaseous Evolutes, Role of Papers impregnated with Reagents in qualitative analysis (with reference to papers impregnated with starch iodide, potassium dichromate, Lead acetate, and dimethyl glyoxime and oxine reagents). Precipitation equilibria, Formation of precipitates like AgCl, AgBr, AgI and $BaSO_4$effect of common ions, uncommon ions, oxidation states, buffer action, complexing agents on precipitation of ionic compounds.(Balanced chemical equations)	**6L**
	Acid Base Theories	Arrhenius, Lowry- Bronsted, Lewis, Solvent–Solute concept of acids and bases, Usanovich concept, Hard and Soft acids and bases, Applications of HSAB.	**4L**

References:

Unit–I: Physical Chemistry

1) Concise Graduate Chemistry – I, II, III and IV, University Text Book of Chemistry, University of Mumbai.
2) Atkins, P. W. and Paula J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).
3) Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4) Keith J. Laidler and John H. Meiser, Physical Chemistry, 2nd Ed. (2004)
5) Puri B.R., Sharma L.R.and Pathania M.S. Principles of Physical Chemistry, Vishal Publishing Company, 2008
6) Ball, D. W. Physical Chemistry Thomson Press, India (2007).
7) Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
8) Engel, T. and Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
9) Mc Quarrie, D. A and Simon, J.D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
10) Levine I. N. *Physical Chemistry* 6thEd.,TataMcGraw Hill(2010)

Unit II: Inorganic Chemistry

1. Concise Graduate Chemistry–I, II, III and IV, University Text Book of Chemistry, University of Mumbai.
2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
3. Douglas, B. E. and Mc Daniel, D. H. Concepts and Models of Inorganic Chemistry,Oxford,1970
4. Atkins, P. W. and Paula,J.PhysicalChemistry,10^{th} Ed., Oxford University Press,2014.Day,M.C.and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications,1962.
5. Rodger, G. E. Inorganic and Solid State Chemistry, Cengage Learning India

Evaluation Pattern:

A) Continuous Evaluation (40%) : 20 Marks

Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
Assignment / seminar / class test / worksheets	15
Attendance and active participation in classroom	05

40 marks of CIE will be converted into 20 Marks.

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

4. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
5. All questions will be compulsory and may be divided into sub-questions.
6. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.

Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I, II, III	15 (5 Marks each unit)
2	I	15
3	II	15
4	III	15

60 marks of SEE will be converted into 30 Marks.

CIE	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	Organic and Inorganic Chemistry II
Course Code	USCH202
Class	F.Y.B.Sc. (Chemistry)
Semester	II
No of Credits	02
Nature	Theory
Type	Major / Minor
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	Restructuring of syllabus has been done to ensure a smooth and logical flow of content throughout the curriculum. It also facilitates the logical progression of subjects which allows learners to build their understanding of subjects progressively and systematically to grasp contents more effectively. The course equips learners with the understanding of chemistry of aliphatic hydrocarbon, stereochemistry II, Aromatic hydrocarbon, chemical bond reactivity, oxidation-reduction chemistry In addition to above, the syllabus also focuses on practical Problem-solving exercises that require learner to apply these theories and basic concepts to real world scenarios. The course includes core courses such as Organic chemistry, and Inorganic Chemistry. Knowledge of aliphatic hydrocarbon is essential for learner pursuing career in industries like Petrochemical, oil and Gas, Plastics. Learner with this expertise may find more job opportunity in Petrochemical, polymer etc. Stereochemistry deals with the three dimensional arrangement of atoms in molecule. Which significantly affects the properties and measurements Acquiring Knowledge stereochemistry learner can contribute to drug design, synthesis and optimization in pharmaceutical industry

Nomenclature: Organic and Inorganic Chemistry.

Course Outcome

After successful completion of this course learners are able to

CO1	Summarize the different methods for the synthesis of alkanes, alkenes, dienes and alkynes
CO2	Predict the product of organic reactions involving alkanes, alkenes and alkynes as substrates.
CO3	Design synthesis of simple saturated and unsaturated hydrocarbons.
CO4	Write the mechanism using fundamental concepts of writing mechanism.
CO5	Identify aromatic system using Huckel's rule.
CO6	Differentiate between Chemical bond and ionic bond.
CO7	Apply VSEPR theory to molecules.
CO8	Determine the number of bonding and nonbonding electron pairs around the atom by applying VSEPR theory.
CO9	Explain the redox reactions.

Curriculum:

Unit	Title	Learning Points	No of Lectures (In hrs.)
I	**Chemistry of Aliphatic Hydrocarbons**	**Carbon-Carbon sigma bonds** Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig reaction, free radical substitutions: Halogenation-relative reactivity and selectivity **Carbon-Carbon pi – bonds** **Formation of alkenes and alkynes by elimination reactions**: Mechanism of E1, E2, E1cb reaction. Saytzeff and Hofmann eliminations **Reactions of alkenes**: Electrophilic additions with mechanisms (Markownikoff/ Anti Markownikoff addition), Mechanism of hydroboration - oxidation, ozonolysis, reduction (catalytic and chemical), syn- and anti-dihydroxylation (oxidation), 1, 2- and1, 4-addition reactions in conjugated dienes, Diels-Alder reaction. **Reaction of alkynes**: Acidity, Electrophilic and Nucleophilic additions with mechanisms. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.	**10L**
II	**Stereochemistry II** **Aromatic Hydrocarbons**	**Conformational analysis of alkanes:** (ethane, propane and n-butane). Relative stability with energy diagram. **Aromaticity:** Hückel's rule, anti-aromaticity, aromatic character of arenes, cyclic carbocations/ carbanions and heterocyclic compounds with suitable examples. **Electrophilic aromatic substitution:** halogenation, nitration, sulphonation and Friedel-Crafts alkylation/ acylation with their mechanism, Directing effects of the groups.	**2L** **8L**

III	**Chemical Bond and Reactivity**	Types of chemical bond, comparison between ionic and covalent bonds, polarizability (Fajan's Rule),shapes of molecules, Lewis dot structure, Sidgwick Powell Theory, basic VSEPR theory for A B n type molecules with and without lone pair of electrons is electronic principles, applications and limitations of VSEPR theory.	**10L**

References:

Unit I: Organic Chemistry

1. Concise Graduate Chemistry–I, II, III and IV, University Text Book of Chemistry, University of Mumbai.
2. Morrison, R.T. and Boyd, R.N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012
3. Finar, I.L. Organic Chemistry (Volume1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
4. Finar, I.L. Organic Chemistry (Volume2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds,Wiley:London,1994
6. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
7. Mc Murry, J.E. Fundamentals of Organic Chemistry,7th Ed. Cengage Learning India Edition, 2013
8. Paula Y Bruice, Organic Chemistry,7th Ed, Pearson education,Asia.2014
9. Graham Solomon, Fryhle, Dnyder, Organic Chemistry,Wileypublication.12thEd,2016
10. Bahland Bahl, Advanced Organic chemistry by S. Chandpublication.2010
11. Peter Sykes. Guidebook to the mechanism in Organic chemistry,6thedition
12. D. Nasipuri. Stereochemistry of Organic Compounds, Principles and Applications, Second Edition

Unit II: Inorganic Chemistry

1. Concise Graduate Chemistry–I, II, III and IV, University Text Book of Chemistry, University of Mumbai.
2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
3. Douglas, B. E. and Mc Daniel, D. H. Concepts and Models of Inorganic Chemistry,Oxford,1970
4. Atkins,P.W.andPaula,J.PhysicalChemistry,10thEd.,OxfordUniversityPress,2014.Day,M.C.and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications,1962.
5. Rodger, G. E. Inorganic and Solid State Chemistry, Cengage Learning India

Evaluation Pattern:

A) Continuous Evaluation (40%) : 20 Marks

Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
Assignment (Min three)	15
Attendance and active participation in classroom	05

40 marks of CIE will be converted into 20 Marks.

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

7. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
8. All questions will be compulsory and may be divided into sub-questions.
9. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.

16 Question Number one consists of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I, II, III	15 (5 Marks each unit)
2	I	15
3	II	15
4	III	15

60 marks of SEE will be converted into 30 Marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	Chemistry Practical II
Course Code	USCH203
Class	F.Y.B.Sc. (Chemistry)
Semester	II
No of Credits	02
Nature	Practical
Type	Major / Minor
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	Restructuring of syllabus has been done to ensure a smooth and logical flow of content throughout the curriculum. It also facilitates the logical progression of subjects which allows learners to build their understanding of subject progressively and systematically and to grasp contents more effectively. The curriculum also demonstrates how principles apply to real world scenarios. Learners will able to operate laboratory equipment like Conductometer, colorimeter, pH meter. Basic experimental techniques and measurement skills make learner suitable for investigation of chemistry related problems Organic spotting/ characterization skill is valuable analytical technique used for qualitative and compound identification. By gaining these skills learner can enhance his employability in chemical analysis role or consider entrepreneurial ventures in analytical services.

Practical:

Course Outcomes: After Completion of the course Lerner will able to

CO1	Operate laboratory equipment such as pH meter, Conductometr, colorimeter and other lab equipment carefully.
CO2	Determine dissociation constant weak acid pH metrically.
CO3	Validate Beer Lambert's law using $KMnO_4$ solution.
CO4	Standardize different solutions using suitable primary standard
CO5	Characterize organic compound
CO6	Purify organic compounds using suitable solvent.
CO7	Estimate amount of copper iodometrically.

Group	Title	Learning points	No. of Hours
Group A	**Physical**	1) To determine the amount of strong acid in the given solution by titrating against strong base conductometrically 2) To determine the dissociation constant of weak acid (Ka) using Henderson's equation and the method of incomplete titration pH metrically. 3) To verify Beer-Lamberts law using $KMnO_4$ solution by colorimetric method. 4) To standardize commercial sample of HCl using borax and to write material safety data of the chemicals involved.	**20**
Group B	**Inorganic Experiments**	**5) Semi-micro Qualitative analysis:(5 mixtures to be analyzed)** Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions(from amongst): *Cations (from amongst):* Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Ni^{2+}, Mn^{2+}, Mg^{2+}, Al^{3+}, Cr^{3+},K^{+},NH_4^{+} *Anions (from amongst):*CO_3^{2-},S^{2-},SO^{2-},NO_2^{-},NO_3^{-}, Cl^{-},Br^{-},I^{-},SO_4^{2-},PO_4 (Scheme of analysis should avoid use of sulphide ion in any form for precipitation/ separation of cations.) **6) Redox Titration :**To determine the percentage of copper(II) present in a given sample by titration against a standard aqueous solution of sodium thiosulfate (iodometry titration)	**20**
Group C	**Organic Experiments**	Characterization of organic compounds containing C,H,(O) N,S,X elements (6 solid/liquid organic compounds)(Preliminary test, solubility/miscibility test, detection of elements, detection of functional groups and determination of physical constant)	**20**

Minimum 80 percent of practical must be completed in each term

References:

Unit I: Physical Chemistry

1) Laboratory Experiment in Chemistry I and II, University Practical Book of Chemistry, University of Mumbai.
2) Athawale, V. D. and Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).
3) Khosla, B. D.; Garg, V.C. and Gulati,A. *Senior Practical Physical Chemistry* ,R. Chand and Co.: New Delhi (2011).
4) Garland, C. W.; Nibler J. W. and Shoemaker, D.P. *Experiments in Physical Chemistry* 8^{th} *Ed*.; McGraw-Hill: New York (2003).
5) Halpern, A. M. and Mc Bane,G.C. *Experimental Physical Chemistry*3rd*Ed.;*W.H.FreemanandCo.:New York (2003).

Unit II: Inorganic Chemistry

1) Laboratory Experiments in Chemistry I and II, University Practical Book of Chemistry, University of Mumbai.
2) Mendham, J., A.I. Vogel's *Quantitative Chemical Analysis* 6^{th}*Ed*, Pearson, 2009.

Unit III: Organic Chemistry

1) Laboratory Experiments in Chemistry I and II, University Practical Book of Chemistry, University of Mumbai.
2) Mann, F.G. and Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
3) Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5^{th}Ed.Pearson (2012).
4) Vogel,A.I.,Tatchell,A.R.,Furnis,B.S.,Hannaford,A.J.andSmith,P.W.G.,Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition,

Evaluation Pattern: Practical Total Marks: 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Group	Title	Method	Marks
1.	B	Physical and Inorganic experiments	Experiment performance as per the practical slip	25
2.	C	Inorganic and Organic experiments	Experiment performance as per the practical slip	25
		Viva Voce and journal		10
Total				**60**

Marks in SME practical examination will be converted into 30 marks.

CIE / Internal	SEE	Total
20	**30**	**50**

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	USCH204
Class	F.Y.B.Sc. (Chemistry)
Semester	II
No of Credits	02
Nature	Practical
Type	Skill Enhancement Course (SEC)
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	Skill Enhancement Course (SEC) introduces classical analytical procedures and chemistry for analyzing various types of the sample matrix quantitatively. The main focus is on Titrimetric methods like Acid Base titrations, Complexometric titrations, and redox and precipitation titration. Basic experimental techniques and measurement skills make learner suitable for investigation of chemistry related problems This could be anything from analyzing the composition of a new drug to detection of impurity in a food samples. By gaining these skills learner can enhance his employability in chemical analysis role or consider entrepreneurial ventures in analytical services.

Skill Enhancement Course (SEC)

Course Code: USCH204: Skill in Chemical Analysis I

No. of Credits: 02

Course Outcomes: After Completion of the course Lerner will able to

CO1 Understand classical methods of chemical analysis

CO2 Explain primary and secondary standards used in titrimetry

CO3 Discuss different types of titration

CO4 Acquire basic laboratory skills

CO5 Estimate Vitamin C in tablet by titration method.

CO6 Detect adulterants in food sample.

Curriculum:

Unit	Description	Hours
I	**Introduction to Classical method of analysis :** Titrimetric Methods Basic terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry, Conditions suitable for titrimetry **Tools of Titrimetry**: Graduated glassware and Calibration Standard solutions (Primary and Secondary standards in Titrimetry) and Calculations in Titrimetry. **Types of titrimetry** – Neutralisation (Acidimetry, alkalimetry), Redox, (Iodometry, Iodimetry,) Precipitation and Complexometric titrations and indicators used in these titrations **Neutralisation Titrations** Concept of pH and its importance in Neutralisation Titrations End point and Equivalence point of Neutralisation titrations Determination of End point by using indicators causing colour change	10 Hrs.
	Description of Experiments	
II	Group A	25 Hrs.
1	Estimation of ibuprofen by titration method	
2	Estimation of Aspirin tablet by titration method	
3	Estimation of alkali content/ acid absorbing capacity in antacid by titration method	
4	Assay of Vitamin C in Tablet by titration method	
5	Assay of Tincture Iodine	
6	Determination of % of Sodium Chloride present in a Saline sample	

III	Group B	25 Hrs.
1	Assay of Ascorbic acid in citrus juice	
2	Estimation of Calcium in Milk powder complexometrically	
3	Estimation of Magnesium in Talcum Powder Complexometrically	
4	Determination of % Sodium Carbonate in Washing Soda	
5	Estimation of acetic acid in Vinegar Titrimetrically.	
6	Detection of adulterants in food sample A) Milk : Sugar, starch, Formalin, Urea, Detergent B) Coffee : Starch/ Cereal, Chicory c) Jaggery : Washing Soda, Chalk Powder, Metanil yellow colour	

References:

1) Vogel's Textbook of Quantitative Chemical Analysis, Fifth Edition, G H Jeffery and J Bassett.

2) Vogel,A.I.,Tatchell,A.R.,Furnis,B.S.,Hannaford,A.J.andSmith,P.W.G.,Textbook ofPracticalOrganic Chemistry, Prentice-Hall, 5th edition, 1996.

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

4) Indian Pharmacopoeia Vol. I and II, 2007

Evaluation Pattern: Practical Total Marks: 50

B) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

C) Semester End Examination: 60% (30 Marks)

Sr. No.	Description	Marks (0 marks)
1	MCQ test Unit I	**15**
1	One experiment from Group A	20
2	One experiment from Group B	20
3	Viva	05
Total Marks		**60**

Marks in SEE practical examination will be converted into 30 marks.

CIE	SEE Exam	Total
20	30	50

Date: 04/11/2023

Chairperson BoS

(Dr. M. G. Gore)

R.E. Society's
R.P. Gogate College of Arts & Science
&
R.V. Jogalekar College of Commerce
(Autonomous)
Ratnagiri
(Affiliated to University of Mumbai)

Syllabus for

S.Y.B.Sc.

(Chemistry)

Semester III & IV

Under Choice Based Credit System

(CBCS)

Revised Scheme of Examination

Faculty of Science

(Under-graduate Programme)

Choice Based Credit System (CBCS)

Scheme of Examination

Bachelor of Science (B.Sc.) Programme

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks and by conducting the Semester End Examinations with 60% marks. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of two hours duration.

2. Theory question paper pattern:

a. There shall be 03 questions each of 15 marks on each unit and one question of 15 marks on all units.

b. All questions shall be compulsory with internal choice within the questions.

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) separately, to pass the course and minimum of Letter Grade “P” in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Performance Grading:

Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	0 (Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+ (Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+ (Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C (Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

Second Year B.Sc.

Course Code	Semester III	Credits	Course Code	Semester IV	Credits
USCH301	Physical , Inorganic and Organic Chemistry I	**02**	USCH401	Physical , Inorganic and Organic Chemistry II	**02**
USCH302	Physical , Inorganic and Organic Chemistry I	**02**	USCH402	Physical , Inorganic and Organic Chemistry II	**02**
USCH303	Analytical Chemistry I	**02**	USCH403	Analytical Chemistry II	**02**
USCHP3	Chemistry Practical III	**03**	USCHP4	Chemistry Practical IV	**03**

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of Programme	B.Sc.
Level	UG
No of Semesters	III and IV
Year of Implementation	2023-24
Programme Specific Outcomes (PSO)	1. To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry such as Electrochemistry, Chemical bonding and Coordination compounds, Reactions and reactivity of hydrocarbons. 2. Demonstrate competence in problem solving skills in different areas of Chemistry 3. Gain the knowledge of the chemical bonding and chemistry of the p-block elements, compare the properties of main group elements in the respective groups, ions in aqueous medium and related effects on environment, solid state , catalysis 4. The student must understand the reactions of carbonyl compounds, amines, heterocyclic compounds and related reactions, the routes of synthesis of different types of materials and their characteristics. 5. Student must understand qualitative and quantitative study of chemical constituents.
Relevance of PSO's to the local, regional, national, and global developmental needs (200 words)	The Bachelor of Science in Chemistry programme equips the candidate with knowledge, general competence, and analytical skills on an advanced level, needed in industry, consulting, education, and research and public and private administration. On completion of the programme, the learner will be able to: 1. Identify, formulate and analyze scientific problems and reach concrete solutions for societal benefits using various principles of chemical sciences. 2. Introduce the concepts useful for industries viz. Pharmaceutical, dyes, bulk chemical 3. Monitor and assess regional environmental issues and industry process effectively.

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	Physical, Inorganic and Organic Chemistry I

Course Code	USCH301
Class	S.Y.B.Sc.(Chemistry)
Semester	III
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--

Nomenclature: Physical, Inorganic and Organic Chemistry

Course Outcomes:

On successful completion of this course learners will be able to:

CO1 : Understand the concept of Free energy functions of Helmholtz free energy, Gibb's Free energy.

CO2 : Study of variation of Gibb's Free energy with Pressure and Temperature.

CO3 : Apply the concept of the Gibb's – Helmholtz function, van't Hoff isotherm and van't Hoff reaction isochore with numerical problem.

CO4 : Understand the chemical bonding with special emphasis on ionic and covalent molecules.

CO5 : Discuss the the concept of weak bond (H_2) and Wander Wall bond

CO6 : Understand concept of MOT with respect to diatomic and triatomic molecules / molecular ions.

CO7 : Illustrate reactivity of halogenated hydrocarbons.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I : Physical Chemistry	Chemical Thermodynamics-II, Electrochemistry	**1.1 Chemical Thermodynamics – II (8L)** 1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's free energy with Pressure and Temperature. 1.1.2 Gibbs-Helmholtz equation, van't Hoff reaction isotherm and van't Hoff reaction isochore. (Numericals are expected). 1.1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation. 1.1.4 Concept of Fugacity and Activity **1.2 Electrochemistry - (7L)** 1.2.1 Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. 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, ionic product of water. (Numericals expected). 1.2.4 Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.	**15**
II : Inorganic Chemistry	Chemical Bonding	**Chemical Bonding** **2.1 Non-Directional Bonding (4L)** 2.1.1 Ionic Bond: Conditions for the Formation of Ionic Bond. 2.1.2 Types of Ionic Crystals	**15**

		2.1.3 Radius Ratio Rules 2.1.4 Lattice Energy, Borne-Lande Equation 2.1.5 Kapustinski Equation 2.1.6 Born-Haber Cycle and its Application **2.2. Directional Bonding: Orbital Approach (6L)** 2.2.1 Covalent Bonding - The Valence Bond Theory-Introduction and basic tenets. 2.2.2 Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system. 2.2.3 Corrections applied to the system of two hydrogen atoms - Formation of H_2 2.2.4 Homonuclear diatomic molecules from He_2 to Ne_2 2.2.5 Resonance and the concept of Formal Charge; Rules for Resonance or Canonical structures. 2.2.6 Bonding in Polyatomic Species: The role of Hybridization and types of hybrid orbitals-*sp, sp*^{2}*, sp*^{3}, *sp*^{3}*d, sp*^{2}*d*^{2}*and sp*^{2}*d sp*^{3}*d*^{2}. 2.2.7 Equivalent and Non-Equivalent hybrid orbitals 2.2.8 Contribution of a given atomic orbital to the hybrid orbitals (with reference to *sp3* hybridisation as in CH_4, NH_3 and H_2O and series like NH_3, PH_3, AsH_3, BiH_3) 2.3 **Molecular Orbital Theory (5L)** 2.3.1. Comparing Atomic Orbitals and Molecular Orbitals. 2.3.2. Linear combination of atomic orbitals to give molecular orbitals LCAO-MO approach for diatomic homonuclear molecules). 2.3.3 Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2,O_2^+ O_2^-,O_2^{2-} (Problems and numerical problems expected wherever possible)	

III: Organic Chemistry	Reactions and reactivity of halogenated hydrocarbons, alcohols, Phenols and epoxides	**3.1.1. Reactions and reactivity of halogenated hydrocarbons [4L]** 3.1.1.**Alkyl halides:** Nucleophilic substitution reactions: S**N**^{1}, S**N**^{2} and S**N**^{i} mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions-nature of substrate, solvent, nucleophilic reagent and leaving group. 3.1.2. **Aryl halides:** Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (S**N**^{Ar}) addition-elimination mechanism and benzyne mechanism. 3.1.2.**Organomagnesium and organolithium compounds [3L]** Nomenclature, nature, type and reactivity of carbon-metal bond. Preparation using alkyl / aryl halide. Structure, stability and reactions with compounds containing acidic hydrogen, carbonyl compounds, CO_2, cyanides and epoxides. **3.2 Alcohols, phenols and epoxides [8L]** 3.2.1. **Alcohols:** Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols 3.2.2. **Phenols:** Preparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols. 3.2.3. **Epoxides:** Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides.	**15**

Name of the Course	Physical , Inorganic and Organic Chemistry I
Course Code	USCH302
Class	S.Y.B.Sc.(Chemistry)
Semester	III
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--

Nomenclature: Physical, Inorganic and Organic Chemistry

Course Outcomes:

On successful completion of this course learners will be able to:

CO1 : Understand the types of complex chemical reactions.

CO2 : Know the reversible or opposing, consecutive and parallel reactions.

CO3 : Understand the thermal chain reaction between H and Br reaction.

CO4 : Discuss formation and bonding of electron deficient molecule of boron and Lewis acidity of halides of boron.

CO5 : Explain various extraction and purification techniques used for Si and Ge.

CO6 : Describe synthesis of ammonia.

CO7 : Examine reactivity of active methylene groups in carbonyl compounds.

CO8 : Predict the product, interpret and propose mechanism involved in different types. of aliphatic and aromatic carbonyl compounds with functional groups.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I : Physical Chemistry	Chemical Kinetics -II, Solutions	**1.1 Chemical Kinetics - II (7L)** 1.1.1 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected), Thermal chain reactions: H. and Br. reaction. (only steps involved, no kinetic expression expected). 1.1.2 Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (Ea). (Numericals expected). 1.1.3 Theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions. Comparison between the two theories (Qualitative treatment only) **1.2 Solutions (8L)** 1.2.1 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. Distillation of solutions. Lever rule. Azeotropes. 1.2.2 Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol-Water , Triethanolamine – Water and Nicotine – Water systems 1.2.3 Immiscibility of liquids- Principle of steam distillation. 1.2.4 Nernst distribution law and its applications, solvent extraction.	**15**

II : Inorganic Chemistry	Selected topics on p block elements	**2. Selected topics on '*p*' block elements (15L)** **2.1 Chemistry of Boron compounds** 2.1.1 Electron deficient compounds – BH_3, BF_3, BCl_3 with respect to Lewis acidity and applications. 2.1.2 Preparation of simple boranes like diborane and tetraborane. 2.1.3 Structure and bonding in diborane and tetraborane (2e-3c bonds) 2.1.4 Synthesis of Borax. **2.2 Chemistry of Silicon and Germanium** 2.2.1 Silicon compounds: Occurrence , Structure and inertness of SiO_2 2.2.2 Preparation of structure of $SiCl_4$ 2.2.3 Occurrence and extraction of Germanium 2.2.4 Preparation of extra pure Silicon and Germanium **2.3 Chemistry of Nitrogen family** 2.3.1 Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen. 2.3.2 Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4. 2.3.3 Synthesis of ammonia by Bosch – Haber process.	**15**
III: Organic Chemistry	Carbonyl Compounds	3.1 Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds. Structure, reactivity of aldehydes and ketones and methods of preparation; Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, action of Grignard reagent on esters, Rosenmund reduction, Gattermann – Koch formylation and Friedel Craft acylation of arenes 3.2 General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions.	**15**

		3.3 Reactions of aldehydes and ketones with $NaHSO_3$, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2, 4-Dinitrophenyl hydrazine, $LiAlH_4$ and $NaBH_4$. 3.4 Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt and Cannizzaro reaction. 3.5 Keto-enol tautomerism: Mechanism of acid and base catalysed enolization 3.6 Active methylene compounds: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilised enols. Reactions of Acetylacetone and ethyl acetoacetate (alkylation, conversion to ketone, mono- and dicarboxylic acid)	

References:

Physical Chemistry

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa Publication (2004).
3. Kotz, J.C., Treichel, P.M. and Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa Publication (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).
6. K. L. Kapoor A textbook of Physical Chemistry 3rd Ed. Vol.1, 2 Macmillan Publishing Co., New Delhi (2001)

Inorganic Chemistry

1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
3. Quantitative Analysis – R. A. Day, A. L. Underwood, sixth edition Prentice Hall of India (1999)
4. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
5. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry.

6. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
7. R. Gopalan, Universities Press India Pvt. Ltd. Inorganic Chemistry for Undergraduates.
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9. J. D. Lee, 4th Edn. Concise Inorganic Chemistry, ELBS, The group III elements Pg.359-648.
10. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 3rd edition, Oxford University Press (1999) page 325-446.
11. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
12. C. N. R. Rao edited, University General Chemistry, 513-578.
13. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,
14. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
15. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
16. Gary Wulfsberg, Inorganic Chemistry, Viva Books Pvt. Ltd. (2002).

Organic Chemistry:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
6. Graham Solomons, T.W. Organic Chemistry, John Wiley and Sons, Inc.
7. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek Barton, W. David Ollis.
8. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd.
9. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
10. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005

Name of the Course	Analytical Chemistry I

Course Code	USCH303
Class	S.Y.B.Sc.(Chemistry)
Semester	III
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--

Nomenclature: Basics in Analytical Chemistry

Course Outcomes:

On successful completion of this course learners will be able to:

CO1 : Explain language of analytical chemistry: important terms and their significance in analytical Chemistry.

CO2 : Discuss purpose of chemical analysis.

CO3 : Illustrate significance of chemical analysis.

CO4 : Understand terms involved in titrimetric methods of analysis.

CO5 : Differentiate between volumetry and titrimetry.

CO6 : Select proper indicators for titration.

CO7 : Classify various analytical methods based upon source of energy.

CO8 : Explain principles of spectral methods in chemical analysis.

CO9 : Discuss construction and working of colorimeter and spectrophotometer.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I: Statistical methods in chemical analysis	Introduction to Analytical Chemistry and Statistical Treatment of analytical data-I	**1.1. Role of Analytical Chemistry (7L)** 1.1.1. Language of analytical chemistry: important terms and their significance in Analytical Chemistry. 1.1.2. Purpose of Chemical Analysis; Analysis Based (i) On the nature of information required: (Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and micro analysis) 1.1.3. Classical and Non-Classical Methods of Analysis; their types and importance. **1.2. Significance of Sampling in Analytical Chemistry (2L)** 1.2.1. Terms involved in Sampling 1.2.2. Types of Sampling 1.2.3. Sampling techniques **1.3. Results of Analysis. (6L)** 1.3.1. Errors in Analysis and their types 1.3.2. Precision and Accuracy in Analysis 1.3.3. Corrections for Determinate Errors *(Problems including Numericals expected wherever required)*	**15**
II: Classical methods in chemical analysis	Classical Methods of Analysis.	**2.1. Titrimetric Methods (5L)** 2.1.1. Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry 2.1.2. The Conditions suitable for titrimetry 2.1.3. Types of titrimetry – Neutralisation (Acidimetry, alkalimetry), Redox, (Iodometry, Iodimetry,) Precipitation and Complexometric titrations and indicators used in these titrations 2.1.4. Tools of Titrimetry: Graduated glasswares and Callibration	**15**

		2.2. Standard solutions (Primary and Secondary standards in Titrimetry) and Calculations in Titrimetry. **2.3. Neutralisation Titrations (4L)** 2.3.1. Concept of pH and its importance in Neutralisation Titrations 2.3.2. End point and Equivalence point of Neutralisation titrations 2.3.3. Determination of End point by using i. Indicators causing colour change ii. Change in potential (by potentiometry) iii. Change in conductance (by conductometry) 2.3.4. Construction of titration curve (on the basis of change in pH) of a titration of i. Strong acid-weak base **ii.** Strong base-weak acid **2.4. Gravimetric analysis (6L)** 2.4.1. General Introduction to Gravimetry. 2.4.2. Types of Gravimetric Methods – 2.4.3. Precipitation Gravimetry: i. Steps involved in precipitation gravimetry analysis ii. Conditions for precipitation iii. Completion of precipitation, iv. Role of Digestion, Filtration, Washing, Drying Ignition of precipitate. v. Applications of Gravimetric Analysis: Determination of sulfur in organic compounds; Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime; Determination of Aluminium by converting it to its oxide.	
III: Instrumental techniques in chemical analysis	Instrumental Methods-I	**Basic concepts in Instrumental Methods (3L)** **3.1.** Relation between the analyte, stimulus and measurement of change in the observable property. **3.2.** Block diagram of an analytical instrument.	**15**

		3.3. Types of analytical instrumental methods based on i. Optical interactions (eg. Spectrometry: UV-visible, Polarimetry) ii. Electrochemical interactions (eg. Potentiometry, Conductometry,) iii. Thermal interactions (eg. Thermogravimetry) **3.4. Spectrometry (10L)** 3.4.1. Interaction of electromagnetic radiation with matter: absorption and emission spectroscopy 3.4.2. Basic Terms: radiant power, absorbance, transmittance, monochromatic light, polychromatic light, wavelength of maximum absorbance, absorptivity and molar absorbtivity 3.4.3. Statement of Beer's Law and Lambert's Law, Combined mathematical expression of Beer - Lambert's Law, Validity of Beer-Lambert's Law, Deviations from Beer-Lambert's law ((Real deviations, Instrumental deviations and chemical deviations) (Numerical problems based on Beer-Lambert's Law) 3.4.4. Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers 3.4.5. Block Diagrams for single beam colorimeter, and spectrophotometer (principles, construction and working-details of components expected i.e. , source, sample holder , filters/monochromators, detectors such as photomultiplier tube) 3.4.6. Applications of UV-Visible Spectrophotometry **(2 L)** (a) Qualitative analysis such as identification of functional groups in organic compounds, chromophores and auxochrome, c*is* and *trans* isomers	

		(b) Quantitative analysis by calibration curve method and 3.4.7. Photometric Titrations: principle, instrumentation, types of photometric titration curves with examples.	

References:

Analytical Chemistry:

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch.
2. Instrumental methods of analysis by Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, 7th Edition.
3. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch.
4. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education.
5. Skoog et al. "Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition, Chapter 13, 14 and 15.
6. Day and Underwood, "Quantitative analysis" prentice hall 1991, chapter 3.
7. S. M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition New Age International Publisher.
8. Gary D. Christan," Analytical Chemistry", VIth Edition, Wiley Students Edition, Chapter No 8,9,10.
9. Modern Analytical Chemistry, David Harvey (page numbers 232 -265).
10. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal, Sham K. Anand pp 2.107-2.148.
11. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp 143-172.
12. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp 118- 181.

Evaluation Pattern:

A) Continuous Evaluation (40%) : 40 Marks

Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
Assignment / seminar / class test / worksheets	15
Attendance and active participation in classroom	05

B) Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
3. Descriptive type of questions, derivation-based questions, problem solving / numericals based questions, etc., will contain internal options.

   Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I, II, III	15 (5 Marks each unit)
2	I	15
3	II	15
4	III	15

CIE	SEE	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	Chemistry Practical I
Course Code	USCHP3
Class	S.Y.B.Sc. Chemistry
Semester	III
No of Credits	03
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----.

Practical I

Course Code: USCHP3

Course Outcomes:

After successful completion of this course learners are able to

CO1 : Verify Ostwald Dilution Law.

CO2 : Determine order of reaction as well as energy of activation.

CO3 : Identify cations from its binary mixture.

CO4 : Estimate hardness of water.

CO5 : Prepare Glucosazone derivative from dextrose.

CO6 : Operate instruments like conductometer and colorimeter.

CO7 : Estimate different metal ions by complexometric method.

CO8 : Draw various analytical tools with respect to principles, construction and its uses.

CO9 : Discuss construction and working of spectral equipment such as spectrophotometer.

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Curriculum:

Paper	Title	Learning points	No. of Hours
I	Physical and Inorganic Chemistry	1. To verify Ostwald's dilution law for weak acid conductometrically. 2. To determine dissociation constant of weak acid conductometrically. 3. To determine the critical solution temperature (CST) of phenol - Water System. 4. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate. 5. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants 6. To determine solubility of sparingly soluble salts (any two) conductometrically. 7. Identification of cations in a given	**36**

		mixture and Analytically separating them [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)] 8. Crystallisation of potassium iodate and to estimate its purity before and after the separation.	
II:	Inorganic and Organic Chemistry	1. Estimation of total hardness 2. Investigation of the reaction between copper sulphate and sodium hydroxide (standard EDTA solution to be provided to the learner). **3. Preparation of :** i. Cyclohexanone-oxime from cyclohexanone. ii. Glucosazone from dextrose or fructose iii. Tribromoaniline from aniline. iv. m-Dinitrobenzene from nitrobenzene v. Phthalic anhydride from phthalic acid by sublimation vi. Acetanilide from aniline vii. p-Bromoacetanilide from acetanilide viii. Iodoform from acetone (Any seven preparations)	**36**

III:	Analytical Chemistry	**1. Tools of Analytical Chemistry-I:** a) Analytical glass wares like burettes, pipettes, Standard flasks, 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, Descicators, Vacuum descicators e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes (The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a) and principle, construction and uses of items (b) to (e) in his journal. **2.** Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error. (The learner is expected to know the role of the various reagents/chemicals used in the estimation, various steps involved. They should write the complete and balanced chemical reaction for the formation of the $[Ni(DMG)_2]$ complex. **3.** Colorimetric Determination of Copper Ions in given Solution by	**36**

		using calibration curve method and calculation of % error. (The learner is expected to learn the relation between concentration and Absorbance, to draw a calibration curve, use the slope of the calibration curve and compare it with the calculated slope. They are also expected to state the error estimate of their results). **4.** Gravimetric estimation of sulfate as $BaSO_4$ and calculation of % error. (The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.) **5.** Estimation of Aspirin **6.** Gravimetric estimation of barium ions using K_2CrO_4 as precipitant calculation of % error. (The learner is expected to learn the skills of using the counterpoise technique used in this gravimetric estimation; Using counterpoise method Whatmann No. 42 for filtration. In such a case no incineration or use of silica crucible is required. They are also expected to state the error estimate of their results)	

References:

1. Khosla B. D., Garg V. C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J. W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A. M. and McBane G. C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V. D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)
5. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
6. Mann, F.G. and Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
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8. Furniss, B. S., Hannaford, A. J., Smith, P.W.G., Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
9. Vogel, A. I., Tatchell, A. R., Furnis, B. S., Hannaford, A. J. and Smith, P. W. G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996
10. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th Edn., Chapter 15, pp. 345-381.
11. A. I. Vogel. “Textbook of Quantitative Inorganic Analysis,” Longman, London (1961).
12. R. V. Dilts. “Analytical Chemistry. Methods of Separation,” van Nostrand, N.Y. (1974).
13. Some Experiments for B. Tech in Chemistry and Chemical Technology compiled by Prof. J. B. Batruah, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi.

Evaluation Pattern: Practical

A) Internal Assessment: 40% (60 Marks)

Paper No.	Performance during practical	Interaction /Viva	Journal	Total Marks
I	05	05	10	20
II	05	05	10	20
III	05	05	10	20
	15	**15**	**30**	**60**

B) Semester End Examination: 60% (90 Marks)

Paper	Experimental work
I	**30**
II	**30**
III	**30**
Total	**90**

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	Physical, Inorganic and Organic Chemistry II
Course Code	USCH401
Class	S.Y.B.Sc. Chemistry
Semester	IV
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--

Nomenclature: Physical and Inorganic Chemistry II

Course Outcomes:

After successful completion of this course learners are able to

CO1 : Learn in depth concepts about electrochemistry.

CO2 : Clarify the concept of Electrochemical conventions, Reversible and irreversible cells.

CO3 : Apply electrochemical conventions.

CO4 : Explain transition elements with respect to electronic configuration, oxidation state, color, magnetism etc.

CO5 : Discuss the role of transition elements in coordination compounds and its formation.

CO6 : Illustrate application of coordination compounds.

CO7 : Study of carboxylic acids and its derivatives.

CO8 : Discuss interconversion of carboxylic acids to its derivatives and vice versa.

CO9 : Explain Mechanism of Claisen condensation.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I :Physical Chemistry	Electrochemistry – II and Phase Equilibria	**Electrochemistry – II (8L)** 1.1.1 Electrochemical conventions, Reversible and irreversible cells. 1.1.2 Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected). 1.1.3 Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. (Numericals expected) 1.1.4 Calculation of equilibrium constant from EMF data. (Numericals expected) 1.1.5 Concentration cells with transference and without transference. Liquid junction potential and salt bridge. 1.1.6 pH determination using hydrogen electrode and quinhydrone electrode.(Numericals expected)	**15**

		1.2 Phase Equilibria: (7L) 1.2.1 Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. 1.2.2 Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. (numericals expected) 1.2.3 Phase diagrams of one-component systems (water and sulphur). 1.2.4 Two component systems involving eutectics, congruent and incongruent melting points (lead-silver system).	
II : Inorganic Chemistry	Comparative Chemistry of the transition metals and Coordination Chemistry	**2.1 Comparative Chemistry of the transition metals (9L)** **2.1.1** Position in the periodic table; Natural occurrence principal ores and minerals; **2.1.2** Significance of special stability of ^{d0}, d^5 and d^{10} leading to variable oxidation states; Unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium, and chromium.) **2.1.3** Origin of colour for transition metals and their compounds: such as reflectivity, surface coatings, particle size, packing density for metals and nature of d-orbitals, number of electrons in the d-orbitals, geometry, and ability for charge transfer). **2.1.4** Magnetic properties of transition metal compounds: Origin of magnetism, spin and orbital motion of electrons; equation for spin only and spin-orbital magnetism in terms of Bohr magnetons (No derivation of relevant equations expected); Reasons for quenching of orbital moments. **2.1.5** Chemistry of Titanium and vanadium: properties of Oxides and chlorides; use in titrimetric analysis	**15**

		2.1.6 Qualitative tests for transition metal ions: General considerations in devising tests (with reference to Chromium, Manganese, iron, Cobalt Nickel and Copper) **2.2 Coordination Chemistry : (6L)** **2.2.1 Introduction to Chemistry of Coordination Compounds** i. Historical perspectives: Early ideas on coordination compounds ii. Basic terms and nomenclature. iii. Types of ligands iv. Isomerism : General Types with special reference to stereoisomerism of coordination compounds (C.N=6) v. Evidence for the formation of coordination compounds, **2.2.2. Theories of coordination compounds** i. Werner's Theory of coordination compounds, ii. Effective atomic number rule. iii. Eighteen electron Rule **2.2.3. Nature of the Metal-Ligand Bond:** i. Valence Bond Theory: Hybridisation of the central metal orbitals-sp^3, sd^3/d^3s sp^3d^2/d^2sp^3, sp^2d, ii. Inner and outer orbital complexes of .(suitable examples of Mn(II) Fe(II), Fe(III), Co(II)/Co(III), Ni(II), Cu(II) Zn(II) complexes with ligands like aqua, ammonia CN- and halides may be used) iii. Limitations of V.B.T **2.2.4.** Application of coordination compounds.	

III : Organic Chemistry	Carboxylic Acids and their Derivatives, Sulphonic acid	**3.1 Carboxylic Acids and their Derivatives : (11 L)** 3.1.1. Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids. 3.1.2. Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis of nitriles. 3.1.3. Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylic acids with $LiAlH_4$, diborane, Hell-Volhard – Zelinsky reaction, Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity. 3.1.4. Mechanism of nucleophilic acyl substitution and acid-catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution. 3.1.5. Mechanism of Claisen condensation and Dieckmann condensation. **3.2 Sulphonic acids: [4L]** Nomenclature, preparation of aromatic sulphonic acids by sulphonation of benzene (with mechanism), toluene and naphthalene, Reactions: Acidity of arene sulfonic acid, Comparative acidity of carboxylic acid and sulfonic acids. Salt formation, desulphonation. Reaction with alcohol, phosphorous pentachloride, IPSO substitution.	**15**

Name of the Course	Physical, Inorganic and Organic Chemistry II
Course Code	USCH402
Class	S.Y.B.Sc. Chemistry
Semester	IV
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--

Nomenclature: Physical, Inorganic and Organic Chemistry II

Course Outcomes:

After successful completion of this course learners are able to

CO1 : Understand the law's of crystallography

CO2 : Derive Bragg's equation.

CO3 : Explain mechanism of acid – base catalyzed reaction and effect of pH.

CO4 : Discuss acid-base theory with respect to inorganic cations and anions.

CO5 : Describe environmental aspects of volatile oxides and oxyacids.

CO6 : Understand Latimer Equation.

CO7 : Study of aromatic amines, its preparations and reactions.

CO8 : Predict products, interpret and propose mechanism involved in different types of aliphatic and aromatic amines.

CO9 : Classify the heterocyclic compounds.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I :Physical Chemistry	**Solid State, Catalysis**	**1.1 Solid State: (7L)** 1.1.1 Recapitulation of laws of crystallography and types of crystals 1.1.2 Characteristics of simple cubic, face centered cubic and body centered cubic systems, interplanar distance in cubic lattice (only expression for ratio of interplanar distances are expected) 1.1.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected), X-rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected) **1.2 Catalysis: (8L)** 1.2.1 Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation 1.2.2 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH.	**15**

		1.2.3 Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis - Menten equation) 1.2.4 Effect of particle size and efficiency of nanoparticles as catalyst	
II : Inorganic Chemistry	Ions in aqueous medium and Uses and Environmental Chemistry of volatile Oxides and oxo-acids	**2 Ions in aqueous medium (10L)** 2.1. Acidity of Cations and Basicity of Anions i. Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radious. ii. Latimer Equation. Relationship between pKa, acidity and z^2/r ratios of metal ions graphical Presentation iii. Classification of cations on the basis of acidity category – Non acidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples iv. Hydration of Anions; Effect of Charge and Radius; Hydration of anions- concept, diagram classification on the basis of basicity **2.2. Uses and Environmental Chemistry of volatile Oxides and oxo-acids (5L)** i. Physical properties of concentrated oxo-acids like Sulphuric, Nitric and Phosphoric acid ii. Uses and environments aspects of these acids	**15**
III : Organic Chemistry	Amines, Diazonium salts, Heterocyclic compounds	**Nitrogen containing compounds and heterocyclic compounds:** **3.1 Amines : (4L)** Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines; 3.1.1. Preparation: Reduction of aromatic nitro compounds using catalytic hydrogenation, chemical reduction using Fe-HCI, Sn-HCl, Zn-acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination , Hofmann bromamide reaction.	**15** **5**

		3.1.2. Reactions- Salt Formation, N-acylation, N-alkylation, Hofmann's exhaustive methylation (HEM),Hofmann-elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation. **3.2 Diazonium Salts**: **(3L)** Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Gomberg reaction, Replacement of diazo group by -H,-OH. Azo coupling with phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine and hydroazobenzene **3.3 Heterocyclic Compounds: (8L)** 3.3.1. Classification, nomenclature, electronic structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; 3.3.2. Synthesis of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), 3.3.3. Reactivity of furan, pyrrole and thiophene towards electrophilic substitution reactions on the basis of stability of intermediate and of pyridine on the basis of electron distribution. Reactivity of pyridine towards nucleophilic substitution on the basis of electron distribution. 3.3.4. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, Ring opening. Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole and pyrrolidine. 3.3.5. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of	

		pyridine (with and without catalyst), reduction and action of sodamide (Chichibabin reaction).	

References:

Physical Chemistry:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. and Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd. New Delhi (2009).
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6. K. L. Kapoor A textbook of Physical Chemistry3rd Ed. vol.1, 2 Macmillan Publishing Co., New Delhi (2001).

Inorganic Chemistry:

1. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972).
2. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002.
3. Quantitative Analysis – R. A. Day, A.L. Underwood, sixth edition.
4. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar.
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6. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
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8. Chemistry of Transition Elements Pg. - 608 – 679.
9. J. D. Lee, 4^{th} Edn. Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359-648.
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12. C. N. R. Rao edited, University General Chemistry, 513-578.
13. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity.,
14. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
15. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.

Organic Chemistry:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J., Greeves, N., Warren, S., Wothers, P., Organic Chemistry, Oxford University Press.
6. Graham Solomons, T.W. Organic Chemistry, John Wiley and Sons, Inc.
7. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek Barton, W. David Ollis.
8. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
9. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
10. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.

Name of the Course	Analytical Chemistry II
Course Code	USCH403
Class	S.Y.B.Sc.(Chemistry)
Semester	IV
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--

Nomenclature: Basics in Analytical Chemistry

Course Outcomes:

On successful completion of this course learners will be able to:

CO1 : Understand the Analytical Separations and its importance in analysis.

CO2 : Explain the various separation techniques viz. paper chromatography, thin layer chromatography.

CO3 : Understand the separation method based on Gravity- Centrifugation, volatility- Distillation, Electrical effects-Electrophoresis etc.

CO4 : Discuss application in acid-base titration.

CO5 : Understand construction, working and handling of instruments like conductometer, pH meter and potentiomenter.

CO6 : Illustrate graphical methods for end point determination.

CO7 : Understand the true and acceptable value of a result of analysis.

CO8 : Calculate central tendency: mean, median, mode, average of data.

CO9 : Apply Q test, 2.5d and 4 d rules for deciding rejection / retention of doubtful Value from the data.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I: Separation techniques in Analytical Chemistry	Separation techniques in Analytical Chemistry	**1. Separation Techniques in Analytical Chemistry (2L)** **1.1.** An Introduction to Analytical Separations and its importance in analysis. **1.2.** Estimation of an analyte without effecting separation. **1.3.** Types of separation methods **1.3.1.** Based on Solubilities (Precipitation, Filtration Crystallisation) **1.3.2.** Based on Gravity- Centrifugation **1.3.3.** Based on volatility-Distillation ; **1.3.4.** Based on Electrical effects-Electrophoresis **1.3.5.** Based on retention capacity of a Stationary Phase -Chromatography; **1.3.6.** Based on distribution in two immiscible phases-Solvent Extraction; **1.3.7.** Based on capacity to exchange with a resin-Ion Exchange; **1.4. Electrophoresis (2L):** Principles, Basic Instrumentation, Working and Application in separation of biomolecules like enzymes and DNA. **1.5. Solvent extraction (6L)** 1.5.1. Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient. 1.5.2. Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH. 1.5.3. Single step and multistep extraction, Percentage extraction for single step and multistep extraction. Separation factor. 1.5.4. Batch and continuous extraction	**15**

		1.6. Chromatography : **(5L)** 1.6.1. Introduction to Chromatography 1.6.2. Classification of chromatographic methods based on stationary and mobile phase 1.6.3. Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations. 1.6.4. Thin layer Chromatography Principle, technique and Applications in determining the purity of a given solute; Following progress of a given reaction.	
II: Instrumental techniques in chemical analysis	Instrumental Methods-II	2. Instruments based on the electrochemical properties of the analytes **(5L)** 2.1. Potentiometry: 2.1.1. Principle. 2.1.2. Role of Reference and indicator electrodes 2.1.3. Applications in Neutralisation reactions with reference to the titration of a Strong acid against a Strong Base (using quinhydrone electrode) 2.1.4. Graphical methods for detection of end points 2.2. pHmetry : **(4L)** 2.2.1. Principle 2.2.2. Types of pH meters. 2.2.3. Principle, Construction Working and Care of Combined Glass electrode 2.2.4. Applications in Titrimetry (Strong acid-Strong Base) biological and environmental analysis. 2.3. Conductometry: **(6L)** 2.3.1. Principle 2.3.2. Conductivity cell its construction and care 2.3.3. Applications in Neutralisation Titrimetry with respect to i. Strong Acid-Strong Base ii. Strong Acid-Weak Base iii. Strong Base-weak Acid iv. Weak Acid- Weak Base**.**	**15**

		2.3.4. Advantages and limitations of conductometric titrations.	
III: Statistical methods in Chemical analysis	Statistical Treatment of analytical data - II	3.1.**Nature of Indeterminate Errors: (3L)** 3.1.1. The true and acceptable value of a result of analysis 3.1.2. Measures of central tendency: mean, median. mode, average 3.1.3. Measures of dispersion: Absolute deviation, relative deviation, relative average deviation, standard deviation,(s, sigma) variance, coefficient of variation 3.2.**Distribution of random errors: (2L)** 3.2.1. Gaussian distribution curve. 3.2.2. Equation and salient features of Gaussian distribution curve **3.3.Concept of Confidence limits and confidence interval and its computation using (3L)** (i) Population standard deviation (ii) Student's *t* test (iii) Range **3.4.Criteria for rejection of doubtful result (2L)** (i) 2.5 d rule (ii) 4.0 d rule (iii) Q test **3.5.Test of Significance (2L)** (i) Null hypothesis (ii) F-test (variance ratio test) **3.6. Graphical representation of data and obtaining best fitting straight line (3L)** (a) For line passing through origin (b) For line not passing through origin [Numerical problems wherever possible, expected]	**15**

References:

Analytical Chemistry:

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch.
2. Instrumental methods of analysis by Willard, H.H., Merritt, L.L. Jr., Dean, J.A., Settle, 7^{th} Edition.
3. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch.
4. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education.
5. Skoog et al. "Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition, Chapter 13, 14 and 15.
6. Day and Underwood, "Quantitative analysis" prentice hall 1991, chapter 3.
7. S.M. Khopkar, "Basic Concepts of Analytical Chemistry", II^{nd} Edition New Age International Publisher.
8. Gary D. Christan," Analytical Chemistry", VI^{th} Edition, Wiley Students Edition, Chapter No 8,9,10.
9. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch.
10. Modern Analytical Chemistry, David Harvey (page numbers 232 -265).
11. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal, Sham K. Anand pp 2.107-2.148.
12. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp 143-172.
13. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7^{th} Edition pp 118-181.

Evaluation Pattern:

A) Continuous Evaluation (40%) : 40 Marks

Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
Assignment / seminar / class test / worksheets	15
Attendance and active participation in classroom	05

B) Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
3. Descriptive type of questions, derivation-based questions, problem solving / numericals based questions, etc., will contain internal options.

Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I, II, III	15 (5 Marks each unit)
2	I	15
3	II	15
4	III	15

CIE	SEE	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	Chemistry Practical IV
Course Code	USCHP4
Class	S.Y.B. Sc.
Semester	IV
No of Credits	03
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--

Practical:

Course Outcomes:

After Completion of the course Lerner will able to

CO1 : Design Danniel cell and determine standard emf.

CO2 : Estimate amount of strong HCl potentiometrically.

CO3 : Use of microscale technique to prepare Ni-DMG complex.

CO4 : Use of PFHS technique to prepare Ca / Mg Oxalate complex.

CO5 : Qualitative analysis to identify organic substance of different chemical nature containing C H (O), C H (O) N, C H (O) N S, C H (O), X element

CO6 : Use of various analytical tools in quantitative analysis.

CO7 : Estimate Fe (II) ions potentiometrically and strong acid conductometrially.

Paper	Title	Learning points	No.of Hours
I:	Physical and Inorganic Chemistry	1. To determine standard EMF and the standard free energy change of Daniel cell potentiometrically. 2. To determine the amount of HCl in the given sample potentiometrically. 3. Compare the strengths of HCl and H_2SO_4 by studying kinetics of acid hydrolysis of methyl acetate. 4. Inorganic preparation – Nickel dimethyl glyoxime using microscale method. 5. Complex cation – *Tris* (ethylene diamine) nickel (II) thiosulphate. 6. Industrial visit report	**36**
II:	Inorganic and Organic Chemistry	**Inorganic Preparations :** 1. Complex preparation of Hexammine nickel (II) sulphate / chloride. 2. Inorganic salt – Calcium or magnesium oxalate using PFHS technique **Qualitative Analysis of bi-functional organic compounds** on the basis of 1. Preliminary examination 2. Solubility 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 to be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halides.	**36**

III:	Analytical Chemistry	1. **Tools of 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 (The learner should draw diagrams and write-ups providing uses of the items mentioned in (a and b) and Principle, Construction care and Uses of items (c) to (f) in his journal.) 2. **Paper chromatography:** Separation of cations like Fe(III), Ni(II) and Cu(II) in a sample. 3. 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 separating funnel, method to estimate the concentrations of the solute distributed in the two immiscible phases, determination of the extraction efficiency) 4. **Conductometric titration**: Estimation of given	**36**

		acid by conductometric titration with strong base and calculation of % error. (The learner is expected to learn the handling of the conductometer and the conductivity cell, determination of end point by plotting a graph. They are also expected to state the error estimate of their results). 5. Estimation of Fe(II) in the given solution by titrating against $K_2Cr_2O_7$ **potentiometrically** and calculation of % error. (The learner is expected to learn the handling of the potentiometer, use of Platinum electrode and reference electrode like SCE. They will learn to determine end point by plotting a graph. They are also expected to state the error estimate of their results). 6. Determination of buffer capacity of acid buffer and basic buffer. (The learner is expected to learn the use pH meter, standardization of pH meter, use of Henderson's equation and calculation of buffer capacity)	

Minimum 80 percent of practical must be completed in each term

References:

1. Khosla B. D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A. M. and McBane G. C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
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5. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)

6. Mann, F.G. and Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
7. Ahluwalia, V.K. and Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. and Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
8. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
9. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. and Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996
10. D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp. 345-381.
11. A.I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman, London (1961).
12. R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).
13. Some Experiments for B. Tech in Chemistry and Chemical Technology compiled by Prof. J.B.Baruah, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi.

Evaluation Pattern: Practical

A) Internal Assessment: 40% (60 Marks)

Paper No.	Performance during practical	Interaction /Viva	Journal	Total Marks
I	05	05	10	20
II	05	05	10	20
III	05	05	10	20
	15	**15**	**30**	**60**

B) Semester End Examination: 60% (90 Marks)

Paper	Experimental work
I	**30**
II	**30**
III	**30**
Total	**90**

Chairperson

R.E. Society’s

R.P. Gogate College of Arts and Science
&
R.V. Jogalekar College of Commerce
(Autonomous)
Ratnagiri

Syllabus for
T.Y.B.Sc.
(Chemistry)
Semester V & VI
Under Choice Based Credit System (CBCS)

With effect from Academic Year- 2023-2024

Name of Programme	**B.Sc.**
Level	UG
No of Semesters	06
Year of Implementation	**2023-24**
Programme Specific Outcomes (PSO)	Upon completion of this programme students will be able to • Understand the fundamental concepts of theoretical and experimental aspects of physical, organic, inorganic, analytical and allied chemistry subjects. • Explain and clarify the understanding of thermodynamic, spectroscopic, kinetic and quantum models, stereochemistry and mechanism of organic reactions, chemical bonding and structure elucidation, analytical techniques and solving numerical problems. • Correlate and apply the theoretical chemistry knowledge in explaining practical schemes • Solve numerical problems, mechanisms, analytical interpretation using chemistry concepts and knowledge. • Interpret spectroscopic data to identify basic organic compounds • Analyse chemical species qualitatively and quantitatively using appropriate analytical techniques. • Understand and explain the processes needed in domain related industries and write their general aspects. • Apply information related to material safety data sheets (MSDS) needed in various industries. • Adopt reduce, recycle and restore chemicals (3R"s) approach and gain the sense of ethical, social and environmental awareness and responsibility.
Relevance of PSOs to the local, regional, national, and global developmental needs (200 words)	• Graduates with strong chemical knowledge and laboratory skills can support industries, research institutions, and local communities in solving local environmental issues, water purification, waste management, and sustainable resource utilization. • Chemistry graduates can foster economic growth by driving innovation and entrepreneurship. They can contribute to regional research and development initiatives, enhance product quality, and support industries in adopting green practices. Additionally, their expertise in chemical safety and ethics can promote responsible industrial practices and environmental protection, benefiting the region. • A skilled chemistry workforce is essential for the development of key sectors like pharmaceuticals, agriculture, energy, and materials. Graduates can participate in groundbreaking research, contributing to advancements that positively impact society's well-being. Their knowledge of interdisciplinary connections can aid in addressing national challenges, such as climate change, health issues, and sustainable development.

Revised Scheme of Examination
Faculty of Science
(Under-graduate Programmes)
Choice Based Credit System (CBCS)
Scheme of Examination
Bachelor of Science (B.Sc.) Programme

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks and by conducting the Semester End Examinations with 60% marks. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Performance Grading:

Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	0 (Outstanding)
$8.00 \leq 9.00$	$80.0 \leq 90.0$	A+ (Excellent)
$7.00 \leq 8.00$	$70.0 \leq 80.0$	A (Very Good)
$6.00 \leq 7.00$	$60.0 \leq 70.0$	B+ (Good)
$5.50 \leq 6.00$	$55.0 \leq 60.0$	B (Above Average)
$5.00 \leq 5.50$	$50.0 \leq 55.0$	C (Average)
$4.00 \leq 5.00$	$40.0 \leq 50.0$	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

Third Year B.Sc. (CBCS)
Course Structure

Course Code	Semester V	Credits	Course Code	Semester VI	Credits
USCH501	Physical Chemistry	**02**	USCH601	Physical Chemistry	**02**
USCH502	Inorganic Chemistry	**02**	USCH601	Inorganic Chemistry	**02**
USCH503	Organic Chemistry	**02**	USCH601	Organic Chemistry	**02**
USCH504	Analytical Chemistry	**02**	USCH601	Analytical Chemistry	**02**
USCHP501	Physical Chemistry Practical	**02**	USCHP601	Physical Chemistry Practical	**02**
USCHP502	Inorganic Chemistry Practical	**02**	USCHP602	Inorganic Chemistry Practical	**02**
USCHP503	Organic Chemistry Practical	**02**	USCHP603	Organic Chemistry Practical	**02**
USCHP504	Analytical Chemistry Practical	**02**	USCHP604	Analytical Chemistry Practical	**02**
USACDD501	Drugs and Dyes	**02**	USACDD601	Drugs and Dyes	**02**
USACDD5P1	Drugs and Dyes Practical	**02**	USACDD6P2	The Regional Case-Study Project	**02**

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCH501**
Class	T.Y. B.Sc.
Semester	V
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-------

Course Code: USCH501

Nomenclature: Physical Chemistry

Course Outcomes: On completing the course, the student will be able to:

CO1 Comprehend the fundamentals of rotational, vibrational spectroscopy.
CO2 understand principles of Raman spectroscopy and its nature,
CO3 Apply Raoult‟s Law and Clapeyron Equation to study Colligative Properties
CO4 Analyse colligative properties of solutions and correlate these with molar masses of The solutes.
CO5 Understand reaction dynamics.
CO6 Apply collision theory to study reactions
CO7 Differentiate between physical and chemical adsorption; correlate adsorption results on The basis of various adsorption isotherm.

CO8 Correlate adsorption results on the basis of various adsorption isotherms.
CO9 Describe nuclear chemistry concepts of radioactive decay, radioactivity, fission process fusion process.
CO10 Discuss application of radioisotopes as a tracer, Q value of nuclear reaction, Types of reactor.
CO11 Illustrate the principle and working of detectors used for detection and measurement of nuclear radiations.

Curriculum:

Unit	Title	Learning Points	No of Lectures
Unit-I	**1.0 MOLECULAR SPECTROSCOPY**	**1.1 Rotational Spectrum**: Introduction to dipole moment, polarization of a bond, bond moment, molecular structure, Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of internuclear distance and isotopic shift. **1.2 Vibrational spectrum**: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum. **1.3 Vibrational-Rotational spectrum of diatomic molecule**: energy levels, selection rule, nature of spectrum, P and R branch lines. Anharmonic oscillator - energy levels, selection rule, fundamental band, overtones. Application of vibrational-rotational spectrum in determination of force constant and its significance. Infrared spectra of simple molecules like H_2O and CO_2. **1.4 Raman Spectroscopy :** Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion- CO_2 molecule.	**15L**
Unit-II	**2.0 CHEMICAL THERMODYNAMICS**	**2.1.1 Colligative properties:** Vapour pressure and relative lowering of vapour pressure. Measurement of lowering of vapour pressure - Static and Dynamic method. **2.1.2 Solutions of Solid in Liquid:** 2.1.2.1. Elevation in boiling point of a solution, thermodynamic derivation relating elevation in boiling point of the solution and molar mass of non-volatile solute. 2.1.2.2. Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute. Beckmann Method and Rast Method. **2.1.3 Osmotic Pressure:** Introduction, thermodynamic derivation of Van't Hoff	**10L**

	2.2 CHEMICAL KINETICS	equation, Van't Hoff Factor. Measurement of Osmotic Pressure - Berkeley and Hartley's Method, Reverse Osmosis. **2.2.1 Collision theory of reaction rates:** Application of collision theory to 1. Unimolecular reaction Lindemann theory and 2. Bimolecular reaction. (derivation expected for both) 2.2.2 Classification of reactions as slow, fast and ultra -fast. Study of kinetics of fast reactions by Stop flow method and Flash photolysis (No derivation expected).	**5L**
Unit-III	**3.0 NUCLEAR CHEMISTRY**	3.1. **Introduction**: **B**asic terms-radioactive constants (decay constant, half-life and average life) and units of radioactivity 3.2 **Detection and Measurement of Radioactivity:** Types and characteristics of nuclear radiations, behaviour of ion pairs in electric field, detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter. 3.3 **Application of use of radioisotopes as Tracers:** chemical reaction mechanism, age determination - dating by C14. 3.4 **Nuclear reactions**: nuclear transmutation (one example for each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy. 3.5 **Fission Process:** Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. Multiplication factor and critical size or mass of fissionable material, nuclear power reactor and breeder reactor. 3.6 **Fusion Process:** Thermonuclear reactions occurring on stellar bodies and earth.	**15 L**
Unit-IV	**4.1SURFACE CHEMISTRY** **4.2 COLLOIDAL STATE**	4.1.1 **Adsorption:** Physical and Chemical Adsorption, types of adsorption isotherms. Langmuir‟s adsorption isotherm (Postulates and derivation expected). B.E.T. equation for multilayer adsorption, (derivation not expected). Determination of surface area of an adsorbent using B.E.T. equation. 4.2.1 **Introduction to colloids** - Emulsions, Gels and Sols 4.2.2 **Electrical Properties:** Origin of charges on colloidal particles, Concept of electrical double layer, zeta potential, Helmholtz and Stern model. Electro-kinetic phenomena - Electrophoresis, Electro-osmosis, Streaming potential,	**6L**

		Sedimentation potential; Donnan Membrane Equilibrium. 4.2.3 **Colloidal electrolytes :** Introduction, micelle formation, 4.2.3 **Colloidal electrolytes :** Introduction, micelle formation, 4.2.4 **Surfactants:** Classification and applications of surfactants in detergents and food industry.	

References:

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co.Ltd.
2. Physical Chemistry, P.C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkota.
3. Physical Chemistry, R.J. Silbey, and R.A. Alberty, 3rd edition , John Wiley and Sons, Inc [part 1]
4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.
5. Modern Electrochemistry, J.O.M Bockris and A.K.N. Reddy, Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint, 2006 Springer
6. Fundamental of Molecular Spectroscopy, 4th Edn., Colin N Banwell and Elaine M McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.
7. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
8. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford.
9. Physical Chemistry, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt.Ltd. New Delhi.
10. Principles of Physical Chemistry B.R. Puri, L.R. Sharma, M.S. Pathania, VISHAL PUBLISHING Company, 2008.
11. Textbook of Polymer Science, Fred W Bilmeyer, John Wiley and Sons (Asia) Ple. Ltd., Singapore, 2007.
12. Polymer Science, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd., Publishers, 2005.
13. Essentials of Nuclear Chemistry, Arnikar, Hari Jeevan , New Age International (P) Ltd., Publishers, 2011..
14. Chemical Kinetics,K. Laidler, Pearson Education India, 1987

Evaluation Pattern:

A) Continuous Evaluation (40%) : 40 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each.	20
02	Assignment / seminar / class test / worksheets	10
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
Total Marks		**40**

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
3. Descriptive type of questions, derivation-based questions, problem solving/ numerical based questions, etc., will contain internal options.
4. Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I	12
2	II	12
3	III	12
4	IV	12
5	I, II, III, IV	12

CIE/ Internal	SEE	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCHP501**
Class	T.Y. B.Sc.
Semester	V
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-------

Course Code: USCHP501
Nomenclature: Physical Chemistry Practical
Course Outcomes: On completing the course, the student will understand

CO1 The Rast method for determining molar mass of compound.
CO2 Experimental determination of order of reaction by fractional change method.
CO3 validation of Freundlich adsorption isotherm
CO4 Determination of Solubility and Solubility product of Silver Chloride Potentiometrically
CO5 Determination of the velocity constant of alkaline hydrolysis of ethyl acetate by conductometric method.
CO6 The concept of isoelectric point, acidic and basic dissociation constants.

Curriculum:

Unit	Title	Learning Points	No of Credits
Non-Instrumental	**Colligative properties**	To determine the molecular weight of compound by Rast Method	**02**
	Chemical Kinetics	To determine the order between $K_2S_2O_8$ and KI by fractional change method.	
	Surface phenomena	To investigate the adsorption of acetic acid on activated charcoal and test the validity of Freundlich adsorption isotherm.	
Instrumental	**Potentiometry**	To determine the solubility product and solubility of AgCl Potentiometrically using chemical cell.	
	Conductometry	To determine the velocity constant of alkaline hydrolysis of ethyl acetate by conductometric method.	
	pH-metry	To determine acidic and basic dissociation constants of amino acid and hence to calculate isoelectric point.	

References:

1. Practical Physical Chemistry 3rd edition, A.M. Jones and F.E. Prichard,Longman Publications
2. Experiments in Physical Chemistry R.C.Das and B. Behra, TataMc Graw Hill
3. Advanced Practical Physical Chemistry J.B. Yadav, Goel Publication House
4. Advanced Experimental Chemistry Vol I J.N. Gurtu, and R. Kapoor, S Chandand Co.
5. Experimental Physical Chemistry l By V.D. Athavale
6. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and A. Gulati, R Chand and Company 2011.S

Evaluation Pattern: Practical Total Marks : 50

A) CIE/ Internal Assessment: 40 % (20 Marks)

Sr.No.	Particulars	Marks
01	Performance during practical session, Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Method	Marks
1.	Instrumental / Non instrumental experiment	Experiment performance as per the practical slip	40
2.	Viva Voce and Journal		05 + 05
Total			**50**

Marks in SEE practical examination will be converted into 30 marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCH502**
Class	T.Y. B.Sc.
Semester	V
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-----

Course Code: USCH502

Nomenclature: Inorganic Chemistry

Course Outcomes: After completion of the course student will able to

CO1 Identify the elements of symmetry.
CO2 Assign point groups to molecules.
CO3 Apply Molecular Orbital theory to polyatomic molecules
CO4 Depict structure of solids and their defects.
CO5 Explain Superconductivity and its applications
CO6 Understand occurrence, extraction, and separation of lanthanides by Ion Exchange method and (ii) Solvent extraction method.
CO7 Study Chemistry of non-aqueous solvents.
CO8 Explain Electronic configurations and allotropy of Group 16 elements.
CO9 Study chemistry of interhalogens.

Curriculum:

Unit	Title	Learning Points	No of Lectures
Unit I	**Molecular Symmetry and Chemical Bonding**	**1.1 Molecular Symmetry: (6L)** 1.1.1 Introduction and Importance of Symmetry in Chemistry. 1.1.2 Symmetry elements and Symmetry operations. 1.1.3 Concept of a Point Group with illustrations using the following point groups :(i)$C_{\infty V}$ (ii) $D_{\infty h}$ (iii) C_{2V} (iv) C_{3v} (v)C_{2h} and (vi)D_{3h}. **1.2 Molecular Orbital Theory for heteronuclear diatomic molecules and polyatomic species: (9L)** 1.2.1 Comparison between homonuclear and heteronuclear diatomic molecules. 1.2.2 Heteronuclear diatomic molecules like CO, NO and HCl. 1.2.3 Molecular orbital theory for H_3 and H_3^+ (correlation diagram expected). 1.2.4 Molecular shape to molecular orbital approach in AB_2 molecules. Application of symmetry concepts for linear and angular species considering σ-bonding only. (Examples like: i) BeH_2, ii) H_2O).	**15L**
Unit II	**Solid State Chemistry**	**2.1 Structures of Solids: (11L)** 2.2.1 Explanation of terms viz. crystal lattice, lattice point, unit cell and lattice constants. 2.1.2 Closest packing of rigid spheres (hcp, ccp), packing density in simple cubic, bcc and fcc lattices. Relationship between density, radius of unit cell and lattice parameters. 2.1.3 Stoichiometric Point defects in solids (discussion on Frenkel and Schottky defects expected). **2.2 Superconductivity: (4L)** 2.2.1 Discovery of superconductivity. Explanation of terms like superconductivity, transition temperature, Meissner effect. 2.2.2 Different types of super conductors viz.conventional superconductors, alkali metal fullerides, high temperature super conductors. 2.2.3 Brief application of superconductors.	**15L**

Unit III	**Chemistry Of Inner Transition Elements**	**3.0 Introduction:** **3.1** Position in periodic table and electronic configuration of lanthanides and actinides. **3.2 Chemistry of Lanthanides with reference to** (i) lanthanide contraction and its consequences(ii) Oxidation states (iii) Ability to form complexes (iv) Magnetic and spectral properties **3.3** Occurrence, extraction and separation of lanthanides by (i) Ion Exchange method and (ii) Solvent extraction method (Principles and technique) **3.4** Applications of lanthanides	**15L**
Unit IV	**Some Selected Topics**	**4.1 Chemistry of Non-aqueous Solvents (5 L)** 4.1.1 Classification of solvents and importance of non-aqueous solvents. 4.1.2 Characteristics and study of liquid ammonia, dinitrogen tetra oxide as non-aqueous solvents with respect to: (i) acid-base reactions and (ii) redox reactions. **4.2 Comparative Chemistry of Group 16 (5L)** 4.2.1 Electronic configurations, trends in physical properties, allotropy 4.2.2 Manufacture of sulphuric acid by Contact process. **4.3 Comparative Chemistry of Group 17 (5L)** 4.3.1Electronic configuration , General characteristics, anomalous properties of fluorine, comparative study of acidity of oxyacids of chlorine w.r.t acidity, oxidizing properties and structures(on the basis of VSEPR theory) 4.3.2 Chemistry of interhalogens with reference to preparations, properties and structures (on the basis of VSEPR theory).	**15L**

References:

1. Per Jensen and Philip R. Bunker , Fundamentals of Molecular Symmetry , Series in Chemical Physics, Taylor and Francis Group
2. J. S. Ogden, Introduction to Molecular Symmetry, Oxford University Press
3. Derek W. Smith, Molecular orbital theory in inorganic chemistry Publisher: Cambridge University Press
4. C. J. Ballhausen, Carl Johan Ballhausen, Harry B. Gray Molecular Orbital Theory: An Introductory Lecture Note and Reprint Volume Frontiers in chemistry Publisher W.A. Benjamin, 1965

5. Jack Barrett and Mounir A Malati, Fundamentals of Inorganic Chemistry, Affiliated East west Press Pvt. Ltd., New Delhi.
6. Satya Prakash, G.D.Tuli, R.D. Madan , , Advanced Inorganic Chemistry.S. Chand and Co Ltd.
7. Lesley E. Smart, Elaine A. Moore Solid State Chemistry: An Introduction, 2nd Edition CRC Press,
8. C. N. R. Rao Advances in Solid State Chemistry
9. R.G. Sharma Superconductivity: Basics and Applications to Magnets
10. Michael Tinkham ,Introduction to Superconductivity: Vol I (Dover Books on Physics)
11. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India.
12. Richard Harwood, Chemistry, Cambridge University Press,
13. Satya Prakash, G.D.Tuli, R.D. Madan , , Advanced Inorganic Chemistry. S .Chand and Co Ltd .
14. Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th Edition.
15. Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth Heinemann. 1997.
16. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
17. G. Singh, Chemistry of Lanthanides and Actinides, Discovery Publishing House
18. Simon Cotton , Lanthanide and Actinide Chemistry Publisher: Wiley-Blackwell
19. B. H. Mahan, University Chemistry, Narosa publishing.
20. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India.
21. J. D. Lee, Concise Inorganic Chemistry, 4thEdn., ELBS,
22. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press.
23. Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th Edition.
24. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt,.Ltd. (2002).
25. Richard Harwood, Chemistry, chapter 10 Industrial inorganic chemistry
26. Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth Heinemann. 1997.
27. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993
28. Satya Prakash, G.D.Tuli, R.D. Madan, Advanced Inorganic Chemistry. S. Chand and Co Ltd 2004.

Evaluation Pattern:

A) Continuous Evaluation (40%) : 40 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
02	Assignment / seminar / class test / worksheets	10
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
Total		**40**

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
2. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.
4. Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I	12
2	II	12
3	III	12
4	IV	12
5	I, II, III, IV	12

CIE/ Internal	SEE	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCHP502**
Class	T.Y. B.Sc.
Semester	V
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

Course Code: USCHP502

Nomenclature: Inorganic Chemistry Practical

Course Outcomes: After completion of the course student will able to

CO1 Acquire skills to prepare Potassium diaquobis- (oxalato)cuprate (II)

CO2 Acquire skills to prepare Ferrous ethylene diammonium sulphate

CO3 Acquire skills to prepare bisacetylacetonatocopper(II)

CO4 Detect impurity in salt qualitatively.

CO5 Determine % purity of given salt

Curriculum:

Unit	Title	Learning Points	No of Cfredits
Non-Instrumental	Inorganic preparations	1. Preparation of Potassium diaquobis-(oxalato)cuprate (II) 2. Preparation of Ferrous ethylene diammonium sulphate. 3. Preparation of bisacetylacetonatocopper(II)	**02**
Non-Instrumental	Estimation And Qualitative Analysis	**Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests).** (Any three salts of transition metal ions)	

References:

1. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.
2. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U. N. Dhur and Sons Pvt Ltd .
3. Vogel's. Text book of. Macro and Semi micro qualitative inorganic analysis. Fifth edition.

Evaluation Pattern: Practical Total Marks: 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Method	Marks
1.	Instrumental / Non instrumental experiment	Experiment performance as per the practical slip	40
2.	Viva Voce + Journal		05 + 05
Total			**50**

Marks in SEE practical examination will be converted into 30 marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCH503**
Class	T.Y. B.Sc.
Semester	V
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

Course Code: USCH503

Nomenclature: Organic Chemistry

Course Outcomes: After studying this course, the learner will be able to:

CO1 Apply fundamentals of Organic Reaction Mechanism to various reactions.

CO2 Identify and Classify Pericyclic reactions.

CO3 Explain Jablonski diagram relating to photochemical phenomenon.

CO4 Discuss the various photochemical reactions.
CO5 Predict Molecular Chirality.
CO6 Define and differentiate between agrochemicals and understand their scope and significance.
CO7 Assign IUPAC names to spiro, bicyclo and heterocyclic compounds.

CO8 Extend green chemistry principles in organic chemistry and justify its applications in practical implementation

CO9 Explain the principle of spectroscopic methods (UV, Mass spectroscopy) and infer the different phenomenon involved in it.

CO10 Understand the fundamental concepts of natural products viz terpenoids, alkaloids and Hormones.

Curriculum:

Unit	Title	Learning Points	No of Lectures
Unit-I	**1.1 Mechanism of organic reactions**	1.1.1 The basic terms and concepts: bond fission, reaction intermediates, electrophiles and nucleophiles, ligand, base, electrophilicity vs. acidity and nucleophilicity vs basicity. 1.1.2 Neighbouring group participation in nucleophilic substitution reactions**:** participation of lone pair of electrons, kinetics and stereochemical outcome. 1.1.3 Acyl nucleophilic substitution (Tetrahedral mechanism): Acid catalyzed esterification of Carboxylic acids (AAC2) and base promoted hydrolysis of esters (BAC2). 1.1.4 Pericyclic reactions, classification and nomenclature 1.1.4.1 Electro cyclic reactions (ring opening and ring closing), cycloaddition, sigma tropic Rearrangement, group transfer reactions, cheletropic reaction (definition and one example of each type) 1.1.4.2 Pyrolytic elimination: Cope, Chugaev, pyrolysis of acetates	**10L**
	1.2 Photochemistry	1.2.1 Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triplet states, allowed and forbidden transitions, fate of excited molecules, Photosensitization. 1.2.2 Photochemical reactions of olefins: photoisomerization, photochemical rearrangement of 1,4-dienes (di- π methane) 1.2.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages. Photo reduction (e.g.benzophenone to benzpinacol)	**5L**
Unit-II	**2.1 Stereochemistry I**	2.1.1 Molecular chirality and elements of symmetry: Mirror plane symmetry, inversion center, roation -reflection (alternating) axis. 2.1.2 Chirality of compounds without a stereo genic center: cummulenes and biphenyls.	**5L**
	2.2Agrochemicals	2.2.1 General introduction and scope, meaning and examples of insecticides, herbicides, fungicide, rodenticide, pesticides, plant growth regulators. 2.2.2 Advantages and disadvantages of agrochemicals 2.2.3 Synthesis and application of IAA (Indole Acetic Acid) and Endosulphan, 2.2.4 Bio pesticides – Neem oil and Karanj oil.	**4L**

	2.3 Heterocyclic chemistry	2.3.1 Reactivity of pyridine-N-oxide, quinoline and iso-quionoline. 2.3.2 Preparation of pyridine-N-oxide, quinoline (Skraup synthesis) and iso-quinoline (Bischler-Napieralski synthesis). 2.3.3 Reactions of pyridine-N-oxide: halogenation, nitration and reaction with $NaNH_2$/liq.NH_3,n-BuLi. 2.3.4 Reactions of quinoline and isoquinoline; oxidation,reduction,nitration,halogenation and reaction with $NaNH_2$/liq.NH_3,n-BuLi.	**6L**
Unit-III	**3.1 IUPAC**	IUPAC Systematic nomenclature of the following classes of compounds (including compounds upto two substituents / functional groups): 3.1.1 Bicyclic compounds – spiro, fused and bridged (upto 11 carbon atoms) – saturated and unsaturated compounds. 3.1.2 Biphenyls 3.1.3 Cummulenes with upto 3 double bonds 3.1.4 Quinolines and isoquinolines	**5L**
	3.2 Synthesis of organic compounds	3.2.1 Introduction: Linear and convergent synthesis, criteria for an ideal synthesis, concept of chemo selectivity and regioselectivity with examples, calculation of yields. 3.2.2 Multicomponent Synthesis: Mannich reaction and Biginelli reaction. Synthesis with examples (no mechanism) 3.2.3 Green chemistry and synthesis: Introduction: Twelveprinciples of green chemistry, concept of atom economy and E-factor, calculations and their significance, numerical examples. i) Green reagents: dimethyl carbonate. ii) Green starting materials : D-glucose iii) Green solvents : supercritical CO_2 iv) Green catalysts: Bio catalysts. 3.2.4 Planning of organic synthesis i) synthesis of nitroanilines. (*oandp*) ii) synthesis of halobenzoic acid.(*oandp*) iii) Alcohols (primary / secondary / tertiary) using Grignard reagents. iv) Alkanes (using organo lithium compounds)	**10L**
Unit-IV	**4.1 Spectroscopy I**	4.1.1 Introduction: Electromagnetic spectrum, units of wavelength and frequency 4.1.2 UV – Visible spectroscopy: Basic theory, solvents, nature of UV-Visible spectrum, concept of chromophore, auxochrome, bathochromic and hypsochromic shifts, hyperchromic and hypochromic effects, chromophore-chromophore and chromophore-	**5L**

		auxochrome interactions. 4.1.3 Mass spectrometry: Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, nitrogen rule, rule of 13 for determination of empirical formula and molecular formula. Fragmentation of alkanes and aliphatic carbonyl compounds.	
	4.2 Natural Products	4.2.1. Terpenoids: Introduction, Isoprene rule, special isoprene rule and the gem-dialkyl rule. 4.2.2 Citral: a) Structural determination of citral. b) Synthesis of citral from methyl heptenone c) Isomerism in citral. (cis and trans form). 4.2.3. Alkaloids Introduction and occurrence. Hofmann's exhaustive methylation and degradation in**:** simple open chain and N – substituted monocyclic amines. 4.2.4 Nicotine: a) Structural determination of nicotine. (Pinner's work included) b) Synthesis of nicotine from nicotinic acid c) Harmful effects of nicotine. 4.2.5 Hormones: Introduction, structure of adrenaline (epinephrine), physiological action of adrenaline. Synthesis of adrenaline from a) Catechol b) p-hydroxybenzaldehyde(Ott's synthesis)	**10L**

References:

1. A guidebook to mechanism in Organic Chemistry, 6**th** edition, Peter Sykes, Pearson education, New Delhi
2. Organic Reaction Mechanism, 4th edition, V. K. Ahluwalia, R. K. Parashar, Narosa Publication.
3. Organic reactions and their mechanisms,3rd revised edition, P.S. Kalsi, New Age International Publishers.
4. M.B.Smith and J. March, Advanced organic chemistry- reactions mechanism and structure, 5th edition.
5. Organic Chemistry, 7th Edition, R.T. Morrison, R. N. Boyd and S. K. Bhattacharjee, Pearson.
6. Organic chemistry,8th edition, John Mc Murry
7. L. Eliel , stereochemistry of carbon compounds, Tata McGraw Hill
8. Stereochemistry P.S.Kalsi , New Age International Ltd.,4th Edition
9. Stereochemistry by Nassipuri.
10. Insecticides and pesticides: Saxena A. B., Anmol publication.
11. Growth regulators in Agriculture and Horticulture: Amarjit Basra, CRC press 2000.
12. Agrochemicals and pesticides: A.Jadhav and T.V.Sathe.
13. Name Reactions in Heterocyclic Chemistry, Jie-Jack Li, Wiley-Interscience publications, 2005.

14. Handbook of Heterocyclic Chemistry, 2nd Edition, Alan R. Katritzky and Alexander F. Pozharskii, Elsevier Science Ltd, 2000.
15. Heterocyclic Chemistry, 5th Edition, John A. Joule and Keith Mills, Wiley publication, 2010.
16. Heterocyclic chemistry, 3rd Edition, Thomas L. Gilchrist, Pearson Education, 2007.
17. Nomenclature of Organic Chemistry**:** IUPAC recommendations and preferred Names 2013, RSC publication.
18. IUPAC nomenclature by S.C.Pal.
19. Green chemistry an introductory text : Mike Lancaster.
20. Green chemistry: V. K. Ahluwalia (Narosa publishing house pvt. ltd.)
21. Green chemistry an introductory text : RSC publishing.
22. New trends in green chemistry V. K. Ahluwalia , M. Kidwai, Klumer Academic publisher
23. Green chemistry by V. Kumar.
24. Organic chemistry: Francis Carey
25. Organic chemistry: Carey and Sundberg.
26. Organic spectroscopy (Second edition),Jag Mohan ,Narosa publication
27. Spectroscopy, Pavia, Lampman, Kriz,Vyvyan.
28. Elementary organic spectroscopy (Third edition), Y.R.Sharma, S.Chand publication..
29. Introduction to spectroscopy (third edition), Pavia ,Lampman,Kriz,john vondeling,Emily Barrosse.
30. Organic chemistry Paula Y. Bruice, Pearson education.
31. Spectral identification of organic molecules by Silverstein.
32. Absorption spectroscopy of organic molecules by V.M.Parikh.
33. Chemistry of natural products by Chatwal Anand – Vol I and Vol II
34. Chemistry of natural products by O.P. Agarwal
35. Chemistry of natural products by Meenakshi Sivakumar and Sujata Bhat.
36. Organic chemistry by Morrision and Boyd,7th edition.
37. I.L.Finar,Vol-I and Vol-II, 5th edition.

Evaluation Pattern:

B) Continuous Evaluation (40%) : 40 Marks

Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
Assignment / seminar / project / worksheets / class tests	15
Attendance and active participation in classroom	05
Total	**40**

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.

2. All questions will be compulsory and may be divided into sub-questions.

3. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.

4. Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I	12
2	II	12
3	III	12
4	IV	12
5	I, II, III, IV	12

CIE/ Internal	SEE	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCHP503**
Class	T.Y. B.Sc.
Semester	V
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

Course Code: USCHP503

Nomenclature: Organic Chemistry Practical

Course Outcomes: After studying this course, the learner will be able to:

CO1 Find the chemical type of mixture in the given binary mixture.

CO2 Decide scheme for separation of components using proper reagents.

CO3 Purify separated organic compound using different purification technique.

CO4 Identify Organic compound.

Curriculum:

Title	Learning Points	No of Credits
Separation of Binary solid-solid mixture (2.0 gms mixture to be given).	1. Minimum Six mixtures to be completed by the students.	**02**
	2. Components of the mixture should include water soluble and water insoluble acids (carboxylic acid), water insoluble phenols(2-naphthol, 1-naphthol), water insoluble bases (nitroanilines) , water soluble neutral (thiourea) and water insoluble neutral compounds (anilides, amides, m-DNB, hydrocarbons)	
	3. After correct determination of chemical type, the separating reagent should be decided by the student for separation	
	4. Follow separation scheme with the bulk sample of binary mixture.	
	5. After separation into component A and component B, one component (decided by the examiner) is to be analyzed and identified with m.p..	

References:

1. Practical organic chemistry – A. I. Vogel
2. Practical organic chemistry – H.Middleton.
3. Practical organic chemistry – O.P.Aggarwal.

Evaluation Pattern: Practical Total Marks: 50

1. Internal Assessment: 40 % (20 Marks)

Sr.No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

2. Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Method	Marks
1.	**Separation of Binary solid-solid mixture**	Experiment performance as per the practical slip	40
2.	Viva Voce + Journal		05 + 05
Total			**50**

Marks in SEE practical examination will be converted into 30 marks.

CIE / Internal	SEE	Total
20	**30**	**50**

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCH504**
Class	T.Y.B.Sc
Semester	V
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----

Nomenclature: ANALYTICAL CHEMISTRY

Course Outcomes: On completion of this course the students will be able

CO1	Understand concepts and importance of Quality, Quality control and Quality assurance
CO2	do calculations relating to interconversion concentration
CO3	Elaborate on the need and importance of sampling and the various methods used for sampling of solid, liquids and gases.
CO4	Explain redox titration, redox indicators.
CO5	Explain the theory of matallochrome indicators and different types of EDTA titrations
CO6	Comprehend the principles, instrumentation and applications of Atomic Absorption Spectroscopy, and Flame emission spectroscopy
CO7	Discuss theory of molecular fluorescence and phosphorescence and instrumentation based on it.
CO8	Explain the basic principle of the solvent extraction and Define the terms partition coefficient and distribution ratio .
CO9	Describe Concept of [pH]1/2 and its significance.
CO10	understand principle of Solid phase extraction
CO11	Comprehend the principles, instrumentation and applications of HPLC and HPTLC and differentiate between TLC and HPTLC

Unit	Title	Learning Points	No of Lectures
UNIT I	**INTRODUCTION TO QUALITY CONCEPTS,CHEMICAL CALCULATIONS AND SAMPLING**	**1.1 Quality in Analytical Chemistry** 1.1.1 Concepts of Quality, Quality Control and Quality Assurance 1.1.2 Importance of Quality concepts in Industry 1.1.3 Chemical Standards and Certified Reference Materials; Importance in chemical analysis Quality of material: Various uses grades of laboratory reagents	**4L**
		1.2 Chemical Calculations (Numerical and word problems are expected) 1.2.1 Inter conversion of various concentration units. (Conversion of concentration from one unit to another unit with examples) 1.2.2 Percent composition of elements in chemical compounds	**5L**
		1.3 Sampling 1.3.1 Purpose, significance and difficulties encountered in sampling 1.3.2 Sampling of solids: Sample size – bulk ratio, size to weight ratio, multistage and sequential sampling, size reduction methods, sampling of compact solids, equipment and methods of sampling of compact solids, sampling of particulate solids, methods and equipment used for sampling of particulate solids. 1.3.3 Sampling of liquids: Homogeneous and heterogeneous, Static and flowing liquids. 1.3.4 Sampling of gases: Ambient and stack sampling: Apparatus and methods for sampling of gases. 1.3.5 Collection, preservation and dissolution of the sample.	**6L**
UNIT II	**CLASSICAL METHODS OF ANALYSIS (TITRIMETRY)**	**2.1 Redox Titrations (Numerical and word Problems are expected)** 2.1.1 Introduction 2.1.2 Construction of the titration curves and calculation of E_{system} in aqueous medium in case of: (1) One electron system (2) Multielectron system	**8L**

		2.1.3 Theory of redox indicators, Criteria for selection of an indicator Use of diphenyl amine and ferroin as redox indicators **2.2 Complexometric Titrations** 2.2.1 Introduction, construction of titration curve 2.2.2 Use of EDTA as titrant and its standardisation, absolute and conditional formation constants of metal EDTA complexes, Selectivity of EDTA as a titrant. Factors enhancing selectivity with examples. Advantages and limitations of EDTA as a titrant. 2.2.3 Types of EDTA titrations. 2.2.4 Metallochromic indicators, theory, examples and applications	**7L**
UNIT III	**OPTICAL METHODS**	**3.1 Atomic Spectroscopy: Flame Emission spectroscopy(FES) and Atomic Absorption Spectroscopy(AAS)** 3.1.1 Introduction, Energy level diagrams, Atomic spectra, Absorption and Emission Spectra 3.1.2 Flame Photometry – Principle, Instrumentation (Flame atomizers, types of Burners, Wavelength selectors, Detectors) 3.1.3 Atomic Absorption Spectroscopy – Principle, Instrumentation (Source, Chopper, Flame and Electro thermal Atomiser) 3.1.4 Quantification methods of FES and AAS – Calibration curve method, Standard addition method and Internal standard method. 3.1.5 Comparison between FES and AAS 3.1.6 Applications, Advantages and Limitations **3.2 Molecular Fluorescence and Phosphorescence Spectroscopy** 3.2.1 Introduction and Principle 3.2.2 Relationship of Fluorescence intensity with concentration 3.2.3 Factors affecting Fluorescence and Phosphorescence 3.2.4 Instrumentation and applications 3.2.5 Comparison of Fluorimetry and	**7L** **4L**

		Phosphorimetry 3.2.6 Comparison with Absorption methods **3.3 Turbidimetry and Nephelometry** 3.3.1 Introduction and Principle 3.3.2 Factors affecting scattering of Radiation: Concentration, particle size, wavelength, refractive index 3.3.3 Instrumentation and Applications	**4L**
UNIT IV	**METHODS OF SEPARATION – I**	**4.1 Solvent Extraction** 4.1.1 Factors affecting extraction: Chelation, Ion pair formation and Solvation 4.1.2 Graph of percent extraction versus pH. Concept of [pH]1/2 and its significance (derivation not expected) 4.1.3 Craig‟s counter current extraction: Principle, apparatus and applications 4.1.4 Solid phase extraction: Principle, process and applications with special reference to water and industrial effluent analysis. 4.1.5 Comparison of solid phase extraction and solvent extraction. **4.2 High Performance Liquid chromatography (HPLC)** 4.2.1 Introduction and Principle Instrumentation- components with their significance: Solvent Reservoir, Degassing system, Pumps-(reciprocating pumps, screw driven- syringe type pumps, pneumatic pumps, advantages and disadvantages of each pump), Precolumn, Sample injection system, HPLC Columns, Detectors(UV – Visible detector, Refractive index detector) 4.2.2 Qualitative and Quantitative Applications of HPLC **4.3 High Performance Thin Layer Chromatography (HPTLC)** 4.3.1 Introduction and Principle Stationary phase, Sample application and mobile phase	**6L** **6L** **3L**

		4.3.2 Detectors a) Scanning densitometer- Components. Types of densitometer- b) Single beam and Double beam c) Fluorometric Detector 4.3.3 Advantages, disadvantages and applications 4.3.4 Comparison of TLC and HPTLC	

References:

1. 3000 solved problems in Chemistry, David E.Goldberg,PhD.,Schaums Outline Unit/s: (1.2)
2. A guide to Quality in Analytical Chemistry: An aid to accreditation, CITAC and EURACHEM, (2002), Unit/s (1.1)
3. A premier sampling solids, liquids and gases, Smith Patricia I,American statistical association and the society for industrial and applied mathematics, (2001) Unit/s (1.3)
4. Analytical Chemistry, Gary.D Christan, 5th edition Unit/s (4.1,4.2,4.3)
5. Analytical Chemistry Skoog, West ,Holler,7th Edition: Unit/s (2.1)
6. Analytical Chromatography, Gurdeep R Chatwal, Himalaya Publication Unit/s (4.1,4.2,4.3)
7. Basic Concepts of Analytical Chemistry, by S M Khopkar, new Age International (p) Limited Unit/s (4.1,4.2,4.3)
8. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969 Unit/s (4.1,4.2,4.3)
9. Fundamentals of Analytical Chemistry by Skoog and West , 8th Edition Unit/s (4.1,4.2,4.3)
10. Handbook of quality assurance for the analytical chemistry laboratory, 2ndEdn., James P. DuxVanNostr and Reinhold,1990 Unit/s (1.1)
11. High Performance Thin Layer Chromatography by Dr P.D. Sethi, CBS Publisher and Distribution Unit/s(4.1,4.2,4.3)
12. High Performance Thin Layer Chromatography in Food analysis, by Prem kumar, CBS Publisher and distributer Unit/s (4.1,4.2,4.3)
13. Instrumental methods of Analysis, by Dr Supriya S Mahajan, Popular Prakashan Ltd Unit/s (4.1,4.2,4.3)
14. Instrumental methods Of Analysis, by Willard Merritt Dean, 7thEdition, CBS Publisher and distribution Pvt Ltd Unit/s (3.1,3.2,3.3)
15. Instrumental Methods of Chemical Analysis by B.K. Sharma Goel Publishing House Unit/s (4.1,4.2,4.3)
16. Principles of Instrumental Analysis , 5th Edition, By Skoog, Holler, Nieman Unit/s (4.1,4.2,4.3)(3.1,3.2,3.3)
17. Quality control and Quality assurance in Analytical Chemical Laboratory, Piotr Konieczka and Jacek Namiesnik, CRC press (2018) Unit/s (1.1)
18. Quality in the Analytical Chemistry Laboratory, Elizabeth Prichard, Neil T. Crosby, Florence Elizabeth Prichard, John Wiley and Sons, 1995 Unit/s (1.1)
19. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969 Unit/s (4.1,4.2,4.3)
20. Thin Layer Chromatography, A LAB. Handbook, Egon Stahl, Springer International Student Edition Unit/s (4.1,4.2,4.3)

Evaluation Pattern:

C) Continuous Evaluation (40%) : 40 Marks

Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
Assignment / seminar / project / worksheets / class tests	15
Attendance and active participation in classroom	05
Total	**40**

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
3. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.
4. Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I	12
2	II	12
3	III	12
4	IV	12
5	I, II, III, IV	12

CIE/ Internal	SEE	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc
Course Code	**USCHP504**
Class	T.Y.B.Sc
Semester	V
No of Credits	02
Nature	Practical
Type (applicable to NEP only)	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

CODE: USCHP504

Nomenclature: ANALYTICAL CHEMISTRY

Course Outcomes: On completion of this course the students will be able

CO1 Estimate amount of Fluoride in a sample Spectrophtometrically.

CO2 Estimate % of Magnesium in Talcum Powder complexometrically

CO3 Determine COD of water sample by redox titration method.

CO4 Determine % of Potassium in fertilizer sample using flame photometer.

CO5 Estimate amount of Sulphate in water sample using turbidimeter.

Curriculum:

Unit	Title	Learning Points	No of Credits
Non-Instrumental	**Complexometry**	Estimation of magnesium content in Talcum powder by complexometrically using standardized solution of EDTA	
	Redox Titration	Determination of COD of water sample.	
	Redox Titration	To determine the amount of persulphate in the given sample solution by back titration with standard Fe (II) ammonium sulphate solution.	**02**
Instrumental	**Spectrophotometry**	Spectrophotometric estimation of fluoride.	
	Flame Photometry	To determine potassium content of a Fertilizer by Flame Photometry (Calibration curve method	
	Turbidimetry	To determine the amount of sulphate in given water sample turbidimetrically.	

References:

1. Vogel"s Textbook of Quantitative Chemical Analysis, 5thEdn., G. H. Jeffery, J Bassett, J Memdham and R C Denney, ELBS with Longmann (1989).

2. Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, J.Mendham et.al

3. The chemical analysis of food and food products III edition Morris Jacob

4. The chemical analysis of food by David Pearson and Henry Edward

Evaluation Pattern: Practical Total Marks: 50

1. Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

2. Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Method	Marks
1.	Instrumental / Non instrumental experiment	Experiment performance as per the practical slip	40
2.	Viva Voce + Journal		05+ 05
Total			**50**

Marks in SEE practical examination will be converted into 30 marks.

CIE / Internal	SEE	Total
20	**30**	**50**

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCH601**
Class	T.Y. B.Sc.
Semester	VI
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-------

Course Code: USCH601

Nomenclature: Physical Chemistry

Course Outcomes: On completing the course, the student will be able to:

CO1	Understand the concept of activity and activity coefficient.
CO2	Classify different types of Concentration cells.
CO3	Recognize the concepts of Decomposition potential and Over voltage .
CO4	Classify polymers and determine their various types of molar masses
CO5	Explain Light emitting polymers ,uses of antioxidants, stabilizers, curing agents in a polymer.
CO6	Describe , Concept of operators State function and its significance
CO7	interprets the Schrodinger time-independent wave equation
CO8	Discuss importance of Renewable energy resources.
CO9	Understand the basic concepts of Nuclear Magnetic Resonance and electron spin resonance
CO10	Interpret NMR spectra after acquiring knowledge of its functioning, principle, chemical shift.

Curriculum :

Unit	Title	Learning Points	No of Lectures
Unit-I	**1.1 ELECTRO CHEMISTRY**	1.1.1 **Activity and Activity Coefficient:** Lewis concept, ionic strength, Mean ionic activity and mean ionic activity coefficient of an electrolyte, expression for activities of electrolytes. Debye-Huckel limiting law (No derivation). 1.1.2 **Classification of cells:** Chemical cells and Concentration cells. Chemical cells with and without transference, Electrode Concentration cells, Electrolyte concentration cells with and without transference (derivations are expected),	**7L**
	1.2 APPLIED ELECTRO CHEMISTRY	1.2.1 **Polarization**: concentration polarization and it‟s elimination 1.2.2 **Decomposition Potential and Overvoltage:** Introduction, experimental determination of decomposition potential, factors affecting decomposition potential. Tafel‟s equation for hydrogen overvoltage, experimental determination of over –voltage	**8L**
Unit-II	**2.0 POLYMERS**	2.1 **Basic terms:** macromolecule, monomer, repeat unit, degree of polymerization. 2.2. **Classification of polymers:** Classification based on source, structure, thermal response and physical properties. 2.3. **Molar masses of polymers:** Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity 2.4. **Method of determining molar masses of polymers :** Viscosity method using Ostwald Viscometer. (derivation expected) 2.5. **Light Emitting Polymers:** Introduction, Characteristics, Method of preparation and applications. 2.6. **Antioxidants and Stabilizers:** Antioxidants, Ultraviolet stabilizers, Colourants, Antistatic agents and Curing agents.	**15L**
Unit-III	**3.1 BASICS OF QUANTUM CHEMISTRY**	3.1.1 **Classical mechanics**: Introduction, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect. 3.1.2 **Quantum mechanics:** Introduction, Planck‟s theory of quantization, wave particle duality, de – Broglie‟s equation, Heisenberg‟s uncertainty principle. 3.1.3 **Progressive and standing waves-** Introduction, boundary conditions, Schrodinger‟s time independent wave equation (No derivation	**10L**

	3.2 RENEWABLE ENERGY RESOURCES	expected), interpretation and properties of wave Function. 3.1.4 **Quantum mechanics** : State function and its significance, Concept of operators - definition, addition, subtraction and multiplication of operators, commutative and non - commutative operators, linear operator, Hamiltonian operator, Eigen function and Eigen value. 3.2.1. **Renewable energy resources:** Introduction. 3.2.2 **Solar energy**: Solar cells, Photovoltaic effect, Differences between conductors, semiconductors, insulators and its band gap, Semiconductors as solar energy converters, Silicon solar cell 3.2.3. **Hydrogen:** Fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.	**5L**
Unit-IV	**4.1 NMR - NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY** **4.2 ELECTRON SPIN RESONANCE SPECTROSCOPY**	**4.1.1. Principle** : Nuclear spin, magnetic moment, nuclear „g" factor, energy levels, Larmor precession, Relaxation processes in NMR (spin -spin relaxation and spin - lattice relaxation). **4.1.2. Instrumentation**: NMR Spectrometer **4.2.1. Principle**: fundamental equation, g-value – dimensionless constant or electron g-factor, hyperfine splitting. **4.2.2. Instrumentation**: ESR spectrometer, ESR spectrum of hydrogen and deuterium.	**7L** **8L**

Learning Resources recommended:

1. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co.Ltd.
2. Physical Chemistry, P.C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkota.
3. Physical Chemistry, R.J. Silbey, and R.A. Alberty, 3rd edition , John Wiley and Sons, Inc [part 1]
4. Physical Chemistry, G. Castellan, 3rd edition, 5th Reprint, 1995 Narosa Publishing House.
5. Modern Electrochemistry, J.O.M Bockris and A.K.N. Reddy, Maria Gamboa – Aldeco 2nd Edition, 1st Indian reprint,2006 Springer
6. Fundamental of Molecular Spectroscopy, 4th Edn., Colin N Banwell and Elaine M McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.
7. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
8. The Elements of Physical Chemistry, P.W. Atkins, 2nd Edition, Oxford Universtity Press Oxford.
9. Physical Chemistry, G.K. Vemullapallie, 1997, Prentice Hall of India, Pvt.Ltd. New Delhi.
10. Principles of Physical Chemistry B.R. Puri, L.R. Sharma, M.S. Pathania, VISHAL PUBLISHING Company, 2008.

11. Textbook of Polymer Science, Fred W Bilmeyer, John Wiley and Sons (Asia) Ple. Ltd., Singapore, 2007.
12. Polymer Science, V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd., Publishers, 2005.
13. Essentials of Nuclear Chemistry, Arnikar, Hari Jeevan , New Age International (P) Ltd., Publishers, 2011..
14. Chemical Kinetics, K. Laidler, Pearson Education India, 1987.

Evaluation Pattern:

D) Continuous Evaluation (40%) : 40 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
02	Assignment / seminar / class test / worksheets	10
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
	Total	**40**

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
3. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.
4. Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I	12
2	II	12
3	III	12
4	IV	12
5	I, II, III, IV	12

CIE/ Internal	SEE	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCHP601**
Class	T.Y. B.Sc.
Semester	VI
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

Course Code: USCHP601

Nomenclature: Physical Chemistry Practical

Course Outcomes: On completing the course, the student will able to

CO1 Interpret the order of reaction graphically
CO2 Determine the molecular weight of polymer by viscosity measurement.
CO3 Estimate the amount % of Iodide, bromide,and chloride in mixture of halide Potentiometrically.
CO4 Determine the number of electrons involved in redox reaction Potentiometric ally
CO5 Estimate the amount / % Strong acid and Weak acid in a mixture conductometrically.
CO6 Estimate the amount of Fe(III) in the complex formation with salicylic acid by Static method.

Curriculum:

Unit	Title	Learning Points	No of credits
Non-Instrumental	**Chemical Kinetics**	To interpret the order of reaction graphically from the given experimental data and calculate the specific rate constant. (No fractional order)	**02**
	Viscosity	To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement.	
Instrumental	**Potentiometry**	To determine the amount of iodide, bromide and chloride in the mixture by Potentiometric titration with silver nitrate. To determine the number of electrons in the redox reaction between ferrous ammonium sulphate. and cerric sulphate Potentiometrically.	
	Conductometry	To titrate a mixture of weak acid and strong acid against strong base and estimate the amount of each acid in the mixture conductometrically.	
	Colorimetry	To estimate the amount of Fe(III) in the complex formation with salicylic acid by Static Method.	

Learning Resources recommended:

1. Practical Physical Chemistry 3rd edition, A.M. Jones and F.E. Prichard,Longman Publications
2. Experiments in Physical Chemistry R.C.Das and B. Behra, TataMc Graw Hill
3. Advanced Practical Physical Chemistry J.B. Yadav, Goel Publication House
4. Advanced Experimental Chemistry Vol I J.N. Gurtu, and R. Kapoor, S Chandand Co.
5. Experimental Physical Chemistry l By V.D. Athavale

Evaluation Pattern: Practical Total Marks: 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
	Total	**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Method	Marks
1.	Instrumental / Non instrumental experiment	Experiment performance as per the practical slip	40
2.	Viva Voce		10
Total			**50**

Marks in SEE practical examination will be converted into 30 marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCH602**
Class	T.Y. B.Sc.
Semester	VI
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

Course Code: USCH602

Nomenclature: Inorganic Chemistry

Course Outcomes: After completion of the course student will able to

CO1 Apply Crystal field theory to octahedral complexes.

CO2 Calculate CFSE of complexes, and thus predict stability.

CO3 Construct ligand group orbitals, σ-molecular orbitals for an ML6 complex.

CO4 Study Thermodynamic and Kinetic Stability of Complexes.

CO5 Correlate between electronic configurations and lability of complexes

CO6 Understand General characteristics of various types of organometallic compounds

CO7 Illustrate Synthesis, properties, structure of Ferocene

CO8 Discuss metallurgy of copper.

Curriculum:

Unit	Title	Learning Points	No of Lectures
Unit I	**Theories of the metal-ligand bond (I)**	1.1 Limitations of Valence Bond Theory. 1.2 Crystal Field Theory and effect of crystal field on central metal valence orbitals in various geometries from linear to octahedral(from coordination number 2 to coordination number 6) 1.3 Splitting of *d* orbitals in octahedral, square planar and tetrahedral crystal fields. 1.4 Distortions from the octahedral geometry: (i) effect of ligand field and (ii) Jahn-Teller distortions. 1.5 Crystal field splitting parameters Δ; its calculation and factors affecting it in octahedral complexes, Spectrochemical series. 1.6 Crystal field stabilization energy (CFSE), calculation of CFSE for octahedral complexes with d^0 to d^{10} metal ion configurations. 1.7 Consequences of crystal field splitting on various properties such as ionic radii, hydration energy and enthalpies of formation of metal complexes of the first transition series. 1.8 Limitations of CFT: Evidences for covalence in metal complexes (i) Intensities of d-d transitions, (ii) ESR spectrum of $[IrCl6]^{2-}$ (iii) Nephelauxetic effect.	**15L**
Unit II	**Theories of the metal-ligand bond (II)**	**2.1 Molecular orbital Theory for coordination compounds. (4L)** 2.1.1 Identification of the central metal orbitals and their symmetry suitable for formation of σ bonds with ligand orbitals. 2.1.2 Construction of ligand group orbitals. 2.1.3 Construction of σ-molecular orbitals for an ML6 complex. 2.1.4 Effect of σ-bonding on complexes. 2.1.5 Examples like $[FeF_6]^{-4}$, $[Fe(CN)_6]^{-4}$, $[FeF_6]^{-3}$, $[Fe(CN)_6]^{-3}$, $[CoF_6]^{-3,}$ $[Co(NH_3)_6]^{+3}$ **2.2 Stability of Metal-Complexes (4L)** 2.2.1 Thermodynamic and kinetic perspectives of metal complexes with examples. 2.2.2 Stability constants: stepwise and overall stability constants and their interrelationship. 2.2.3 Factors affecting thermodynamic stability. **2.3 Reactivity of metal complexes. (4L)** 2.3.1 Comparison between Inorganic and organic reactions. 2.3.2 Types of reactions in metal complexes. 2.3.3 Inert and labile complexes: correlation between electronic configurations and lability of complexes. 2.3.4 Ligand substitution reactions: Associative and	**15L**

		Dissociative mechanisms. 2.2.5 Acid hydrolysis, base hydrolysis and anation reactions. **2.4 Electronic Spectra. (3L)** 2.4.1 Origin of electronic spectra 2.4.2 Types of electronic transitions in coordination compounds: intra- ligand, Charge transfer and intra-metal transitions. 2.4.3 Selection rules for electronic transitions. 2.4.4 Electronic configuration and electronic micro states, Terms and Term symbols for transition metal ions, rules for determination of ground state term. 2.4.5 Determination of Terms for p^2 and d^1 electronic configurations.	
Unit III	**Organometallic Chemistry**	**3.1 Organometallic Compounds of main group metal (6L)** 3.1.1 General characteristics of various types of organometallic compounds, viz. ionic, σ-bonded and electron deficient compounds. 3.1.2 General synthetic methods of organometallic compounds: (i) Oxidative-addition, (ii) Metal-metal exchange (transmetallation), (iii) Carbanion-halide exchange, (iv) Metal-hydrogen exchange (metallation) and (v) Methylene insertion reactions. 3.1.3 Some chemical reactions of organometallic compounds: (i) Reactions with oxygen and halogens, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents, (iv) Redistribution reactions and (v) Complex formation reactions. **3.2 Metallocenes (5L)** Introduction, Ferrocene: Synthesis, properties, structure and bonding on the basis of VBT. **3.3 Catalysis (4L)** 3.3.1 Comparison between homogeneous and heterogeneous catalysis 3.3.2 Basic steps involved in homogeneous catalysis 3.3.3 Mechanism of Wilkinson‟s catalyst in hydrogenation of alkenes.	**15L**
Unit IV	**Some Selected Topics**	**4.1 Metallurgy (7L)** 4.1.1 Types of metallurgies, 4.1.2 General steps of metallurgy; Concentration of ore, calcinations, roasting, reduction and refining. 4.1.3 Metallurgy of copper: occurrence, physicochemical principles, Extraction of copper from pyritesand refining by electrolysis. **4.2 Chemistry of Group 18 (5L)** 4.2.1 Historical perspectives 4.2.2 General characteristics and trends in physical and chemical properties 4.2.3 Isolation of noble gases 4.2.4 Compounds of Xenon (oxides and fluorides) with respect to preparation and structure (VSEPR)	**15L**

		4.2.5 Uses of noble gases **4.3 Introduction to Bioinorganic Chemistry. (3L)** 4.3.1Essential and non-essential elements in biological systems. 4.3.2 Biological importance of metal ions such as Na^{+},K^{+},Fe^{+2}/Fe^{+3} and Cu^{+2}(Role of Na^{+} and K^{+} w. r. t ion pump)	

References:

1. Geoffrey A. Lawrance Introduction to Coordination Chemistry John Wiley and Sons.
2. R. K. Sharma Text Book of Coordination Chemistry Discovery Publishing House
3. R. Gopalan , V. Ramalingam Concise Coordination Chemistry , Vikas Publishing House;
4. Shukla P R, Advance Coordination Chemistry , Himalaya Publishing House
5. Glen E. Rodgers, Descriptive Inorganic, Coordination, and Solid-State Chemistry Publisher: Thomson Brooks/Cole
6. Ramesh Kapoor and R.S. Chopra, **Inorganic Chemistry**, R. Chand publishers,
7. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley and Sons, NY,
8. Twigg, Mechanisms of Inorganic and Organometallic Reactions Publisher: Springer
9. R.K. Sharma Inorganic Reaction Mechanisms Discovery Publishing House
10. M. L. Tobe Inorganic Reaction Mechanisms Publisher Nelson, 1972
11. Cotton, Wilkinson, Murillo and Bochmann, Advanced **Inorganic Chemistry**, 6th Edition..
12. H.W. Porterfield, Inorganic Chemistry, Second Edition, Academic Press, 2005
13. Purecell, K.F. and Kotz, J.C., Inorganic Chemistry W.B. Saunders Co. 1977.
14. Robert H. Crabtree ,The Organometallic Chemistry of the Transition Metals, Publication by John Wiley and Sons
15. B D Gupta and Anil J Elias Basic Organometallic Chemistry: Concepts, Syntheses and Applications, University press
16. Ram Charan Mehrotra, Organometallic Chemistry: A Unified Approach, New Age International.
17. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India.
18. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press
19. Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6th Edition.
20. Jack Barrett and Mounir A Malati, Fundamentals of Inorganic Chemistry, Affiliated East west Press Pvt. Ltd., New Delhi.
21. R.Gopalan, Chemistry for undergraduates. Chapter 18. Principles of Metallurgy. (567-591)
22. Puri, Sharma Kalia Inorganic chemistry. Chapter 10, Metals and metallurgy.(328-339)
23. Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth Heinemann. 1997.
24. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
25. Lippard, S.J. and Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
26. Satya Prakash, G. D. Tuli, R.D. Madan , , Advanced Inorganic Chemistry.S. Chand and Co Ltd

Evaluation Pattern:

E) Continuous Evaluation (40%) : 40 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
02	Assignment / seminar / class test / worksheets	10
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
Total		**40**

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.

2. All questions will be compulsory and may be divided into sub-questions.

3. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.

4. Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I	12
2	II	12
3	III	12
4	IV	12
5	I, II, III, IV	12

CIE/ Internal	SEE	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCHP602**
Class	T.Y. B.Sc.
Semester	VI
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

Course Code: USCHP602

Nomenclature: Inorganic Chemistry Practical

Course Outcomes: After completion of the course student will able to

CO1 Acquire skills to prepare Tris(acetylacetonato) iron(III)

CO2 Acquire skills to prepare bis(dimethylglyoximato) nickel(II)

CO3 Acquire skills to prepare potassium trioxalato aluminate (III)

CO4 Detect impurity in salt qualitatively.

CO5 Determine % purity of given salt

Curriculum:

Unit	Title	Learning Points	No of credits
Non-Instrumental	**Inorganic preparations**	1. Preparation of Tris(acetylacetonato) iron(III) 2. Green synthesis of bis(dimethylglyoximato) nickel(II) complex using nickel carbonate and sodium salt of dmg 3. Preparation of potassium trioxalato aluminate (III)	**02**
	Estimation and Qualitative Analysis	Determination of percentage purity of the given water soluble salt and qualitative detection w.r.t added cation and/or anion (qualitative analysis only by wet tests). (Any three salts of main group metal ions)	

References :

1. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.
2. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U. N. Dhur and Sons Pvt Ltd .
3. Vogel's. Text book of. Macro and Semi micro qualitative inorganic analysis. Fifth edition.

Evaluation Pattern: Practical Total Marks: 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Method	Marks
1.	Instrumental / Non instrumental experiment	Experiment performance as per the practical slip	40
2.	Viva Voce + Journal		05 + 05
Total			**50**

Marks in SEE practical examination will be converted into 30 marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	**USCH603**
Class	T.Y. B.Sc.
Semester	VI
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-------------

Course Code: USCH603

Nomenclature: Organic Chemistry

Course Outcomes: After studying this course, the learner will be able to:

CO1 Define and differentiate between stereoselectivity and stereo specificity.

CO2 Apply stereochemistry concepts to addition, substitution reactions

CO3 Understand nature of peptide bond and discuss synthesis of Polypeptides and structure of proteins.

CO4 Explain mechanism of molecular rearrangements.

CO5 Classify carbohydrates and draw conformations of different carbohydrate molecules.

CO6 Study reactions of Glucose and fructose

CO7 Understand and differentiate between various foundational terms in polymer chemistry.

CO8 Elucidate structure of organic compounds based on UV, IR and NMR spectral information.

CO9 Demonstrate knowledge in functional group transformations using catalysts and reagents.

Curriculum:

Unit	Title	Learning Points	No of Lectures
Unit-I	**1.1 Stereochemistry II**	1.1.1 Stereoselectivity and stereo specificity: Idea of enantioselectivity (ee) and diastereoselectivity (de) , Topicity : enantiotopic and diasterotopic atoms, groups and faces. 1.1.2 Stereochemistry of – i) Substitution reactions : SN_1 (reaction of alcohol with thionyl chloride) ii) Elimination reactions: E2–Base induced dehydrohalogenation of 1-bromo-1,2-diphenylpropane. iii) Addition reactions to olefins: a) bromination (electrophilic anti addition) b) syn hydroxylation with OsO4 and KMnO4 c) epoxidation followed by hydrolysis.	**10L**
	1.2 Amino acids and Proteins	**1.2.1** α-Amino acids: General Structure, configuration, and classification based on structure and nutrition. Properties: pH dependency of ionic structure, isoelectric point and zwitter ion. Methods of preparations: Strecker synthesis, Gabriel phthalamide synthesis. **1.2.2** Polypeptides and Proteins: nature of peptide bond. Nomenclature and representation of polypeptides (di-and tri-peptides) with examples Merrifield solid phase polypeptide synthesis. Protiens:general idea of primary,secondary,tertiary and quaternary structure	**5L**
Unit-II	**2.1 Molecular Rearrangements**	Mechanism of the following rearrangements with examples and stereochemistry wherever applicable. 2.1.1 Migration to the electron deficient carbon: Pinacol-pinacolone rearrangement. 2.1.2 Migration to the electron deficient nitrogen: Beckmann rearrangement. 2.1.3 Migration involving a carbanion : Favorski rearrangement. 2.1.4 Name reactions: Michael addition, Wittig reaction.	**5L**
	2.2 Carbohydrates	2.2.1 Introduction: classification, reducing and non-reducing sugars, DL notation 2.2.2 Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides) and Haworth formula (furanose and pyranose forms of pentoses and hexoses)	**10L**

		Interconversion: open chain and Haworth forms of monosaccharides with 5 and 6 carbons. Chair conformation with stereochemistry of D-glucose, Stability of chair form of D-glucose 2.2.3 Stereoisomers of D-glucose: enantiomer, diastereomers, anomers, epimers. 2.2.4 Mutarotation in D-glucose with mechanism 2.2.5 Chain lengthening and shortening reactions: Modified Kiliani-Fischer synthesis (D-arabinose to D-glucose and D-mannose), Wohl method (D-glucose to D-arabinose) 2.2.6 Reactions of D-glucose and D-fructose: (a) Osazone formation (b) reduction: Hi/Ni, NaBH4 (c) oxidation: bromine water, HNO3, HIO4 (d) acetylation (e) methylation:(d) and (e) with cyclic pyranose forms 2.2.7 Glycosides: general structure	
Unit-III	**3.1 Spectroscopy II** **3.2 Nucleic Acids**	**3.1.1** IR Spectroscopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region. **3.1.2** PMR Spectroscopy: Basic theory of PMR, nature of PMR spectrum, chemical shift (δ unit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2) anisotropic effect (with reference to C=C, C≡C, C=O and benzene ring). Spin- spin coupling and coupling constant. application of deuterium exchange technique. application of PMR in structure determination. **3.1.3** Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to IR and PMR: (1) alkanes (2) alkenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) amines (broad regions characteristic of different groups are expected). Problems of structure elucidation of simple organic compounds using individual or combined use of UV-Vis, IR, Mass and NMR spectroscopic technique are expected. (Index of hydrogen deficiency should be the first step in solving the problems). Controlled hydrolysis of nucleic acids. sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structures of nucleic acids (DNA and RNA) including base pairing.	**10L** **5L**

Unit-IV	**4.1 Polymer**	4.1.1 Introduction: terms monomer, polymer, homopolymer, copolymer, thermo plastics and thermosets. 4.1.2 Addition polymers: polyethylene, polypropylene, teflon, polystyrene, PVC, Uses. 4.1.3 Condensation polymers: polyesters, polyamides, polyurethanes, polycarbonates, phenol formaldehyde resins. Uses 4.1.4 Stereochemistry of polymers: Tacticity, mechanism of stereochemical control of polymerization using Ziegler Natta catalysts. 4.1.5 Natural and synthetic rubbers: Polymerisation of isoprene: 1,2 and 1,4 addition (cis and trans), Styrene butadiene copolymer. 4.1.6 Additives to polymers: Plasticisers, stabilizers and fillers. 4.1.7 Biodegradable polymers: Classification and uses. polylactic acid structure, properties and use for packaging and medical purposes. (Note : Identification of monomer in a given polymer and structure of polymer for a given monomer is expected. condition for polymerization is not expected)	**8L**
	4.2 Catalysts and Reagents	Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism). **4.2.1** Catalysts: Catalysts for hydrogenation: a. Raney Nickel b. Pt and PtO2 (C=C, CN, NO2, aromatic ring) c. Pd/C : C=C, COCl→CHO (Rosenmund) d. Lindlar catalyst: alkynes **d.2.2** Reagents**:** a. LiAlH4 (reduction of CO, COOR, CN,NO2) b. NaBH4 (reduction of CO) c. SeO2 (Oxidation of CH2 alpha to CO) d. mCPBA (epoxidation of C=C) e. NBS (allylic and benzylic bromination)	**7L**

References:

1. Refer Stereochemistry –I (Sem-V, Unit-II)
2. Biochemistry, 8th Ed., Jeremy Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto Pub. W. H. Freeman Publishers
3. Lehninger Principles of Biochemistry 7th Ed., David Nelson and Michael Cox, Publisher W. H. Freeman
4. Name Reactions – Jie Jack Li, 4th Edition, Springer Pub.
5. Refer Mechanism of organic reaction (Sem-V, Unit-I)
6. Organic chemistry (fourth edition),G,Marc Loudon,Oxford University press.
7. Introduction to Organic Chemistry (Third edition), Andrew Streitwieser, Jr. Clayton H. Heathcock, Macmilan publishing.
8. Organic chemistry fourth edition, Morrision and Boyd.
9. Introduction to Organic chemistry,John McMurry.
10. Organic chemistry volume-1and2 (fifth and sixth edition) IL Finar.
11. Refer spectroscopy –I, (Sem-V, Unit-IV)
12. Organic chemistry R.T.Morrison and R.N.Boyd, 6th edition, pearson education
13. S.H.Pine, organic chemistry 4th edition. McGraw Hill
14. Polymer chemistry by M.G.Arora, K.Singh.
15. Polymer science – a text book by Ahluwalia and Mishra
16. Introduction to polymer chemistry - R.Seymour, Wiley Interscience.
17. Organic chemistry by Francis Carey – McGrawHill .
18. Organic chemistry by Carey and Sundberg, Part A and B

Evaluation Pattern:

A) Continuous Evaluation (40%): 40 Marks

Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
Assignments / seminar / project / worksheets / class tests	15
Attendance and active participation in classroom	05
Total	**40**

B) Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
3. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.
4. Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I	12
2	II	12
3	III	12
4	IV	12
5	I, II, III, IV	12

CIE/ Internal	SEE	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course code	**USCHP603**
Class	T.Y. B.Sc.
Semester	VI
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----------------

Course Code : USCHP603

Nomenclature: Organic Chemistry Practical

Course Outcomes: After studying this course, the learner will be able to:

CO1 Find the chemical type of mixture in the given binary mixture

CO2 Decide scheme for separation of components using proper reagents.

CO3 Purify separated organic compound using different purification technique.

CO4 Identify Organic compound.

Curriculum:

Title	Learning Points	No of credits
Separation of Binary liquid-liquid and liquid-solid mixture.	1. Minimum Six mixtures to be completed by the students.	**02**
	2. Components of the liq-liq mixture should include volatile liquids like acetone, methylacetate, ethylacetate, isopropylalcohol, ethyl alcohol, EMK and non volatile liquids like chlorobenzene , bromobenzene, aniline, N,N dimethylaniline, acetophenone, nitrobenzene, ethyl benzoate.	
	3. Components of the liq- solid mixture should include volatile liquids like acetone, methylacetate, ethylacetate, ethyl alcohol, IPA, EMK and solids such as water insoluble acids, phenols, bases, neutral.	
	4. A sample of the mixture one ml to be given to the	

	student for detection of the physical type of the mixture.	
	5. After correct determination of physical type, separation of the binary mixture to be carried out by distillation method using micro scale technique.	
	6. After separation into component A and component B, the compound to be identified can be decided by examiner	

References :

1. Practical organic chemistry – A. I. Vogel
2. Practical organic chemistry – H.Middleton.
3. Practical organic chemistry – O.P.Aggarwal

Evaluation Pattern: Practical Total Marks : 50

A) Internal Assessment: 40 % (20 Marks)

Sr.No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Method	Marks
1.	Instrumental / Non instrumental experiment	Experiment performance as per the practical slip	40
2.	Viva Voce + Journal		05+ 05
Total			**50**

Marks in SEE practical examination will be converted into 30 marks.

CIE / Internal	SEE	Total
20	**30**	**50**

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc
Course Code	**USCH604**
Class	T.Y.B.Sc
Semester	VI
No of Credits	02
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--------

COURSE CODE: USCH604

Nomenclature: ANALYTICAL CHEMISTRY

Course Outcomes: On completion of this course the students will be able

CO1 understand basic principle of Polarography, amperometric titration

CO2 explain different terms involved in polarography

CO3 Solve Ilkovic equation for quantitative analysis using polarographic method

CO4 understand theory, principle and instrumentation of Gas Chromatography

CO5 Discuss Ion exchange Chromatography and its applications.

CO6 explain food preservation techniques, determination of boric acid by titrimetry mthod

CO7 understand various constituents in food maerial like tea, coffee, milk

CO8 explain chemical composition in Talcum powder, Deodernts

CO9 understand theory, principle, instrumentation and application of TGA and DTA

CO10 Describe Thermometric titration and its application

CO11 explain need of method validation and its parameters

Curriculum:

Unit	Title	Learning Points	No of Lectures
UNIT I	**ELECTRO ANALYTICAL TECHNIQUES**	**1.1 Polarography (Numerical and word problems are expected)** 1.1.1 Difference between potentiometry and voltammetry, Polarizable and non-polarizable electrodes 1.1.2 Basic principle of polarography H shaped polarographic cell, DME (construction, working, advantages and limitations) 1.1.3 DC polarogram: Terms involved - Residual current, Diffusion current, Limiting current, Half-Wave Potential Role and selection of supporting electrolyte, Interference of oxygen and its removal, polarographic Maxima and Maxima Suppressors Qualitative aspects of Polarography: Half wave potential E1/2, Factors affecting E1/2 Quantitative aspects of polarography: Ilkovic equations: various terms involved in it (No derivation) 1.1.4 Quantification 1) Wave height – Concentration plots (working plots/calibration) 2) Internal standard (pilot ion) method 3) Standard addition method 1.1.5 Applications advantages and limitations **1.2 Amperometric Titrations** 1.2.1 Principle, Rotating Platinum Electrode(Construction, advantages and limitations) 1.2.2 Titration curves with example 1.2.3 Advantages and limitations	**11L** **4L**
UNIT II	**METHODS OF SEPARATION - II**	**2.1 Gas Chromatography (Numerical and word problems are expected)** 2.1.1 Introduction, Principle, Theory and terms involved 2.1.2 Instrumentation: Block diagram and components, types of columns, stationary phases in GSC and GLC, Detectors: TCD, FID, ECD 2.1.3 Qualitative, Quantitative analysis and applications 2.1.4 Comparison between GSC and GLC **2.2 Ion Exchange Chromatography** 2.2.1 Introduction, Principle. 2.2.2 Types of Ion Exchangers , Ideal	**9L** **6L**

		properties of resin 2.2.3 Ion Exchange equilibria and mechanism, selectivity coefficient and separation factor Factors affecting separation of ions 2.2.4 Ion exchange capacity and its determination for cation and anion exchangers. 2.2.5 Applications of Ion Exchange Chromatography with reference to Preparation of demineralized water, Separation of amino acids	
UNIT III	**FOOD AND COSMETICS ANALYSIS**	**3.1 Introduction to food chemistry** 3.1.1 Food processing and preservation: Introduction, need, chemical methods, action of chemicals(sulphur dioxide, boric acid, sodium benzoate, acetic acid, sodium chloride and sugar) and pH control Physical methods (Pasteurization and Irradiation) 3.1.2 Determination of boric acid by titrimetry and sodium benzoate by HPLC. 3.1.3 Study and analysis of food products and detection of adulterants **1)** Milk: Composition and nutrients, types of milk (fat free, organic and lactose milk) Analysis of milk for lactose by Lane Eynon‟s Method **2)** Honey: Composition Analysis of reducing sugars in honey by Coles Ferricyanide method **3)** Tea: Composition, types (green tea and mixed tea) Analysis of Tannin by Lowenthal‟s method **4)** Coffee: Constituents and composition, Role of Chicory, Analysis of caffeine by Bailey Andrew method **3.2 Cosmetics** 3.2.1 Introduction and sensory properties 3.2.2 Study of cosmetic products – **1)** Face powder: Composition Estimation of calcium and magnesium by complexometric titration **2)** Lipstick: Constituents Ash analysis for water soluble salts: borates, carbonates and zinc oxide **3)** Deodorants and Antiperspirants: Constituents, properties Estimation of zinc by gravimetric method.	**10L** **5L**
UNIT IV	**THERMAL METHODS AND ANALYTICAL METHOD VALIDATION**	**4.1 Thermal Methods** 4.1.1 Introduction to various thermal methods (TGA, DTA and Thermometric titration) 4.1.2 **Thermogravimetric Analysis(TGA)** Instrumentation-block diagram,thermobalance (Basic components: balance, furnace,	**12L**

		temperature measurement and control, recorder) Thermogram (TG curve)for$CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$ Factors affecting thermogram- Instrumental factors and Sample characteristics Applications: Determination of drying and ignition temperature range Determination of percent composition of binary mixtures (Estimation of Calcium and Magnesium oxalate) 4.1.3 **Differential Thermal Analysis (DTA):** Principle**,** Instrumentation, and Reference material used Differential thermogram (DTA curve) CaC_2O_4 $.H_2O$ and $CuSO_4.5H_2O$ Applications Comparison between TGA and DTA. 4.1.4 **Thermometric Titrations –** Principle and Instrumentation Thermometric titrations of : 1) HCl v/s NaOH 2) Boric acid v/s NaOH 3) Mixture of Ca^{+2} and Mg^{+2} v/s EDTA 4) Zn^{+2} with Disodium Tartarate**.**	
		4.2 Analytical Method Validation 4.2.1 Introduction and need for validation of a method 4.2.2 Validation Parameters: Specificity, Selectivity, Precision, Linearity, Accuracy and Robustness	**3L**

References :

1. An Advance Dairy chemistry, V 3, P. F. Fox, P. L. H. McSweeney Springer Unit/s (3.1,3.2)
2. Analysis of food and Beverages, George Charalanbous, Academic press 1978 Unit/s (3.1,3.2)
3. Analytical Chemistry of Open Learning(ACOL),James W. Dodd and Kenneth H. Tonge Unit/s (4.1,4.2)
4. Analytical chemistry David Harvey The ,McGraw Hill Companies, Inc. Unit/s (4.1,4.2)
5. Analytical Chemistry, Gary.D Christan, 5th edition Unit/s (2.1,2.2)
6. Analytical chemistry, R. K. Dave. Unit/s (2.1,2.2)
7. Chemical methods of separation, J A Dean, Van Nostrand Reinhold,1969 Unit/s (2.1,2.2)
8. Egyankosh.ac.in/bitstream/123456789/43329/1/Unit-8 Unit/s (1.1,1.2,1.3)
9. Food Analysis, Edited by S. Suzanne Nielsen, Springer Unit/s (3.1,3.2)
10. Food Analysis: Theory and practice, YeshajahuPomeranz, Clifton E. Meloan, Springer Unit/s (3.1,3.2)
11. Formulation and Function of cosmetics, Sa Jellineck Unit/s (3.1,3.2)
12. Fundamentals of Analytical Chemistry, D .A. Skoog and D. M. West and F. J. Holler Holt., Saunders 6th Edition (1992) Unit/s (2.1,2.2)
13. Government of India publications of food drug cosmetic act and rules. Unit/s (3.1,3.2)

14. Harry"s Cosmetology, Longman scientific co. Unit/s (3.1,3.2)
15. High Performance Thin Layer Chromatography in Food analysis, by Prem kumar, CBS Publisher and distributer Unit/s (3.1,3.2)
16. Instrumental methods Of Analysis, by Willard Merritt Dean, 7thEdition, CBS Publisher and distribution Pvt Ltd Unit/s (1.1,1.2,1.3) (4.1,4.2,4.3)
17. Introduction to Polarography and Allied Techniques, By Kamala Zutshi, New Age International, 2006. Unit/s (1.1,1.2,1.3)
18. Modern cosmetics, E. Thomessen Wiley Inter science Unit/s (3.1,3.2) 19. Principles of Instrumental Analysis , 5th Edition, By Skoog, Holler, Nieman Unit/s (4.1,4.2,4.3)
19. Principles of Polarography by Jaroslav Heyrovský , Jaroslav Kůta, 1st Edition, Academic Press, eBook ISBN: 978148326478 Unit/s (1.1,1.2,1.3)
20. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969 Unit/s (2.1,2.2,)

Evaluation Pattern:

A) Continuous Evaluation (40%) : 40 Marks

Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
Assignments / seminar / project / worksheets / class tests	15
Attendance and active participation in classroom	05
Total	**40**

B) Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.

2. All questions will be compulsory and may be divided into sub-questions.

3. Descriptive type of questions, derivation-based questions, problem solving / numerical based questions, etc., will contain internal options.

4. Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I	12
2	II	12
3	III	12
4	IV	12
5	I, II, III, IV	12

CIE/ Internal	SEE	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc
Course Code	**USCHP604**
Class	T.Y.B.Sc
Semester	VI
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-------

COURSE CODE: USCHP604

Nomenclature: ANALYTICAL CHEMISTRY

Course Outcomes: On completion of this course the students will be able

CO1 Estimate chromium content in water sample using spectrophotometer.

CO2 Estimate reducing sugar in honey by Wilstatter method

CO3 Apply Ion exchange chromatographic method for separation of Mg^{+2} and Zn^{+2} ions.

CO4 determine % of Acetic acid in Vinegar sample by potentiometric method

CO5 Estimate amount of Phosphoric acid in Cola sample pH metrically.

Curriculum :

Unit	Title	Learning Points	No of Credits
Non-Instrumental	**Redox Titration**	Estimation of reducing sugar in honey by Willstatter method.	**02**
	Ion Exchange Chromatography	Estimation of Mg^{+2} and Zn^{+2} by anion exchange resin. using an anion exchange resin	
Instrumental	**Spectrophotometry**	Estimation of Chromium in water sample spectrophotometrically by using Diphenyl carbazide.	
	Potentiometry	Estimation of acetic acid in Vinegar sample by using Quinhydrone electrode potentiometrically.	
	pH metry	Determination of phosphoric acid in cola sample pH metrically.	

References:

1. Vogel‟s Textbook of Quantitative Chemical Analysis, 5thEdn., G. H. Jeffery, J Bassett, J Memdham and R C Denney, ELBS with Longmann (1989).
2. Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, J.Mendham et.al
3. The chemical analysis of food and food products III edition Morris Jacob
4. The chemical analysis of food by David Pearson and Henry Edward

Evaluation Pattern: Practical Total Marks : 50

1. Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

2. Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Method	Marks
1.	Instrumental / Non instrumental experiment	Experiment performance as per the practical slip	40
2.	Viva Voce + Journal		05+ 05
Total			**50**

Marks in SEE practical examination will be converted into 30 marks.

CIE / Internal	SEE	Total
20	**30**	**50**

Chairperson

R.P. Gogate College of Arts & Science
&
R.V. Jogalekar College of Commerce, (Autonomous) Ratnagiri

Syllabus for
T.Y.B.Sc.
Chemistry
(Applied Component)
Drugs & Dyes
Semester V & VI
Under Choice Based Credit System
(CBCS)

With Effect from Academic Year 2023-2024

Revised Scheme of Examination
Faculty of Science
(Under-graduate Programmes)
Choice Based Credit System (CBCS)
Scheme of Examination
Bachelor of Science (B.Sc.) Programme

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks and by conducting the Semester End Examinations with 60% marks. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment & Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment& Semester End Examination together.

Performance Grading:

Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	0 (Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+ (Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+ (Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C (Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	USACDD501
Class	T.Y. B.Sc.
Semester	V
No of Credits	02
Nature	Theory
Type	AC
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

Course Code: USACDD501

Nomenclature: Drugs and Dyes

Course Outcomes: On completing the course, the student will be able to:

CO1 : To get comprehensive information about classification, nomenclature and various routs of durg administration.
CO2 : To study the synthesis of different durg intermediates and drugs.
CO3 : To familiarize with the mode of actions of drugs.
CO4 : To be exposed to the applications of analgesics, antipyretics, antidiabetic, anti-inflammatory drugs etc.
CO5 : To study the concept of dyes, its property and nomenclature dyes.
CO6 : To study the concept of natural and synthetic dyes.
CO7 : To familiarize with the types of fibers, application of dyes and how the dyes are attached to them.
CO8 : To study the concept of optical brighteners and their classes.
CO9 : Learn Witt's theory and complementary colour theory.
CO10: To study the relation between colour and chemical compounds.
CO11: To get insight into various commercially important processes such as nitration, sulphonation and diazotization etc.
CO12: To study the synthesis of Dyes intermediate.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**General Introduction to Drugs**	**1.1 General Introduction to Drugs (8L)** 1.1.1 Definition of a drug, sources of drugs, requirements of an ideal drug, classification of drugs (based on therapeutic action), 1.1.2 Nomenclature of drugs: Generic name, Brand name, Systematic name 1.1.3 Definition of the following medicinal terms: Pharmacon, Pharmacology, Pharmacophore, Prodrug, Half-life efficiency, LD_{50}, ED_{50}, GI_{50} Therapeutic Index. 1.1.4 Brief idea of the following terms: Receptors, Agonists, Antagonists, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia. **1.2 Routes of Drug Administration and Dosage Forms (3L)** **1.2.1** Oral and Parenteral routes with advantages and disadvantages. **1.2.2** Formulations & combination formulation, Different dosage forms (including Patches & Adhesives, emphasis on sustained release formulations and enteric coated tablets). **1.3 Pharmacodynamic agents:** A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects. **1.3.1 CNS Drugs: (4L)** Classification based on pharmacological actions: CNS Depressants & CNS Stimulants. Concept of sedation and hypnosis, anaesthesia. • Phenytoin (Hydantoin) • Trimethadione (Oxazolidinediones) (**Synthesis from acetone)** • Alprazolam (Benzodiazepines) • Levetiracetam (Pyrrolidines) • Amphetamine (Phenethylamine) (**Asymmetric synthesis from phenyl acetic acid)** • Chlorpromazine (Phenothiazines)	**15L**
II	**Analgesics, Antipyretics and Anti-inflammatory Drugs.**	**2.1 Analgesics, Antipyretics and Anti-inflammatory Drugs. (4L)** **2.1.1 Analgesics and Antipyretics** • Morphine (Phenanthrene alkaloids) • Tramadol (Cyclohexanols) (**Synthesis from salicylic**	**15L**

		acid) • Aspirin (Salicylates) • Paracetamol (p-Amino phenols) 2.1.2 **Anti-inflammatory Drugs** Mechanism of inflammation and various inflammatory conditions. • Steroids: Prednisolone, Betamethasone • Sodium Diclofenac, Aceclofenac (N- Aryl anthranilic acids) **(Synthesis from 2,6-dichlorodiphenyl amine)** **2.2 Antihistaminic Drugs (2L)** • Diphenhydramine (Ethanol amines) • Cetrizene (Piperazine) (**Synthesis from 4-Chlorobenzhydryl chloride)** • Chlorpheniramine maleate (Ethyl amines) • Pantoprazole (Benzimidazoles) **2.3 Cardiovascular drugs (3L)** Classification based on pharmacological action • Isosorbide dinitrate (Nitrates) • Valsartan (Amino acids) (structure not expected) • Atenolol (Aryloxy propanol amines) (**Synthesis from 3-Hydroxy phenyl acetamide)** • Amlodipine (Pyridines) • Frusemide /Furosemide (Sulfamoyl benzoic acid) • Rosuvastatin (Pyrimidine) **2.4 Antidiabetic Agents (2L)** General idea and types of diabetes; Insulin therapy • Glibenclamide (Sulphonyl ureas) • Metformin (Biguanides) • Dapagliflozin (Pyranose) • Pioglitazone (Thiazolidinediones) (**Synthesis from 2-(5-** **ethylpyridin-2-yl) ethanol)** **2.5 Antiparkinsonism Drugs (2L)** Idea of Parkinson’s disease. • Procyclidine hydrochloride (Pyrrolidines) • Ethopropazine hydrochloride (Phenothiiazines) • Levodopa (Amino acids) (**Synthesis from Vanillin)** **2.6 Drugs for Respiratory System (2L)** General idea of: Expectorants; Mucolytes; Bronchodilators; Decongestants; Antitussives • Ambroxol (Cyclohexanol) (**Synthesis from paracetamol)** • Salbutamol (Phenyl ethyl amines) • Oxymetazoline (Imidazolines) • Codeine Phosphate (Opiates)	

III	**Introduction to the dye-stuff Industry**	**3.1** Introduction to the dye-stuff Industry **(5L)** 3.1.1 Dyes Definition of dyes, requirements of a good dye i.e.Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability. Definition of fastness and its properties and Mordants with examples Explanation of nomenclature or abbreviations of commercial dyes with at least one example suffixes – G, O, R, B, K, L, C, S H, 6B, GK, 6GK, Naming of dyes by colour index (two examples) used in dye industries. 3.1.2 Natural and Synthetic Dyes Natural Dyes: Definition and limitations of natural dyes. Examples and uses of natural dyes w.r.t Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll –**names** of the chief dyeing material/s in each natural dye **[structures not expected]**, Synthetic dyes: Definition of synthetic dyes, primaries and intermediates. Important milestones in the development of synthetic dyes -Emphasis on Name of the Scientist, dyes and the year of the discovery is required. (structure is not expected) **3.2** Substrates for Dyes : Types of fibres **(3L)** 3.2.1 Natural: cellulosic and proteinaceous fibres, examples – wool, silk and cotton structures and names of dyes applied on each of them. 3.2.2 Semi – synthetic: definition and examples [structures not expected] 3.2.3 Synthetic: Nylon, Polyesters and Polyamides structures and names of dyes applied on each of them 3.2.4 Blended fabrics: definition and examples [structures not expected] 3.2.5 Binding forces of dyes on substrate: ionic forces, covalent linkages, hydrogen bonding, vander-walls forces **3.3** Classification of dyes based on applications and dyeing methods **(7L)** 3.3.1 Dyeing methods Basic Operations involved in dyeing process: i. Preparation of fibres ii. Preparation of dyebath iii. Application of dyes iv. Finishing Dyeing Method of Cotton Fibres: (i) Direct dyeing (ii) Vat dyeing (iii) Mordant dyeing (iv) Disperse dyeing 3.3.2 Classification of dyes based on applicability on substrates (examples with structures) (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes – Diazo components; Fast yellow G, Fast	**15L**

		orange R. Coupling components. Naphthol AS, Naphthol ASG (e) Mordant Dyes-Eriochrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, (i) Reactive Dyes- Cibacron Brilliant Red B, 3.3.3 Optical Brighteners: General idea, important characteristics of optical brighteners and their classes [Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthylamide derivatives] general structure of each class.	
IV	**Colour and Chemical Constitution of Dyes**	**4.1 Colour and Chemical Constitution of Dyes (4L)** 4.1.1 Absorption of visible light, Colour of wavelength absorbed, Complementary colour. 4.1.2 Relation between colour and chemical constitution. i. Armstrong theory (quinonoid theory) and its limitations. ii. Witt's Theory: Chromophore, Auxochrome, Bathochromic & Hypsochromic Shift, Hypochromic & Hyperchromic effect iii. Valence Bond theory, comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenzene, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. iv. Molecular Orbital Theory. **4.2 Unit process and Dye Intermediates** **4.2.1 A brief idea of Unit Processes (3L)** Introduction to primaries and intermediates Unit processes: definition and brief ideas of below unit processes: (a) Nitration (b) Sulphonation (c) Halogenation (d) Diazotization: (3 different methods & its importance) (e) Ammonolysis (f) Oxidation NB: Definition, Reagents, Examples of each unit processes mentioned above with reaction conditions (mechanism is not expected) 4.2.2 **Preparation of the Following Intermediates (8L)** Benzene derivatives: Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; sulphanilic acid; o-, m-, p-chloronitrobenzenes; o-, m-, p-nitroanilines; o-, m-, p-phenylene diamines; Naphthol ASG Naphthalene Derivative: Schaeffer acid; Tobias acid; Naphthionic acid; N.W. acid; cleve-6-acid; H-acid; Naphthol AS Anthracene Derivative: 1-Nitroanthraquinone; 1-Aminoanthraquinone Anthraquinone-2-sulphonic acid; Benzanthrone.	**15L**

References:

Units I & II

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger's Medicinal Chemistry, Drug Discovery and Development. Abraham and Rotella. Wiley.
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 &2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey.

Units III & IV:

11. Chemistry of Synthetic Dyes, Vol I – VIII, Venkatraman K., Academic Press 1972.
12. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing
13. Company, NY ,1995.
14. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973.

Evaluation Pattern:

A) Continuous Evaluation (40%) : 40 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
02	Assignment / seminar / class test / worksheets	10
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
	Total Marks	**40**

B) Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numerical examples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
3. Descriptive type of questions, derivation-based questions, problem solving/ numerical based questions, etc., will contain internal options.
4. Question Number one consist of MCQs, fill in the blanks, match the following, true or false, etc., type of questions.

Question Number	Unit	Marks
1	I	12
2	II	12
3	III	12
4	IV	12
5	I, II, III, IV	12

CIE/ Internal	Semester End	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	USACDD5P1
Class	T.Y. B.Sc.
Semester	V
No of Credits	02
Nature	Practical
Type	AC
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

Course Code: USACDD5P1

Nomenclature: Drugs and Dyes Practical

Course Outcomes: On completing the course, the student will be able to:

CO1 : Will gain hands on experience to synthesise aspirin.
CO2 : To get quantitative determination of drug ibuprofen.
CO3 : To learn estimate acid neutralizing capacity of an antacid.
CO4 : Independently separates natural pigments by paper chromatography.
CO5 : To study methylation of beta naphthol.
CO6 : To introduce students to synthesis of a commercial dye.
CO7 : Independently separate mixture of dyes by thin layer chromatography.

Curriculum:

Unit	Title	Learning Points	No of Credits
I	**Estimations**	1. Estimation of Ibuprofen from the commercial tablet (back titrationmethod). 2. Estimation of Acid neutralizing capacity of a drug. 3. Estimation of Tincture iodine from commercial sample.	**02**
II	**Preparations**	4. Preparation of Aspirin from salicylicacid. 5. Preparation of Fluorescein. 6. O-Methylation of β-naphthol 7. Separation of components of natural pigments by paper chromatography (eg: chlorophylls). 8. TLC of a mixture of dyes (safranine- T, Indigo carmine, methylene blue).	

References:

1. Practical organic chemistry – A. I. Vogel
2. Practical organic chemistry – H.Middleton.
3. Practical organic chemistry – O.P.Aggarwal.

Evaluation Pattern: Practical Total Marks : 100

A. CIE/ Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	Performance during practical session Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	30
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	10
Total		**40**

B. Semester End Examination: 60% (30 Marks)

Sr. No.	Title	Experimental work	Journal	Viva	Total
1.	Estimation	40	05	05	50
2.	Preparation	40	05	05	50
Total					**100**

Marks in SEE practical examination will be converted into 60 marks.

CIE/ Internal	Semester End	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	USACDD601
Class	T.Y. B.Sc.
Semester	VI
No of Credits	02
Nature	Theory
Type	AC
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--------

Course Code : USACDD601

Nomenclature: Drugs and Dyes

Course Outcomes: On completing the course, the student will be able to:

CO1 : To study the discovery of drug from different sources.
CO2 : To know the uses and the side effects of certain drugs for various diseases.
CO3 : To study the basic concept of drug designing.
CO4 : To study the different class of chemotherapeutic agents.
CO5 : To study the synthesis of durg intermediate.
CO6 : To study the importance of nanomaterial in medicinal chemistry.
CO7 : To study the classification of dyes based on chemical constitution, its synthesis and applications.
CO8 : To create an awareness of the current concern about the toxicity of dyes and their effect on ecology.
CO9 : To study the non-textile use of dyes.
CO10: To familiarize the students with the application of dyes in medical field.
CO11: To study the concept of pigments.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Drug Discovery, Design and Development**	**1.1 Drug Discovery, Design and Development (6L)** 1.1.1 Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation, Lipinski's rule of 5 1.1.2 Medicinal properties of compounds from Natural Sources: Anti-infective and anticancer properties of Turmeric (Curcumin) 1.1.3 Development of drug: The Pharmacophore identification, modification of structure or functional group, Structure activity relationship (Sulphonamides). 1.1.4 Structure modification to increase potency: Homologation, Chain branching and Extension of the structure. 1.1.5 Computer assisted drug design. **1.2 Drug Metabolism: (3L)** Introduction, Absorption, Distribution, Biotransformation, Excretion Different types of chemical transformation of drugs with specific examples. **1.3 Chemotherapeutic Agents:** Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable. **1.3.1 Antibiotics and antivirals: (2L)** Definition, • Amoxicillin (β-lactum antibiotics) • Cefpodoxime (Cephalosporins) • Doxycycline (Tetracyclines) • Levofloxacin (Quinolones) (**Synthesis from 2,3,4 -Trifluro -1-nitrobenzene)** • Aciclovir/Acyclovir (Purines) 1.3.2 **Antimalarials: (2L)** Types of malaria; Symptoms; Pathological detection during window period (Life cycle of the parasites not to be discussed) • Chloroquine (3-Amino quinolones) • Artemether(Benzodioxepins) **Following combination to be discussed:** Atremether-Lumefantrine (no structure) 1.3.3 **Anthelmintics and AntiFungal agents (2L)** Drugs effective in the treatment of Nematodes and Cestodes infestations. • Diethyl carbamazine (Piperazines) • Albendazole (Benzimidazoles) (**Synthesis from 2-Nitroaniline)**	**15 L**

		• Clotrimazole (Imidazole) • Fluconazole (Triazole) (**Synthesis from 1- Bromo -2,4-difluorobenzene)**	
II		**2.1 Antiamoebic Drugs (1L)** Types of Amoebiasis • Metronidazole, Ornidazole, Tinidazole (Imidazole) Synthesis of Metronidazole from glyoxal by Debus-Radziszewski imidazole synthesis route **Following combination therapy to be discussed:** Ciprofloxacin- Tinidazole **2.2 Antitubercular and Antileprotic Drugs (3L)** Types of Tuberculosis; Symptoms and diagnosis of Tuberculosis. Types of Leprosy. General idea of Antibiotics used in their treatment. • PAS (Amino salicylates) • Isoniazide (Hydrazides) • Pyrazinamide (Pyrazines) • (+) Ethambutol (Aliphatic diamines) (**Synthesis from 1- Nitropropane)** • Dapsone(Sulphonamides) (**Synthesis from 4-Chloronitrobenzene)** • Clofazimine (Phenazines) • Bedaquiline (Quinoline) **Following combination therapy to be discussed:** (i) Rifampin + Ethambutol + Pyrazinamide (ii) Rifampin + Isoniazide + Pyrazinamide **2.3 Anti-Neoplastic Drugs (2L)** Idea of malignancy; Causes of cancer Brief idea of Immuno Stimulants &Immuno depressants • Lomoustine (Nitrosoureas) • Anastrozole(Triazoles) (**Synthesis from 3,5-bis (bromo methyl) toluene)** • Cisplatin (Chloro Platinum) • Vincristine, Vinblastine, Vindesine) (Vinca alkaloids) (structure not expected) **2.4 Anti-HIV Drugs (1L)** Idea of HIV pathogenicity, Symptoms of AIDS • AZT/Zidovudine, Lamivudine,DDI (Purines) **2.5 Drug Intermediates: (2L)** Synthesis and uses 1. 2,3,6-Triamino-6- hydroxypyrimidine from Guanidine 2. p-[2’-(5-Chloro-2-methoxy benzamido) ethyl]-benzenesulphonamide from Methyl-5-chloro-2-methoxybenzene 3. 3-(p-Chlorophenyl)-3- hydroxypiperidine from 3-Chloroacetophenone 4. *p*-Acetyl amino benzenesulphonyl chloride from	**15L**

		Aniline. 5. Epichlorohydrine from propene. **2.6 Nano particles in Medicinal Chemistry (4L)** Introduction; Carbon nano particles (structures) and Carbon nano tubes: • Functionalization for Pharmaceutical applications • Targeted drug delivery • In vaccine (Foot and mouth disease) • Use in Bio-physical treatment. Gold nano particles in treatment of: Cancer; Parkinsonism; Alzheimer. Silver nano particles: Antimicrobial activity. **2.7 Drugs and Environmental Aspects (2L)** • Impact of Pharma-industry on environment, • International regulation for human experimentation with reference to: "The Nuremberg Code" and "The 5. Helsinki Declaration".	
III	**Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes**	**3.1 Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes(12L)** (Synthesis of the dyes marked with * is expected) **i) Nitro Dye**: Naphthol Yellow S **ii) Nitroso Dye**: Gambine Y **iii)Azo dyes:** a) Monoazo dyes: Orange IV *(from sulphanilic acid) & Eriochrome Black T* (from β- naphthol) b) Bisazo dyes: Congo Red* (from nitrobenzene) c) Trisazo Dye: Direct Deep Black EW* (from benzidine) **iv) Diphenylmethane dye**: Auramine O* (from N,N-dimethyl aniline) **v)Triphenylmethane dye**: a) Diamine series: Malachite Green* (from benzaldehyde) b) Triamine series: Acid Magenta c) Phenol series: Rosolic acid **vi) Heterocyclic Dyes**: a) Thiazine dyes: Methylene Blue b) Azine dyes: Safranin T* (from o-toluidine) c) Xanthene Dyes: Eosin* (from phthalic anhydride) d) Oxazine Dyes: Capri Blue e) Acridine Dyes: Acriflavine **vii)Quinone Dyes**: a) Naphthaquinone: Naphthazarin b) Anthraquinone Dyes: Indanthrene Blue* (from anthraquinone) **viii) Indigoid Dyes**: Indigo* (from aniline + monochloroacetic acid) **ix) Phthalocyanine Dyes**: Monastral Fast Blue B **3.2 Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes**	**15L**

		(3L) **3.2.1 Impact of the textile and leather dye Industry on the environment** with special emphasis on water pollution. 3.2.2 **Health Hazards:** Toxicity of dyes w.r.t food colours. 3.2.3 **Effluent Treatment Strategies**: Brief introduction to effluent treatment plants (ETP) Primary Remediation processes:(Physical Processes) Sedimentation, Aeration, Sorption (activated charcoal, fly ashetc.) Secondary Remediation processes: Biological Remediation – Biosorption, bioremediation and biodegradation Chemical Remediation: Oxidation Processes (chlorination), Coagulation-flocculation –Precipitation	
IV	**Non-textile usesof dyes**	**4.1 Non-textile uses of dyes: (8L)** **4.1.1 Biomedical uses of dyes** i) Dyes used in formulations (Tablets, capsules, syrups etc) Indigo carmine, Sunset yellow, Tartrazine ii) Biological staining agents Methylene blue, Crystal violet and Safranine T iii) DNA markers Bromophenol blue, Orange G, Cresol red iv) Dyes as therapeutics Mercurochrome, Acriflavine, Crystal Violet, Prontosil 4.1.2 **Dyes used in food and cosmetics:** i) Properties of dyes used in food and cosmetics ii) Introduction to FDA and FSSAI iii) Commonly used food colours and their limits 4.1.3 **Paper and leather dyes** i) Structural features of paper and leather ii) Dyes applicable to paper and leather 4.1.4 **Miscellaneous dyes** i) Hair dyes ii) Laser dyes iii) Indicators iv) Security inks iv) Coloured smokes and camouflage colours **4.2 Pigments (3L)** Definition of pigments, examples, properties of pigments, difference between dyes and pigments. Definition of Lakes and Toners **4.3 Dyestuff Industry - Indian Perspective (4L)** 4.3.1 Growth and development of the Indian Dyestuff Industry 4.3.2 Strengths, Weaknesses, Opportunities and Challenges of the Dyestuff industry in India Make in India - Future Prospects of the Dye Industry.	**15L**

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1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippmcolt Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson &Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger’s Medicinal Chemistry, Drug Discovery & Development. Abraham & Rotella. Wiley
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 & 2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitsher, Wliey.
11. Text book of drug design and discovery. Povl-Krog-Sgaard-Larsen, Tommy Liljefors and ULF Madsen, 3rd Edition Taylor & Francis.
12. Bio-applications of nanoparticles. Edited by Warren C.W. Chan, Springer Publication.
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14. Nano forms of carbon and its applications. Edited by Maheshwar Sharon and Madhuri Sharon. Monad Nanotech Pvt. Ltd.
15. Environmental Chemistry. A. K. De
16. Text Book on Law and Medicine. Chokhani and Ghormade. 2nd Edition. Hind Law House,Pune.
17. Essentials of Medical Pharmacology. K D Tripathi, Jaypee Brothers Medical publishers Pvt. ltd. Practical organic chemistry, Vogel.

Units III & IV

1. Chemistry of Synthetic Dyes, Vol I – IV, Venkatraman K., Academic Press 1972.
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995.
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973
4. Environmental Studies, Joseph Benny, Tata McGraw Hill Education, 2005
5. Fundamental Concepts of Environmental Chemistry, Sodhi. G. S**.,** Alpha Science International, 2009.
6. Planning Commission, Niti Aayog, FSSAI and FDA websites.
7. Green Chemistry for Dyes Removal from Waste Water- Research Trends and Applications, Ed. Sharma S.K., Wiley, 2015.
8. Environmental Pollution- Monitoring and Control, Khopkar S.M., New Age International (P) Ltd, New Delhi, 1982.

Evaluation Pattern:

A. Continuous Evaluation (40%) : 40 Marks

Sr. No.	Particulars	Marks
01	Unit Test (MCQ / Descriptive – Based on Theory and/or Problems - Online/Offline – 1 unit test of 20 marks / 2 unit tests of 10 marks each .	20
02	Assignment / seminar / class test / worksheets	10
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10
	Total	**40**

B. Semester End Evaluation (Paper Pattern) (60 Marks – 2 hours): 60 Marks

Guidelines for paper pattern for Semester End Evaluation:

1. As far as possible, one fifth weightage of the total should be given to numericalexamples in above paper pattern.
2. All questions will be compulsory and may be divided into sub-questions.
3. Descriptive type of questions, derivation-based questions, problem solving/ numerical based questions, etc., will contain internal options.
4. Question Number one consist of MCQs, fill in the blanks, match the following,true or false, etc., type of questions.

Question Number	Unit	Marks
1	I	12
2	II	12
3	III	12
4	IV	12
5	I, II, III, IV	12

CIE/ Internal	Semester End	Total Marks
40	60	100

Syllabus for B.Sc. Chemistry from the year 2023-24

Name of the Course	B.Sc.
Course Code	USACDD6P2
Class	T.Y. B.Sc.
Semester	VI
No of Credits	02
Nature	Case Study
Type	AC
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

Course Code: USACDD6P2

Nomenclature: The Regional Case-Study Project

Course Outcomes: After completing course, students will be able to:

CO1 : Gain an understanding of rural/urban life, culture and social realities
CO2 : Gain an understanding real-life problems
CO3 : Develop a sense of empathy and bonds of mutuality with local community
CO4 : Learn to value the local knowledge and wisdom of the community
CO5 : Identify opportunities for contributing to community's socio-economic improvement

Curriculum:

Unit	Title	Learning Points	No of Credits
I	**Theory of case study**	• Introduction to case study • What is a case study? • Types of case studies • Planning a Case Study • Researching a Case Study • Strengths and Weaknesses of Case Studies • Writing a Case Study • References	**02**
II	**Case study Project (Field work)**	**Typical Key Areas for field-based project activities:** • Environmental Problems: For example estimation of PAH from soil/sewage samples, estimation of water pollution in nearby locality, estimation of the micro plastics in Soil in the nearby locality, study of solidand liquid waste generation in a Ward/city/village etc. • Analysis of food Material: For example identification and estimation of food Adulterants, estimation of selenium content in bread available in the local market etc. • Soil, Water, material analysis: For example, examination and analysis water quality in nearby locality, study of materials and dyes used in a local industry, conduct soil health test (for analysis of Pb, N, P, K, S, C, moisture content, pH and micronutrient Contents such as Cu, Zn, Mn, Fe) etc. • Study of government development programs: For example effects of Swachh Bharat Abhiyan on the quality of soil and water, to prepare a village sanitation plan, Energy use and fuel efficiency surveys etc. • Agriculture: For example, Organize orientation programmes for farmers regarding organic cultivation, rational use of irrigation and fertilizers and promotion of traditional species of crops and plants etc.	

References:

1. Abramson, P.R. (1992). A Case for Case Studies: An Immigrant's Journal. Newbury Park: Sage.
2. Bassey, M. (1999). Case Study Research in Educational Settings. Buckingham: Open University.
3. Campbell, D.T. & Stanley, J.C. (1966) Experimental and Quasi-experimental Designs for Research. Chicago: Rand McNally.
4. Kazdin, A. E. (1982). Single-case Research Designs: Methods for Clinical and Applied Settings. New York: Oxford Press.
5. Zaidah Zainal, Case study as a research method, JurnalKemanusiaan bil.9, (2007)
6. WALTER ISARD, Methods of Regional Analysis: An Introduction to Regional Science, THE M. I. T. PRESS, Cambridge, Massachusetts, (1960).

Case-Study Project Evaluation:

Project Report:

After successful completion of a case-study project, the student group will prepare a consolidated report covering title, Rational and gap analysis, objectives, hypothesis, project design and methodology, preliminary work/survey, expected out-come, benefits to society (Project outcome), SWOC analysis and important references etc.

Project presentation (by students Group):

The students group will present the case study project at the time of practical examination.

Evolution Pattern:

Evaluation of student based on Part I	20 Marks
Identification of problem, Rational, Problem statement and expected benefits	10 Marks
Case-study design and methodology, Data management and interpretation, , clarity, coherence and appropriateness of case study design, Organization and logical flow of ideas and materials	30 Marks
Presentation skills, role, responsibilities involvement of group members, learning mechanism in group, clear, concise and thoughtful responses to questions, team work.	30 Marks
Major findings and outcome reported, Stakeholders feedback	10 Marks
Total	**100 Marks**

Chairperson

R.E. Society's
R.P. Gogate College of Arts & Science
&
R.V. Jogalekar College of Commerce
(Autonomous)
Ratnagiri
(Affiliated to University of Mumbai)

Syllabus For

M. Sc. I

Chemistry

Semester I and II

Under Choice Based Credit System

(CBCS)

As Per framework of NEP 2020

With effect from Academic Year 2023-2024

Name of Programme	**Masters of Science**
Level	PG
No of Semesters	04
Year of Implementation	**2023-24**
Programme Specific Outcomes (PSO)	At the end of the Programme, Learner will be able to 1. Gain knowledge of the advanced concepts in the branch of chemistry, scrutinize and accomplish a solution to problems encountered in the field of research and analysis. 2. Apply the basic knowledge of chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the global standards. 3. Deduce qualitative and quantitative information of chemical compounds using advanced spectroscopic methods which can further be analysed using practical skills inculcated in them during the course. 4. Imbibe the attitude as well as aptitude of a scientific approach along with analytical reasoning with respect to the novel techniques actually implemented in the Industry. 5. Use the subject knowledge, communication and ICT skills to become an effective team leader/team member in the interdisciplinary fields. 6. Understand, Manage and contribute to solve basic societal issues and environmental concerns ethically based on principles of scientific knowledge gained. 7. Exhibit professional work ethics and norms of scientific development 8. Conduct research projects, utilize appropriate methodologies, and effectively execute projects in the field of science.
Relevance of PSOs to the local, regional, national, and global developmental needs	Post Graduates with strong chemical knowledge and laboratory skills can support industries, research institutions, and local communities in solving local environmental issues, water purification, waste management, and sustainable resource utilization. Chemistry Post Graduates can foster economic growth by driving innovation and entrepreneurship. They can contribute to regional research and development initiatives, enhance product quality, and support industries in adopting green practices. Additionally, their expertise in chemical safety and ethics can promote responsible industrial practices and environmental protection, benefiting the region.

	Chemistry graduates can contribute to addressing pressing global challenges, such as climate change mitigation, renewable energy development, and pollution control. Their research and problem-solving abilities can lead to the discovery of new materials, technologies, and treatments with global applications.

Revised Scheme of Examination
Faculty of Science
(Post-graduate Programmes)
Choice Based Credit System (CBCS)
Scheme of Examination

Master of Science (M.Sc.) Programme

The performance of the learners shall be evaluated into two parts. The learner‟s performance shall be assessed by Internal Assessment with 40% marks and by conducting the Semester End Examinations with 60% marks. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) separately, to pass the course and minimum of Letter Grade “P” in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Performance Grading:

Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	0 (Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+ (Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+ (Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C (Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

Master of Science (M.Sc.) Programme
Under Choice Based Credit System
Course Structure

M.Sc. I

(with effect from Academic Year- 2023-24)

No. of Courses	Semester I	Credits		No. of Courses	Semester II	Credits	
	Major Mandatory				Major Mandatory		
PSCH 101	Inorganic Chemistry-I	04		PSCH 201	Inorganic Chemistry-II	04	
PSCH 102	Organic Chemistry-I	04		PSCH 202	Organic Chemistry-II	04	
PSCH 103	Analytical Chemistry-I	04		PSCH 203	Analytical Chemistry-II	04	
PSCH 104	Chemistry Practical-I (Organic Chemistry and Analytical Chemistry)	02		PSCH 204	Chemistry Practical- (Organic Chemistry and Analytical Chemistry)	02	
	Major Electives				Major Electives		
PSCH 105	Physical Chemistry I	02	04	PSCH 205	Physical Chemistry III	02	04
PSCH 106	Chemistry Practical E-I (Physical and Inorganic Chemistry)	02		PSCH 206	Chemistry Practical E-III (Physical and Inorganic Chemistry)	02	
	OR				OR		
PSCH 107	Physical Chemistry II	02	04	PSCH 207	Physical Chemistry IV	02	04
PSCH 108	Chemistry Practical E-II (Physical and Inorganic Chemistry)	02		PSCH 208	Chemistry Practical E-IV (Physical and Inorganic Chemistry)	02	
PSCH 109	Research Methodology	04		PSCH209	On Job Training/Internship Field Project/Extended Experiment	04	
Total Credits		22		Total Credits		22	

SMART Criteria for Course Outcomes:

Specific: Each course outcome is specific, outlining the knowledge and skills students are expected to acquire in relation to the specific topics covered.

Measurable: Each outcome can be measured through assessments, tests, or projects to determine the level of understanding and proficiency achieved by the students.

Achievable: The outcomes are achievable within the duration of the course, considering the number of lectures allocated to each topic.

Relevant: The outcomes are relevant to the subject of financial services and capital market, addressing important concepts, types, and mechanisms involved.

Time-bound: The outcomes are expected to be achieved by the end of the course, providing a clear timeline for assessment and evaluation.

No. of Courses	Semester I	Credits
	Major: Mandatory	
PSCH 101	Inorganic Chemistry-I	4
PSCH 102	Organic Chemistry-I	4
PSCH 103	Analytical Chemistry-I	4
PSCH 104	Chemistry Practical-I (Organic Chemistry and Analytical Chemistry)	2
	Major: Elective (Any One from below)	
PSCH 105	Physical Chemistry I	4
PSCH 106	Chemistry Practical E-I (Physical and Inorganic Chemistry)	
PSCH 107	Physical Chemistry II	4
PSCH 108	Chemistry Practical E-II (Physical and Inorganic Chemistry)	
PSCH 109	Research Methodology	4
Total Credits		22

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme atSemester I with Effect from the Academic Year 2023-2024

Name of the Course	Inorganic Chemistry-I
Course Code	PSCH101
Class	M.Sc.
Semester	I
No of Credits	4
Nature	Theory
Type	Major: Mandatory-1
Employability/ Entrepreneurship/ Skill Development	Inorganic chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as material science, electronics, ceramics, pharmaceuticals, and environmental science. Entrepreneurs in fields like material science and nanotechnology rely on inorganic chemistry principles to innovate. Thus a course provides Post Graduates with analytical skills, problem solving skills, research capabilities which empower them to pursue a diverse path career.

Inorganic Chemistry-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Chemical Bonding	15
2	Molecular Symmetry and Group Theory	15
3	Materials Chemistry and Nanomaterials	15
4	Characterization of Coordination compounds	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. The learner will know the important fundamental concept of Group Theory, which helps them in understanding the properties and bonding in polyatomic molecules.
2. The learner gets the knowledge about the various techniques used for Characterization coordination compounds.
3. The learners develop the skill in interpretation of the spectra.
4. The learners will get comprehensive idea about established instrumental techniques and significant characterization tools available to study inorganic complexes having wide applications in industries.

Curriculum:

Sr. No.	Modules / Units
1	**Chemical Bonding** **(15 Lectures)**
	1.1 Recapitulation of hybridization Derivation of wave functions for sp, sp^2, sp^3 orbital hybridization types considering only sigma bonding. **1.2** Discussion of involvement of d orbitals in various types of hybridizations. Concept of resonance, resonance energy derivation expected. Formal charge with examples. **1.3** Molecular Orbital Theory for diatomic species of First transition Series. **1.4** Molecular Orbital Theory for Polyatomic species considering σ bonding for SF_6, CO_2, B_2H_6, I_3 - molecular species.

	1.5 Weak forces of attraction: Hydrogen bonding – concept, types, properties, methods of detection and importance. Van der Waal's forces, ion-dipole, dipole-dipole, London forces.
2	**Molecular Symmetry and Group Theory (15 Lectures)**
	2.1 Symmetry criterion of optical activity, symmetry restrictions on dipole moment. A systematic procedure for symmetry classification of molecules. **2.2** Concepts of Groups, Sub-groups, Classes of Symmetry operations, Group Multiplication Tables. Abelian and non-Abelian point groups. **2.3** a) Representation of Groups: Matrix representation of symmetry operations, reducible and irreducible representations. The Great Orthogonality Theorem and its application in construction of character tables for point groups C_{2v}, C_{3v} and C_{2h}, structure of character tables. b) Determination of symmetry species for translations and rotations. c) Mulliken"s notations for irreducible representations. d) Reduction of reducible representations using reduction formula. **2.4** Applications of Group Theory Symmetry adapted linear combinations (SALC), symmetry aspects of MO theory, sigma bonding in AB_n (NH_3, CH_4) molecule.
3	**Materials Chemistry and Nanomaterials (15 Lectures)**
	3.1 Solid State Chemistry : **3.1.1** Electronic structure of solids and band theory, Fermi level, K Space and Brillouin Zones. **3.1.2** Structures of Compounds of the type: AB [nickel arsenide (NiAs)], AB_2 [fluorite (CaF_2) and anti-fluorite structures, rutile (TiO_2) **3.1.3** Solid state lasers: Introduction, Types, Working and Applications **3.2 Nanomaterials :** **3.2.1** Preparative methods, Chemical methods, solvothermal, combustion synthesis, microwave, Co-precipitation, Langmuir-Blodgett (L-B) method, Biological methods, synthesis using microorganism. **3.2.2** Applications in the field of semiconductors, solar cells.
4	**Characterization of Coordination compounds (15 Lectures)**
	4.1 Methods of Characterization: thermal studies, Conductivity measurements, electronic spectral and magnetic measurements, IR, NMR and ESR spectroscopic methods. **4.2** Introduction to Orgel and Tanabe Sugano Diagram, Terms, Splitting of terms in Octahedral weak field, Calculation of electron parameters Δ, β, C and Nephlauxetic ratio with suitable examples. **4.3** Determination of formation constants of metal complexes (Overall and Stepwise): Comparative studies of Potentiometric and spectrophotometric methods.

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Unit I

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.
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12. G. A. Jeffrey, an Introduction to Hydrogen Bonding, Oxford University Press, Inc., 1997.

Unit II

1. F. A. Cotton, Chemical Applications of Group Theory, 2nd Edition, Wiley Eastern Ltd., 1989.
2. H. H. Jaffe and M. Orchin, Symmetry in Chemistry, John Wiley and Sons, New York, 1996.
3. R. L. Carter, Molecular Symmetry and Group Theory, John Wiley and Sons, New York, 1998.
4. K. V. Reddy. Symmetry and Spectroscopy of Molecules, 2nd Edition, New Age International Publishers, New Delhi, 2009.
5. A. Salahuddin Kunju and G. Krishnan, Group Theory and its Applications in Chemistry, PHI Learning, 2012.
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7. S. Swarnalakshmi, T. Saroja and R. M. Ezhilarasi, A Simple Approach to Group Theory in Chemistry, Universities Press, 2008.

Unit III

1. Lesley E. Smart, Elaine A. Moore, Solid State Chemistry Introduction, ISBN 0- 203-49635-3, Taylor and Francis Group, LLC.
2. Catherine Brechignac, Philippe Houdy, Marcel Lahmani, Nanomaterials and Nanochemistry, 2007, ISBN 978-3-540-72992-1 Springer Berlin Heidelberg New York.
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4. Morton Rosoff, Nano-Surface Chemistry, 2001, ISBN: 0-8247-0254-9, Marcel DekkerInc. New York.
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9. M. Grishin, Advances in solid state lasers development and Applications.
10. Walter Koechner, Michael Bass, Springer, Solid state Lasers- A Graduate Text.
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Unit IV

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2. D. Banerjea, Coordination Chemistry.
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5. F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann; Advanced Inorganic Chemistry, 6th ed. Wiley, 1999.
6. B. Douglas, D. McDaniel and J. Alexander. Concepts and Models of InorganicChemistry (3rd Edn.), John Wiley and Sons (1994).

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Organic Chemistry-I
Course Code	PSCH102
Class	M.Sc.
Semester	I
No of Credits	4
Nature	Theory
Type	Major: Mandatory-II
Relevance with Employability/ Entrepreneurship/ Skill development	Organic chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as polymer, pharmaceuticals, petrochemicals, agrochemicals, cosmetics, and environmental science. Understanding Organic reactions and synthesis is essential for designing and creating new compound with specific properties. Learner can apply organic chemistry knowledge to develop innovative products such as specialty chemicals, natural based products to meet specific market demand.

Organic Chemistry-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Physical Organic Chemistry	15
2	Stereochemistry	15
3	Nucleophilic substitution reactions and Aromaticity	15
4	Oxidation and Reduction	15
Total		**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Predict the reactivity of organic compound from its structure.
2. Understand different methods used for determination of Organic Reaction Mechanism.
3. Understand the fundamental concept in stereochemistry by applying various symmetry elements of organic molecule.
4. Acquire the knowledge of chirality by taking examples of symmetrical and unsymmetrical molecule.
5. Develop interest in stereochemistry by studying stereochemical features of different classes of organic compounds.
6. Identify the nomenclature of various stereochemical phenomena
7. Organize the techniques of aromatic nucleophilic substitution reactions for synthesizing/transforming molecules.
8. Understand the concept of aromaticity and to know the nature of bonds, electronic effects and other properties of molecules.
9. Understand the preparation of important oxidizing reagent and predict the selectivity of the reagents in organic reactions.
10. Explain the preparation and uses of important reducing reagents in various organic transformation reactions.

Curriculum:

Sr. No.	Modules / Units
1	**Physical Organic Chemistry** **(15 Lectures)**
	1.1. Thermodynamic and kinetic requirements of a reaction: rate and equilibrium constants, reaction coordinate diagram, transition state (activated complex), nature of activated complex, Hammond postulate, Reactivity vs selectivity, Curtin-Hammett Principle, Microscopic reversibility, Kinetic vs thermodynamic control of organic reactions. **1.2. Determining mechanism of a reaction:** Product analysis, kinetic studies, use of isotopes (Kinetic isotope effect – primary and secondary kinetic isotope effect). Detection and trapping of intermediates, crossover experiments and stereochemical evidence. **1.3. Acids and Bases:** Factors affecting acidity and basicity: Electronegativity and inductive effect, resonance, bond strength, electrostatic effects, hybridization, aromaticity and solvation. Comparative study of acidity and basicity of organic compounds on the basis of pKa values, Leveling effect and non-aqueous solvents. Acid and base catalysis – general and specific catalysis with examples.
2	**Stereochemistry** **(15 Lectures)**
	2.1. Concept of Chirality: Recognition of symmetry elements. **2.2.** Molecules with tri- and tetra-coordinate centers: Compounds with carbon, silicon, nitrogen, phosphorous and sulphur chiral centers, relative configurational stabilities. **2.3. Molecules with two or more chiral centers:** Constitutionally unsymmetrical molecules: erythro-threo and syn-anti systems of nomenclature. Interconversion of Fischer, Sawhorse, Newman and Flying wedge projections. Constitutionally symmetrical molecules with odd and even number of chiral centers: enantiomeric and meso forms, concept of stereogenic, chirotopic, and pseudoasymmetriccentres. R-S nomenclature for chiral centers in acyclic and cyclic compounds. **2.4. Axial and planar chirality:** Principles of axial and planar chirality. Stereo chemical features and configurational descriptors (R, S) for the following classes of compounds: allenes, alkylidene cycloalkanes, spirans, biaryls (buttressing effect) (including BINOLs and BINAPs), ansa compounds, cyclophanes, trans-cyclooctenes. **2.5. Prochirality:** Chiral and prochiral centres; prochiral axis and prochiral plane. Homotopic, heterotopic (enantiotopic and diastereotopic) ligands and faces. Identification using substitution and symmetry criteria. Nomenclature of stereoheterotopic ligands and faces. Symbols for stereoheterotopic ligands in molecules with i) one or more prochiralcentres ii) a chiral as well as a prochiralcentre, iii) a prochiral axis iv) a prochiral plane v) pro-pseudo-asymmetric centre. Symbols for enantiotopic and diastereotopic faces.
3	**Nucleophilic substitution reactions and Aromaticity** **(15 Lectures)**

	3.1. Nucleophilic substitution reactions: (9L) **3.1.1 Aliphatic nucleophilic substitution:** SN^1, SN^2, SN^i reactions, mixed SN^1 and SN^2 and SET mechanisms. SN reactions involving NGP - participation by aryl rings, σ and pi-bonds. Factors affecting these reactions: substrate, nucleophilicity, solvent, steric effect, hard-soft interaction, leaving group. Ambident nucleophiles. SNcA, SN^1 and SN^2 reactions. SN at sp2 (vinylic) carbon. **3.1.2 Aromatic nucleophilic substitution:** S_NAr, S_N1, benzyne mechanisms. Ipso, cine, tele and vicarious substitution. **3.1.3 Ester hydrolysis:** Classification, nomenclature and study of all eight mechanisms of acid and base catalyzed hydrolysis with suitable examples. **3.2. Aromaticity: (6L)** **3.2.1** Huckel‟s (4n+2) and 4n rules, structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. Delocalization and aromaticity. **3.2.2** Aromatic and antiaromatic compounds up-to 18 carbon atoms. Homoaromatic compounds. Aromaticity of all benzenoid systems, heterocycles, metallocenes, azulenes, annulenes, aromatic ions and Fullerene (C60).
4	**Oxidation and Reduction** **(15 Lectures)**
	4.1 Oxidation: General mechanism, selectivity, and important applications of the following: **4.1.1 Dehydrogenation:** Dehydrogenation of C-C bonds including aromatization of six membered rings using metal (Pt, Pd, Ni) and organic reagents (chloranil, DDQ). **4.1.2 Oxidation of alcohols to aldehydes and ketones:** Chromium reagents such as $K_2Cr_2O_7/H_2SO_4$ (Jones reagent), CrO_3-pyridine (Collin‟s reagent), PCC (Corey‟s reagent) and PDC (Cornforth reagent), hypervalent iodine reagents (IBX, Dess-Martin periodinane). DMSO based reagents (Swern oxidation), Corey-Kim oxidation - advantages over Swern and limitations; and Pfitzner-Moffatt oxidation-DCC and DMSO and Oppenauer oxidation. **4.1.3 Oxidation involving C-C bonds cleavage:** Glycols using HIO_4; cycloalkanones using CrO_3; carbon-carbon double bond using ozone, $KMnO_4$, CrO_3, $NaIO_4$ and OsO_4; aromatic rings using RuO_4 and $NaIO_4$. **4.1.4 Oxidation involving replacement of hydrogen by oxygen:** oxidation of CH_2 to CO by SeO_2, oxidation of arylmethanes by CrO_2Cl_2 (Etard oxidation). **4.1.5 Oxidation of aldehydes and ketones:** with H_2O_2 (Dakin reaction), with peroxy acid (Baeyer-Villiger oxidation) **4.2 Reduction:** General mechanism, selectivity, and important applications of the following reducing reagents: **4.2.1 Reduction of CO to CH_2 in aldehydes and ketones**-Clemmensen reduction, Wolff-Kishner reduction and Huang-Minlon modification. **4.2.2 Metal hydride reduction:** Boron reagents ($NaBH_4$, $NaCNBH_3$, diborane, 9-

	BBN, $Na(OAc)_3BH$, aluminium reagents ($LiAlH_4$, DIBAL-H, Red Al, L and K-selectrides). **4.2.3** N_2H_2 (diimide reduction) and other non-metal based agents including organic reducing agents (Hantzschdihydropyridine). **4.2.4 Dissolving metal reductions:** using Zn, Li, Na, and Mg under neutral and acidic conditions, Li/Na-liquid NH3 mediated reduction of aromatic compounds (Birch reduction) and Alkynes.

References:

1. NeilIsaacs, Physical Organic Chemistry.
2. Eric V. Anslynand Dennis A.Dougherty, Modern Physical Organic Chemistry.
3. Barton and Ollis, Comprehensive Organic chemistry, Vol-1.
4. J. Claydens, N. Greeves, S.Warren and P. Wothers, Oxford University Press, Organic Chemistry,
5. F.A. Careyand R.J. Sundberg, Part A and B, Plenum Press, Advanced Organic Chemistry.
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7. E.L Eliel, S.H Wilen and L.N Manden, Wiley, Stereochemistry of carbon compounds,.
8. D. Nasipuri. New International Publishers Ltd, Stereochemistry of Organic Compounds- Principles and Applications.
9. Michael B. Smith, Jerry March, Wiley, March’s Advanced Organic Chemistry: Reactions, Mechanisms and Structure.
10. B. Millerand R. Prasad, Pearson Education, Advanced Organic Chemistry: Reactions and mechanism.
11. R. Bruckner, Academic Press, Advanced Organic Chemistry: Reaction mechanisms.
12. Adams Jacobs, Cambridge University Press, Understanding Organic Reaction Mechanisms.
13. A. Miller, P. H. Solomons,Academic Press, Writing Reaction Mechanism inorganic chemistry.
14. L.G. Wade, Jr., Maya Shankar Singh, Pearson Education, Advanced Organic Chemistry: Reactions and mechanism.
15. Peter sykes, Mechanism in Organic Chemistry, 6th edition onwards.
16. W. Carruthers and Iain Coldham, Cambridge University Press, Modern Methods of Organic Synthesis.
17. Jagdamba Singh, L. D. S. Yadav, Pragati Prakashan, Organic Synthesis.
18. P.S. Kalsi, Organic reactions and their Mechanisms, New Age International Publishers.
19. R.O.C. Norman and J.M. Coxon, Nelson Thornes, Principles of Organic Synthesis.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Analytical Chemistry-I
Course Code	PSCH103
Class	M.Sc.
Semester	I
No of Credits	4
Nature	Theory
Type	Major: Mandatory-III
Relevance with Employability/ Entrepreneurship/ Skill development	Analytical chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as polymer, pharmaceuticals, cement, ceramics, petrochemicals, agrochemicals, cosmetics, and environmental science. Learner can apply Analytical chemistry knowledge to develop and validate analytical method for particular pharmaceutical product. Learner can work as Quality control chemist in Laboratories of various chemical industry. Entrepreneurs can establish analytical testing laboratory that offer services to various industries including QC, environmental analysis.

Analytical Chemistry-I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1.	Language of Analytical Chemistry and Quality in Analytical Chemistry	15
2.	Calculations based on Chemical Principles	15
3.	Optical Methods	15
4.	Instrumental Methods-I	15
Total		**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Understand various terms used in analytical chemistry.
2. Identify the different types of errors in analysis.
3. Sketch out the role and importance of total quality management, safety, accreditations and GLP in industries.
4. Understand the efficacy of automation in chemical analysis.
5. Design and specify applications of advanced analytical techniques in various fields.
6. Explore the applications of IR spectroscopy and thermal methods.
7. Perform basic calculations required in chemical analysis.
8. Interpret the experimental results of analytical technique

Curriculum:

Sr. No.	Modules / Units
1	**Language of Analytical Chemistry and Quality in Analytical Chemistry (15 Lectures)**
	1.1 Language of Analytical Chemistry [8L] **1.1.1 Analytical perspective [3L]** Analytical approach. Common analytical problems. Terms involved in analytical chemistry - Analysis, Analyte, Matrix, Determination, Measurement, Techniques, Methods, Procedures and protocol. **1.1.2 An overview of analytical methods [3L]** Analytical methods - Types, classification and selection. Quantitative method of Analysis- Calibration method, Method of Standard addition, Internal standard method. Performance Characteristics of analytical method- Accuracy, Precision, Selectivity, Sensitivity, Detection limit (LOD, LOQ, LOL), Dynamic range and Robustness and Ruggedness.

	1.1.3 Errors [2 L] Types of errors. Absolute error, Relative error, Constant error and Proportionate errors. Minimization of errors. **1.2 Quality in Analytical Chemistry [7L]** **1.2.1 Total Quality Management- TQM [3L]** Definition, Principles, Importance and benefits. Philosophy of implementation of TQM - Process steps, Advantages and Limitations i) Kaizen -Six steps ii) Six Sigma approach iii) 5S and 5S audit check for laboratories. **1.2.2 Safety in laboratories [2L]** Basic concept of safety in laboratory- The Industrial Hygiene Principles.Personal protection equipment (PPE).Occupational Safety and Health Administration (OSHA). **1.2.3 Accreditations [2L]** Accreditation of laboratories, NABL, Indian Government standards (ISI, HALLMARK, AGMARK). Meaning and significance.
2	**Calculations based on Chemical Principles (15 Lectures)**
	2.1.1 Concentration of a solution based on volume and mass units. **2.1.2** Calculations of ppm, ppb and dilution of the solutions, concept of mmol. **2.1.3** Stoichiometry of chemical reactions, concept of kg /mol, limiting reactant, theoretical and practical yield. **2.1.4** Solubility and solubility equilibria, effect of presence of common ion in solution. **2.1.5** Calculations of pH of acids, bases, acidic and basic buffers. **2.1.6** Concept of formation constants, stability and instability constants, stepwise formation constants. **2.1.7** Oxidation number, rules for assigning oxidation number, redox reaction in term of oxidation number, oxidizing and reducing agents, equivalent weight of oxidizing and reducing agents, stoichiometry of redox titration (Normality of a solution of an oxidizing / reducing agent and its relationship with molarity).
3	**Optical Methods (15 Lectures)**
	3.1 Infrared Absorption Spectroscopy [6L] **3.1.1** Instrumentation: Sources, Sample handling, Transducers, Dispersive, non-dispersive instrument. **3.1.2** Applications of IR [Mid IR, Near IR, Far IR]: Qualitative with emphasis on “Finger print” and Quantitative analysis. **3.1.3** Advantages and Limitations of IR. **3.2 FT Technique [3 L]** **3.2.1** Introduction of Fourier Transform. **3.2.2** Laser as a source of radiation, sample containers. **3.2.3** Detectors, Fiber optics. **3.2.4** FTIR and its advantages. **3.3 Molecular Ultraviolet and Visible Spectroscopy [6L]** **3.3.1** Factors affecting molecular absorption: pH, temperature, solvent and effect of substituents, types of transitions [emphasis on charge transfer absorption]. **3.3.2** Applications of Ultraviolet and Visible spectroscopy: i) On charge transfer

	absorption ii) Simultaneous spectroscopy iii) Derivative Spectroscopy **3.3.3** Dual spectrometry – Introduction, Principle, Instrumentation and Applications.
4	**Instrumental Methods-I (15 Lectures)**
	4.1 Thermal Methods: [9L] **4.1.1** Introduction: Types of thermal methods, comparison between TGA and DTA. **4.1.2** Differential Scanning Calorimetry-Principle, comparison of DTA and DSC. **4.1.3** Instrumentation, Block diagram, Nature of DSC Curve, Factors affecting DSC Curves. **4.1.4** Applications - Heat of reaction, Safety screening, Polymers, liquid crystals, Drug analysis. **4.2 Automation in chemical analysis: [6L]** **4.2.1** Need for automation, Objectives of automation. **4.2.2** An overview of automated instruments. **4.2.3** Process control analysis, flow injection analysis, discrete automated systems, automatic analysis based on multi-layered films, gas monitoring equipments. **4.2.4** Automatic titrators.

References:

Unit I

1. David Harvey, McGraw-Hill, Higher Education, Modern Analytical Chemistry ; (2000).
2. Skoog, Holler and Nieman, Principles of Instrumental Analysis ; 5th Edition, Ch: 1
3. Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, Fundamentals of Analytical Chemistry, 9th Edition, 2004, Ch: 5.
4. J W Robinson, Marcel Dekker, Undergraduate Instrumental Analysis; 6th edition Ch:1.
5. David Hoyle, ISO 9000 Quality Systems Handbook; 4th edition (Chapter: 3 and 4) (Freedownload).
6. Elizabeth Pichard, Wiley India, Quality in the Analytical Laboratory ; Ch: 5, Ch: 6 andCh: 7.
7. Donna C S Summers, Prentice-Hall of India, Quality Management; Ch:3.
8. Parag Diwan, Deep and Deep Publications, Quality in Totality: A Manager‟s Guide To TQM and ISO 9000, 1st Edition, 2000.
9. P.L. Jain-Tata McGraw-Hill, Quality Control and Total Quality Management - ; (2006) Total Quality Management - Bester field - Pearson Education, Ch:5.
10. M H Fulekar, Industrial Hygiene and Chemical Safety,; Ch:9, Ch:11 and Ch:15.
11. M N Vyas, Atlantic Publisher, Safety and Hazards Management in Chemical Industries; Ch:4, Ch:5 and Ch:19.
12. World Health Organization (2009) Handbook: Good Laboratory Practice (GLP)
13. OECD Principles of Good Laboratory Practice (as revised in 1997)". OECD Environmental Health and Safety Publications. OECD. 1. 1998.

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Unit II

1. Chaums Solved problem series, ; David E.Goldbers, Mc Graw Hill international Editions, 3000 solved problems in chemistry, S Chapter 11,15,16,21,22.

Unit III

1. D. A. Skoog, F. J. Holler, T. A. Nieman, Principles of Instrumental Analysis,; 5th Edition, Harcourt Asia Publisher. Chapter 6, 7,8, 13, 14, 16,17
1. H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental Methods of Analysis,; 6th Edition, CBS Publisher. Chapter 2.
2. R. D. Braun, McGraw Hill Publisher, Introduction to Instrumental Analysis, Chapter 5, 8, 12.
3. G. W. Ewing, McGraw Hill Publisher, Instrumental Methods of Chemical Analysis, 5th Edition, Chapter 3.
4. M. Ito, J. Mol. Spectrosc, The effect of temperature on ultraviolet absorption spectra and its relation to hydrogenbonding, 4 (1960) 106-124.
5. A. J. Somnessa, Spectrochim. Acta, The effect of temperature on the visible absorption band of iodine in several solvents;Part A: Molecular Spectroscopy, 33 (1977) 525-528.
6. Z. M. Khoshhesab (2012). Prof. TheophanidesTheophile (Ed.), Infrared Spectroscopy-Materials Science, Engineering and Technology. ISBN: 978-953- 51-0537-4, In Tech, (open access).

Unit IV

1. Robert D. Braun, Mc. Graw Hill,Introduction to instrumental methods of analysis; (1987): Chapter 27, 28.
2. R. T. Sane, Ghadge, Quest Publications, Thermal Analysis-theory and applications.
3. Willard, Merrit, Dean, Instrumental methods of analysis; 7 th Edition, Chapter 25, 264.
4. Skoog, Holler and Nieman, Instrumental Analysis, ; 5th Edition, Chapter 31,33
5. Vogel‟s Quantitative Chemical Analysis,; 6th Edition, Chapter 12.
6. James W. Dodd, W. James and Kenneth H. Tonge, Analytical Chemistry - Open Learning: Thermal Methods.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Chemistry Practical-I (Organic Chemistry and Analytical Chemistry)
Course Code	PSCH104
Class	M.Sc.
Semester	I
No of Credits	2
Nature	Practical
Type	Major: Mandatory- IV
Relevance with Employability/ Entrepreneurship/ Skill development	Practical Skills of organic and analytical chemistry experiments involve wide range of laboratory techniques Synthesis/preparation, distillation, extraction and purification., chromatography, Instrumental analysis Learner who have hands on experience with these techniques are highly sought in industries like pharmaceuticals, polymers, petrochemicals. Product development and analytical method development knowledge can be valuable for entrepreneurs looking for to develop new products and its analytical method development.

Chemistry Practical-I

(Organic Chemistry and Analytical Chemistry)

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Learn determination of chemical types of different organic binary mixture
2. Learn to separate solid organic binary mixtures on the basis of solubility.
3. Learn to purify the separated organic compound by recrystallization technique.
4. Learn characterization steps of organic compounds.
5. Handle and get familiar with SOP's of instruments like potentiometer, conductivity meter, colorimeter and spectrophotometer.
6. Understand the concept of complexometric titrations and factors enhancing selectivity of EDTA as a titrant.
7. Apply the theory of FES to fertilizers analysis.
8. Develop scientific temperament and research-based skills accomplish to encountered in the field of research.

Curriculum:

Course	Modules	No. of Credits
Organic Chemistry	**Preparation :** **One step preparations (1.0 g scale)** 1. Bromobenzene to p-nitrobromobenzene 2. Anthracene to anthraquinone 3. Benzoin to benzyl 4. Anthracene to Anthracene maleic anhydride adduct 5. 2-Naphthol to BINOL 6. p-Benzoquinone to 1,2,4-triacetoxybenzene 7. Ethyl acetoacetate to 3-methyl-phenylpyrazol-5-one 8. o-Phenylenediamine to 2-methylbenzimidazole 9. o-Phenylenediamine to 2,3-diphenylqunooxaline 10. Urea and benzil to 5,5-diphenylhydantoin **(Minimum 08 experiments are expected)**	01

Analytical Chemistry	**Non-Instrumental** 1. To carry out assay of the sodium chloride injection by Volhard‟s method. 2. To determine (a) the ion exchange capacity (b) exchange efficiency of the given cation exchange resin. 3. To determine amount of Cr (III) and Fe (II) individually in a mixture of the two by titration with EDTA. 4. To determine number of nitro groups in the given compound using$TiCl_3$. **Instrumental** 1. To determine percentage purity of sodium carbonate in washing soda pH metrically. 2. To determine amount of Ti (III) and Fe(II) in a mixtureby titration with Ce (IV) potentiometrically. 3. To determine the percentage purity of a sample (glycine/sodium benzoate/primary amine) by titration with perchloric acid in a non-aqueous medium using glass calomel system potentiometrically. 4. To determine the amount of nitrite, present in the given water sample colorimetrically.	01
Total		**02**

References:

1. A. I.Vogels, Quantitative Inorganic Analysis including Elementary Instrumental Analysis, 3rd Ed. ELBS (1964).
2. Mendham, Denny, Barnes,Thomas, Pearson education, Vogel's textbook of quantitative chemical analysis, Sixth Ed.
3. F. J. Welcher, Standard methods of chemical analysis; 1975.
4. F. J. Welcher, Standard methods of chemical analysis: Instrumental methods of Analysis; vol. 3, 1966.
5. W. W. Scott, "Standard methods of Chemical Analysis"; Vol. I, Van NostrandCompany, Inc.,1939.
6. E. B. Sandell and H. Onishi, "Spectrophotometric Determination of Traces of Metals" Part II, 4th Ed., A Wiley Interscience Publication, New York, 1978.

Evaluation Pattern: Practical

Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Analytical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Organic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
3.	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme atSemester I with Effect from the Academic Year 2023-2024

Name of the Course	Physical Chemistry I
Course Code	PSCH105
Class	M.Sc.
Semester	I
No of Credits	2
Nature	Theory
Type	Major: Elective I
Relevance with Employability/ Entrepreneurship/ Skill development	Chemical kinetics plays a crucial role in optimizing industrial process by understanding reaction rates and able to design efficient reactors. Learner can apply concept of kinetics in drug stability studies, and understanding pathways drug synthesis. Electrochemistry offers entrepreneurs to create environmentally friendly and sustainable solutions such as water purification system and renewable energy technologies.

Physical Chemistry I

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Chemical Kinetics and Molecular Dynamics-I	15
2	Electrochemistry	15
	Total	**30**

Course Outcomes:

1. The learners evaluate the different theories of chemical kinetics and effect of temperature on reaction rates.
2. The learners will understand the applications of chain reactions in the field of Polymer Chemistry.
3. The learners will evaluate the resting membrane potential by using the concept of bio electrochemistry.
4. The learners will try to accomplish a solution to problems encountered in the field of research.

Curriculum:

Sr. No.	Modules / Units
1	**Chemical Kinetics and Molecular Dynamics-I (15 Lectures)**
	1.1 Composite Reactions: Recapitulation: Rate laws, Differential rate equations Consecutive reactions, Steady state Approximation, rate determining steps, Microscopic Reversibility and Detailed Balanced Chain reactions-chain initiation processes. Some inorganic mechanisms: formation and decomposition of phosgene, decomposition of ozone, Reaction between Hydrogen and Bromine and some general examples Organic Decompositions: Decomposition of ethane, decomposition of acetaldehyde Gas phase combustion: Reaction between hydrogen and oxygen, Semenov – Hinshelwood and Thompson mechanism, Explosion limits and factors affecting explosion limits. **1.2** Polymerization reactions: Kinetics of stepwise polymerization, Calculation of degree of polymerization for stepwise reaction. Kinetics of free radical chain polymerization, Kinetic chain length and estimation of average no .of monomer units in the polymer produced by chain polymerization.
2	**Electrochemistry (15 Lectures)**
	Recapitulation – basics of electrochemistry. **2.1** Debye-Hückel theory of activity coefficient, Debye-Hückel limiting law and its extension to higher concentration (derivations are expected). **2.2** Electrolytic conductance and ionic interaction, relaxation effect,.Debye-

	Hückel Onsager equation (derivation expected). Validity of this equation for aqueous and non- aqueous solution, deviations from Onsager equation, Debye - Falkenhagen effect (dispersion of conductance at high frequencies), Wien effect. **2.3** Batteries: Alkaline fuel cells, Phosphoric acid fuel cells, High temperature fuel cells [Solid –Oxide Fuel Cells (SOFC) and Molten Carbonate Fuel Cells] **2.4** Bio-electrochemistry: Introduction, cells and membranes, membrane potentials, theory of membrane potentials, interfacial electron transfer in biological systems, adsorption of proteins onto metals from solution, electron transfer from modified metals to dissolved protein in solution, enzymes as electrodes, electrochemical enzyme-catalysed oxidation of styrene. Goldmann equation. (derivations are expected) [Ref: 14 and 16, 17, 18] **[Note: Numerical and theoretical problems from each unit are expected]**

References:

1. Peter Atkins and Julio de Paula, Atkin‟s Physical Chemistry, 7th Edn., Oxford University Press, 2002.
2. K.J. Laidler and J.H. Meiser, Physical Chemistry, 2nd Ed., CBS Publishers and Distributors, New Delhi, 1999.
3. Robert J. Silby and Robert A. Alberty, Physical Chemistry, 3rd Edn., John Wiley and Sons (Asia) Pte. Ltd., 2002.
4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.
5. G.W. Castellan, Physical Chemistry, 3rdEdn.,Narosa Publishing House, New Delhi, 1983.
6. S. Glasstone, Text Book of Physical Chemistry, 2nd Edn., McMillan and Co. Ltd., London, 1962
7. B.K. Sen, Quantum Chemistry including Spectroscopy, Kalyani Publishers, 2003.
8. A.K. Chandra, Introductory Quantum Chemistry, Tata McGraw – Hill, 1994.
9. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.
10. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.
11. W.G. Davis, Introduction to Chemical Thermodynamics – A Non – Calculus Approach, Saunders, Philadelphia, 19772.
12. Peter A. Rock, Chemical Thermodynamics, University Science Books, Oxford University Press, 1983.
13. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.
14. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson EducationLimited 2013.
15. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.
16. Bockris, John O'M., Reddy, Amulya K.N., Gamboa-Aldeco, Maria E., Modern Electrochemistry, 2A, Plenum Publishers, 1998.
17. Gurtu and Gurtu, Physical Chemistry.
18. Dr. Harichandra A Parbat and Dr. Damodar V Prabhu, Essence of Chemical Kinetics, Sara Publication, First Edition, Sept. 2022.
19. K L Kapoor, A Text book of Physical Chemistry by Vol 5, 2nd Edn.

Evaluation Pattern:

Max. Marks 50

A) Continuous assessment : 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	05

B) Semester End Examination: 60% (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 two questions each of 10 marks on each unit and one question of 10 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Chemistry Practical-E-I (Physical and Inorganic)
Course Code	PSCH106
Class	M.Sc.
Semester	I
No of Credits	2
Nature	Practical
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	Practical Skills of physical and inorganic chemistry experiments involve wide range of laboratory techniques like Synthesis/preparation, extraction and purification, Instrumental analysis. Learners who have hands on experience with these techniques are highly sought in industries like pharmaceuticals, fine chemicals, ceramics. Product development and analytical method development knowledge can be valuable for entrepreneurs looking for to develop new products and its analytical method development.

Course Outcomes:

At the end of the Course, the Learner will be able to

Physical Chemistry Practical:

1. To Gain knowledge of the advanced concepts in pH metry, quantum mechanics, potentiometry and conductometry experiments.

2. To understand advance concept of thermodynamics and chemical kinetics in the chemical reactions.

3. To develop scientific temper and research based skills accomplish to encountered in the field of research.

4. To usage of subject fundamentals-principles with practical knowledge to design experiments, analyze and interpret data so as to reach to proper conclusions.

5. Learner will train the handling of equipments like potentiometer, conductivity meter, colorimeter and spectrophotometer.

6. Learner will develop scientific temper and research based skills accomplish to encountered in the field of research.

Inorganic Chemistry Practical:

1. To apply basic concepts of separation and estimation of metals ions from constituent ores/alloys effectively using chemical analysis.

2. To gain knowledge of employing instrumental techniques for quantitative analysis.

3. The learner can able to analyze structure, reactivity and reaction mechanisms of coordination compounds.

4. It explains various methods, concepts, highlights on effect of environment on human beings.

5. Will able to understand Commercial applications of novel materials in synthesis of compounds.

Curriculum:

Course	Modules	No. of Credits
Physical Chemistry	**Non – Instrumental:** 1. To determine the heat of solution (ΔH) of a sparingly soluble acid (benzoic/salicylic acid) from solubility measurement at three different temperature. 2. To study the variation of calcium sulphate with ionic strength and hence determine the thermodynamic solubility product of $CaSO_4$ at room temperature. 3. To investigate the reaction between acetone and iodine. 4. Graph Plotting of mathematical functions –linear, exponential and trigonometry and identify whether functions are acceptable or non-acceptable? **Instrumental:** 1. To determine the mean ionic activity coefficient of an electrolyte by e.m.f. measurement. 2. To study the effect of substituent on the dissociation constant of acetic acid conductometrically. 3. To determine pKa values of phosphoric acid by potentiometric titration with sodium hydroxide using glass electrode. 4. To verify Ostwald"s dilution law and to determine the dissociation constant of a weak mono-basic acid conductometrically.	**01**
Inorganic Chemistry	**Ores and Alloys** 1. Analysis of Devarda"s alloy 2. Analysis of Cu – Ni alloy 3. Analysis of Limestone. 4. Analysis of Tin Solder alloy **Instrumentation** 1. Estimation of Fe (III)solution using Ce (IV) ions Potentiometrically 2. Estimation of Copper using Iodometric method Potentiometrically 3. Estimation of Na_2CO_3 in washing soda by pH metry 4. Estimation of Cl^- ion in NaCl / KCl by Conductometry.	**01**
Total		**02**

References:

Physical Chemistry Practical:

1. B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, Practical Physical Chemistry, 2005.
2. A.M. James and F.E. Prichard, Practical Physical Chemistry, 3rd Edn., Longman Group Ltd., 1974.
3. V.D. Athawale and P. Mathur, Experimental Physical Chemistry, New Age International Publishers, 2001.

Inorganic Chemistry Practical:

1. G. N. Mukherjee., Advanced experiments in Inorganic Chemistry., 1st Edn., 2010., U. N. Dhuri and Sons Pvt. Ltd.
2. William L. Jolly, The Synthesis and Characterization of Inorganic Compounds.
3. Dr. Deepak Pant, Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities.

Evaluation Pattern: Practical

Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Physical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Inorganic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme atSemester I with Effect from the Academic Year 2023-2024

Name of the Course	Physical Chemistry II
Course Code	PSCH107
Class	M.Sc.
Semester	I
No of Credits	2
Nature	Theory
Type	Major: Elective II
Relevance with Employability/ Entrepreneurship/ Skill development	Quantum chemistry plays a crucial role in computational chemistry which is used to predict mode of chemical reaction and molecular properties. Learner with knowledge of Chemical thermodynamics and Quantum chemistry are in demand in academia, industries and research institutes.

Physical Chemistry II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Thermodynamics-I	15
2	Quantum Chemistry	15
Total		**30**

Course Outcomes: At the end of the Course, the Learner will be able to

1. The learners will apply the advanced thermodynamics, Maxwell equation and its applications to ideal gasses.
2. The learners will implement the applications of chemical thermodynamics to real gases, solutions, surfaces and their energetics.
3. The learners will understand the applications of operators and Schrodinger equation in the field of quantum Chemistry.
4. The learners will try to accomplish a solution to problems encountered in the field of research.

Curriculum:

Sr. No.	Modules / Units
1	**Thermodynamics-I** **(15 Lectures)**
	1.1 State function and exact differentials. Maxwell equations, Maxwell thermodynamic Relations; it‟s significance and applications to ideal gases, Joule Thomson experiment, Joule Thomson coefficient, inversion temperature, Joule Thomson coefficient in terms of van der Waals constants. **[8L]** **1.2** Third law of Thermodynamics, Entropy change for a phase transition, absolute entropies, determination of absolute entropies in terms of heat capacity, standard molar entropies and their dependence on molecular mass and molecular structure, residual entropy. **[7L]** **[Ref 2 and 1,10,11,12 17]**
2	**Quantum Chemistry** **(15 Lectures)**
	2.1 Classical Mechanics, failure of classical mechanics: Need for Quantum Mechanics. **2.2** Particle waves and Schrödinger wave equation, wave functions, properties of wave functions, Normalization of wave functions, orthogonality of wave functions. **2.3** Operators and their algebra, linear and Hermitian operators, operators for the

	dynamic variables of a system such as, position, linear momentum, angular momentum, total energy, eigen functions, eigen values and eigen value equation, Schrödinger wave equation as the eigen value equation of the Hamiltonian operator, average value and the expectation value of a dynamic variable of the system, Postulates of Quantum Mechanics, Schrodinger‟s Time independent wave equation from Schrodinger‟s time dependent wave equation. **2.4.** Application of quantum mechanics to the following systems: a) Free particle, wave function and energy of a free particle. b) Particle in a one, two and three dimensional box, separation of variables, Expression for the wave function of the system, expression for the energy of the system, concept of quantization, introduction of quantum number, degeneracy of the energy levels. c) Harmonic oscillator, approximate solution of the equation, Hermite polynomials, expression for wave function, expression for energy, use of the recursion formula. **[Ref 7, 8 and 9]**

References:

1. Peter Atkins and Julio de Paula, Atkin's Physical Chemistry, 7th Edn., OxfordUniversity Press, 2002.
2. K.J. Laidler and J.H. Meiser, Physical Chemistry, 2nd Ed., CBS Publishers and Distributors, New Delhi, 1999.
3. Robert J. Silby and Robert A. Alberty, Physical Chemistry, 3rd Edn., John Wiley and Sons (Asia) Pte. Ltd., 2002.
4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.
5. G.W. Castellan, Physical Chemistry, 3rd Edn., Narosa Publishing House, New Delhi, 1983.
6. S. Glasstone, Text Book of Physical Chemistry, 2nd Edn., McMillan and Co. Ltd., London, 1962
7. B.K. Sen, Quantum Chemistry including Spectroscopy, Kalyani Publishers, 2003.
8. A.K. Chandra, Introductory Quantum Chemistry, Tata McGraw – Hill, 1994.
9. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.
10. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.
11. W.G. Davis, Introduction to Chemical Thermodynamics – A Non – Calculus Approach, Saunders, Philadelphia, 1972.
12. Peter A. Rock, Chemical Thermodynamics, University Science Books, Oxford University Press, 1983.
13. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.
14. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson Education Limited 2013.
15. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.
16. Bockris, John O'M., Reddy, Amulya K.N., Gamboa-Aldeco, Maria E., Modern Electrochemistry, 2A, Plenum Publishers, 1998.

17. Gurtu and Gurtu, Physical Chemistry.
18. Dr. Harichandra A Parbat and Dr. Damodar V Prabhu, Essence of Chemical Kinetics, Sara Publication, First Edition, Sept. 2022.
19. K L Kapoor, A Text book of Physical Chemistry by Vol 5, 2nd Edn.

Evaluation Pattern:

Max. Marks 50

A) Continuous assessment : 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	05

B) Semester End Examination: 60% (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 two questions each of 10 marks on each unit and one question of 10 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Physical and Inorganic Chemistry Practical-II
Course Code	PSCH108
Class	M.Sc.
Semester	I
No of Credits	2
Nature	Practical
Type	Major: Elective II
Relevance with Employability/ Entrepreneurship/ Skill development	Physical chemistry experiments require precise laboratory skills, such as handling of sensitive instruments. Measuring accurately and executing complex procedures. It enhances ability to design and execute experiments and analyze data. By conducting advance Inorganic chemistry experiments at PG level hones laboratory techniques and analytical skills, making learner suitable for research and industry.

Course Outcomes:

At the end of the Course, the Learner will be able to

Physical Chemistry Practical:

1. To Gain knowledge of the advanced concepts in pH metry, quantum mechanics, potentiometry and conductometry experiments.
2. To understand advance concept of thermodynamics and chemical kinetics in the chemical reactions.
3. To develop scientific temper and research based skills accomplish to encountered in the field of research.
4. To usage of subject fundamentals-principles with practical knowledge to design experiments, analyze and interpret data so as to reach to proper conclusions.
5. Learner will train the handling of equipments like potentiometer, conductivity meter, colorimeter and spectrophotometer.
6. Learner will develop scientific temper and research based skills accomplish to encounteredin the field of research.

Inorganic Chemistry Practical:

1. To apply basic concepts of separation and estimation of metals ions from constituent ores/alloys effectively using chemical analysis
2. To gain knowledge of employing instrumental techniques for quantitative analysis.
3. The learner can able to analyze structure, reactivity and reaction mechanisms of coordination compounds.
4. It explains various methods, concepts, highlights on effect of environment on human beings.
5. Will able to understand Commercial applications of novel materials in synthesis of compounds.

Course	Modules	No. of Credits
Physical Chemistry	**Non – Instrumental:** 1. To determine the heat of solution (ΔH) of a sparingly soluble acid (benzoic/salicylic acid) from solubility measurement at three different temperature. 2. To study the variation of calcium sulphate with ionic strength and hence determine the thermodynamic solubility product of $CaSO_4$ at room temperature. 3. To investigate the reaction between acetone and iodine. 4. Graph Plotting of mathematical functions –linear, exponential and trigonometry and identify whether functions are acceptable or non-acceptable? **Instrumental:** 5. To determine the mean ionic activity coefficient of an electrolyte by e.m.f. measurement. 6. To study the effect of substituent on the dissociation constant of acetic acid conductometrically. 7. To determine pKa values of phosphoric acid by potentiometric titration with sodium hydroxide using glass electrode. 8. To verify Ostwald"s dilution law and to determine the dissociation constant of a weak mono-basic acid conductometrically.	01
Inorganic Chemistry	**Ores and Alloys** 1. Analysis of Devarda"s alloy 2. Analysis of Cu – Ni alloy 3. Analysis of Limestone. 4. Analysis of Tin Solder alloy **Instrumentation** 5. Estimation of Fe (III)solution using Ce (IV) ions Potentiometrically 6. Estimation of Copper using Iodometric method Potentiometrically 7. Estimation of Na_2CO_3 in washing soda by pH metry 8. Estimation of Cl^- ion in NaCl / KCl by Conductometry.	01
Total		**02**

References:

Physical Chemistry Practical:

1. B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, Practical Physical Chemistry, 2005.
2. A.M. James and F.E. Prichard, Practical Physical Chemistry, 3rdEdn., LongmanGroup Ltd., 1974.
3. E V.D. Athawale and P. Mathur, New Age International Publishers, experimental Physical Chemistry, 2001.

Inorganic Chemistry Practical:

1. G. N. Mukherjee., U.N. Dhuri and Sons Pvt Ltd. Advanced experiments in Inorganic Chemistry., 1st Edn., 2010.,
2. William L. Jolly, The Synthesis and Characterization of Inorganic Compounds.
3. Dr. Deepak Pant, Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities.

Evaluation Pattern: Practical Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of Journal.	15
04	Overall performance (attendance, punctuality, interaction during Practical session throughout semester).	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Physical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Inorganic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE/ Internal	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester I with Effect from the Academic Year 2023-2024

Name of the Course	Research Methodology
Course Code	PSCH109
Class	M.Sc.
Semester	I
No of Credits	4
Nature	Theory
Type	Research Methodology
Relevance with Employability/ Entrepreneurship/ Skill development	Learner will gain the knowledge of Research Methodology in Chemistry. Further, the learner will be benefited in the form of increase in research aptitude, analytical and decision- making skills. Acquisition of the knowledge in the field of research will increase the chances of employability and will offer better prospects in industry.

Research Methodology

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Fundamentals of Research Methods	15
2	Research Design and Measurement Concepts and LiteratureSearching	15
3	Documentation, scientific writing and Academic Integrity	15
4	Hypothesis Testing and Communication Skills in Research	15
Total		**60**

Course Outcomes:

Student will able to: -

1. Understand fundamentals of research methods
2. Learn design and measurement concepts of research
3. Know data collection and analysis tools
4. Test the hypothesis and communicate the research findings effectively
5. Write research report, research proposal, research paper etc. and get acquainted with ethicalconsiderations in research tools.

Curriculum:

Sr. No.	Modules / Units
1	**Fundamental of Research Methods** **(15 Lectures)**
	Definition of research, Role and objectives of research, importance of research, Applications and types of research, Creativity and innovation, Critical thinking, Research process and steps in it, Collecting and reviewing the literature, Conceptualization and Formulation of: research problem, identifying variables, constructing hypothesis and Synopsis. Interpretation of resultsand discussion

2	**Research Design and Measurement Concept and Literature Searching (15 Lectures)**
	Selecting and defining a research problem, Need forresearch design, Features of a good research design, Different research designs, Scales of measurements,Nominal, Ordinal, Internal and ratio scales, Errors in measurements, Validity and Reliability in measurement, Scale Construction Techniques. Digital: Web sources, E-journals, Journal access,Citation Index, Impact factor, H-index, E- consortium, UGC info net, eBooks, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Google Scholar,Scopus.
3	**Documentation, scientific writing and Academic Integrity (15 Lectures)**
	Documentation and scientific writing: Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing. Structure and Components of Research Report, Types of Report: research papers, thesis, Research Project Reports, Pictures and Graphs, citation styles, writing a review of paper, Bibliography. for illustration, style,publications of scientific work, Research and Academic Integrity: Intellectual property rights (IPRs). Plagiarism, Copyright issues,Ethics in research, and case studies.
4	**Hypothesis Testing and Communication Skills in Research (15 Lectures)**
	Hypotheses, Meaning, Nature of hypothesis, Functions of Hypothesis, Importance of Hypothesis, Kinds of Hypothesis, Characteristics of good hypothesis Hypothesis testing**:** Null and alternate hypothesis, Type I and Type II errors, Level of significance, Power of test, p-value Communication skills: Importance communication through English, The process of communication and factors that influence communication. Sender, receiver, channel, code, topic, message, context, feedback, noise, filters, and barriers. Verbal and Non verbal communication, Comparison of general communication andbusiness communication. Presentation skills: Structure of presentation, Types of presentation, oral power Presentation Handling, power point slides, organization, content, bodylanguage geasture and voice, modulation

References:

1. Kothari C.R., "Research Methodology, Methods and Techniques" (Second revised edition,New Age International Publication, 2004).
2. Saravanavel P., "Research Methodology" (Kitab Mahal, Sixteenth edition, 2007).
3. Ranjit Kumar, "Research Methodology, a step-by-step guide for beginners" (Pearsoneducation Australia, Second edition 2005).
4. Mark Saunders, Philip Lewis, Adrain Thornhiu, "Research Methods for BusinessStudents"(Pearson Education ltd, Seventh edition, 2016)
5. Research Methodology and Scientific Writing by C. George Thomas 2^{nd} Ed. Springer
6. Thesis & Assignment Writing–J Anderson, B.H.Dursten & M.Poole, Wiley Eastern, 1977
7. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press,1976.
8. The Craft of Scientific Writing by Michael Alley, (Springer).
9. Research Methodology by R. Panneerselvam, PHI, New Delhi 2005
10. Research Methodology- A step by step Guide for Beginners, (2nd ed.) Kumar Ranjit,2005, Pearson Education.
11. How to write and publish by Robert A. Day and Barbara Gastel, (Cambridge University Press).
12. S. Gupta, (2005). Research Methodology and Statistical techniques, Deep and Deep Publications (P) Ltd. New Delhi, India.
13. R. Kothari, (2008). Research Methodology, New Age International, New Delhi, India.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II with Effect from the Academic Year 2023-2024

No. of Courses	Semester II	Credits
	Major: Mandatory	
PSCH 201	Inorganic Chemistry-II	4
PSCH 202	Organic Chemistry-II	4
PSCH 203	Analytical Chemistry-II	4
PSCH 204	Chemistry Practical-II (Organic Chemistry and Analytical Chemistry)	2
	Major: Elective (Any One from below)	
PSCH 205	Physical Chemistry III	4
PSCH 206	Chemistry Practical E-III (Physical and Inorganic Chemistry)	
PSCH 207	Physical Chemistry IV	4
PSCH 208	Chemistry Practical E-IV (Physical and Inorganic Chemistry)	
PSCH 209	On the Job Training/ Field Projects	4
Total Credits		22

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Inorganic Chemistry-II
Course Code	PSCH201
Class	M.Sc.
Semester	II
No of Credits	4
Nature	Theory
Type	Major: Mandatory-II
Employability/ Entrepreneurship/ Skill Development	Inorganic chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as material science, electronics, ceramics, pharmaceuticals, and environmental science. Entrepreneurs in fields like material science and nanotechnology rely on inorganic chemistry principles to innovate. Thus a course provides Post Graduates with analytical skills, problem solving skills, research capabilities which empower them to pursue a diverse path career.

Inorganic Chemistry-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Inorganic Reaction Mechanism	15
2	Organometallic Chemistry of Transition metals	15
3	Environmental Chemistry	15
4	Bioinorganic Chemistry	15
Total		**60**

Course Outcomes:

The learners will be able to study rates of reactions and the factors affecting them and understand the different techniques used to study the rate of the reaction.

1. The learners will be able to learn ligand substitution reactions of Octahedral and Square planar complexes, Trans effect and factors affecting these substitution reactions.
2. The learners will be able to understand the 18 and 16 electron square planar complexes by studying different examples. They will also learn the preparation and properties of a few selected compounds including sandwich compounds of Fe, Cr
3. The learners will understand the structure and bonding of a few inorganic compounds like Ziese‟s salt, ferrocene and bis(arene)chromium(0)
4. The learners will understand the occurrence and effect of toxic metals like Pb, As, Cu, Cd, and Hg on the environment, the different diseases caused by poisoning of metals and the impact these metals have on the living organism.
5. The learners will be familiar with the role of Inorganic chemistry in Biological systems, understand the structure of various biological oxygen carriers and molecules involved in electron storage and transport.

Curriculum:

Sr. No.	Modules / Units
1	**Inorganic Reaction Mechanism** **(15 Lectures)**
	1.1 Rate of reactions, factors affecting the rate of reactions, techniques for determination of rate of reaction (Direct chemical analysis, spectrophotometric method, electrochemical and flow methods). **1.2 Ligand substitution reactions of:** a) Octahedral complexes without breaking of metal-ligand bond (Use of isotopic labelling method). b) Square planar complexes, trans-effect, its theories and applications. Mechanism and factors affecting these substitution reactions. **1.3 Redox reactions:** inner and outer sphere mechanisms, complimentary and non-complimentary reactions. **1.4** Isomerization and racemization reactions.
2	**Organometallic Chemistry of Transition metals** **(15 Lectures)**
	2.1 Eighteen electron rule and electron counting with examples, sixteen electronSquare Planar complexes. **2.2** Preparation and properties of the following compounds (a) Alkyl and aryl derivatives of Pd and Pt complexes (b) Carbenes and carbynes of Cr, Mo and W (c) Alkene derivatives of Pd and Pt (d) Alkyne derivatives of Pd and Pt (e) Allyl derivatives of nickel (f) Sandwich compounds of Fe, Cr and Half Sandwich compounds of Cr, Mo. **2.3** Structure and bonding on the basis of VBT and MOT in the following organometallic compounds: Zeise"s salt, bis(triphenylphosphine)diphenylacetylene platinum (0) $[Pt(PPh_3)_2(HC{\equiv}CPh)_2]$, diallylnickel(diallylnickel(II), ferrocene and bis(arene)chromium(0), tricarbonyl (η^2-butadiene) iron(0).
3	**Environmental Chemistry** **(15 Lectures)**
	3.1. Conception of Heavy Metals: Critical discussion on heavy metals **3.2. Toxicity of metallic species:** a) Mercury, lead, cadmium, arsenic, copper and chromium, with respect to their sources, distribution, speciation, biochemical effects and toxicology, control and treatment. b) Itai-itai disease for Cadmium toxicity, c) Arsenic Poisoning in the Indo-Bangladesh region. **3.3. Interaction of radiation in context with the environment:** Sources and biological implication of radioactive materials. Effect of low-level radiation on cells- Its applications in diagnosis and treatment, Effect of radiation on cell proliferation and cancer.

4	**Bioinorganic Chemistry** **(15 Lectures)**
	4.1 Biological oxygen carriers; hemoglobin, hemerythrene and hemocyanine- structure of metal active center and differences in mechanism of oxygen binding, Differences between hemoglobin and myoglobin: Cooperativity of oxygen binding in hemoglobin and Hill equation, pH dependence of oxygen affinity in hemoglobin and myoglobin and its implications. **4.2** Activation of oxygen in biological system with examples of mono-oxygenases. **4.3** Copper containing enzymes- superoxide dismutase, **4.4** Nitrogen fixation-nitrogenase, hydrogenases. **4.5** Metal ion transport and storage: Ionophores, transferrin, ferritin and metallothionins. **4.6** Medicinal applications of cis-platin and related compounds.

References:

Unit I

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Unit III

1. Colin Baird Michael Cann, W. H. Freeman and Company, Environmental Chemistry 5th edition, New York, 2012.
2. Stanley E. Manahan, CRC Press Publishers, Environmental Chemistry 7th edition.
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4. G. Tyler Miller Jr. and Scott E. Spoolman, Environmental Science 13th edition, ISBN-10: 0-495-56016-2, Brooks/Cole, Cengage Learning, 2010.
5. Stanley E. Manahan, Fundamentals of Environmental and Toxicological Chemistry 4th edition, ISBN: 978-1-4665-5317-0, CRC Press Taylor and Francis Group, 2013.
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8. Casarett and Doull‟s Toxicology- The Basic Science of Poisons 6th edition, McGraw-Hill, 2001.

Unit IV

1. R. W. Hay, Bioinorganic Chemistry, Ellis Harwood, England, 1984.
2. I. Bertini, H.B.Gray, S. J. Lippard and J.S. Valentine, Bioinorganic Chemistry, First South Indian Edition, Viva Books, New Delhi, 1998.
3. J. A. Cowan, Inorganic Biochemistry-An introduction, VCH Publication, 1993.
4. S. J. Lippard and J. M. Berg, Principles of Bioinorganic Chemistry, University Science Publications, Mill Valley, Caligronic, 1994.
5. G.N. Mukherjee and A. Das, Elements of Bioinorganic Chemistry, Dhuriand Sons, Calcutta, 1988.
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9. J. R. Frausto da Silva and R. J. P. Williams The Biological Chemistry of the Elements, Clarendon Press, Oxford, 1991.
10. JM. D. Yudkin and R. E. Offord A Guidebook to Biochemistry, Cambridge University Press, 1980.

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given Semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two and half hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Organic Chemistry-II
Course Code	PSCH202
Class	M.Sc.
Semester	II
No of Credits	4
Nature	Theory
Type	Major: Mandatory-II
Relevance with Employability/ Entrepreneurship/ Skill development	Organic chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as polymer, pharmaceuticals, petrochemicals, agrochemicals, cosmetics, and environmental science. Learner can apply organic chemistry knowledge to develop innovative products such as specialty chemicals, natural based products to meet specific market demand. Learners will be able to interoperate spectra using 13C NMR and Mass spectrometry.

Organic Chemistry-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Alkylation of Nucleophilic Carbon Intermediates and Reaction of carbonnucleophiles with carbonyl groups	15
2	Introduction to Molecular Orbital Theory for Organic Chemistry andApplications of UV and IR spectroscopy	15
3	Reactions and Rearrangements	15
4	^{1}H and ^{13}C NMR spectroscopy and Mass spectrometry	15
Total		**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Recognize the type of mechanism and intermediates involved in the given organic reaction and to prove mechanism for the reaction.
2. Identify the ways to modify aliphatic and aromatic compounds via Nucleophilc substitution reactions.
3. Predict the mechanism and stereochemistry of important organic reactions.
4. Understand and write the mechanism of rearrangement reactions with stereochemistry and its applications.
5. Understand the HOMO-LUMO concept and it significance in organic chemistry.
6. Understand the basic principle and concepts in UV and IR spectroscopy
7. Understand the basic concepts of ^{1}H, ^{13}C NMR, and mass spectroscopy.
8. Understand how ^{1}H, ^{13}C NMR and Mass spectroscopy are important for the structure determination of organic compounds.

Curriculum:

Sr. No.	Modules / Units
1	**Alkylation of Nucleophilic Carbon Intermediates and Reaction of carbon nucleophiles with carbonyl groups (15 Lectures)**
	1.1 Alkylation of Nucleophilic Carbon Intermediates: **1.1.1** Generation of carbanion, kinetic and thermodynamic enolate formation, Regioselectivity in enolate formation, alkylation of enolates. **1.1.2** Generation and alkylation of dianion, medium effects in the alkylation of enolates, oxygen versus carbon as the site of alkylation. **1.1.3** Alkylation of aldehydes, ketones, esters, amides and nitriles.

	1.1.4 Nitrogen analogs of enols and enolates- Enamines and Imines anions, alkylation of enamines and imines. **1.1.5** Alkylation of carbon nucleophiles by conjugate addition (Michael reaction). **1.2. Reaction of carbon nucleophiles with carbonyl groups:** **1.2.1** Mechanism of Acid and base catalyzed Aldol condensation, Mixed Aldol condensation with aromatic aldehydes, regiochemistry in mixed reactions of aliphatic aldehydes and ketones, intramolecular Aldol reaction and Robinson annulation. **1.2.2** Addition reactions with amines and iminium ions; Mannich reaction. **1.2.3** Amine catalyzed condensation reaction: Knoevenagel reaction. **1.2.4** Acylation of carbanions.
2	**Introduction to Molecular Orbital Theory for Organic Chemistry and Applications of UV and IR spectroscopy (15 Lectures)**
	2.1. Introduction to Molecular Orbital Theory for Organic Chemistry: (7L) **2.1.1** Molecular orbitals: Formation of σ- and π-MOs by using LCAO method. Formation of π MOs of ethylene, butadiene, 1, 3, 5-hexatriene, allyl cation, anion and radical. Concept of nodal planes and energies of π-MOs **2.1.2** Introduction to FMOs: HOMO and LUMO and significance of HOMO LUMO gap in absorption spectra as well as chemical reactions. MOs of formaldehyde: The effect of electronegativity perturbation and orbital polarization in formaldehyde. HOMO and LUMO (π and π* orbitals) of formaldehyde. A brief description of MOs of nucleophiles and electrophiles. Concept of „donor-acceptor" interactions in nucleophilic addition reactions on formaldehyde. Connection of this HOMO-LUMO interaction with „curved arrows" used in reaction mechanisms. The concept of hardness and softness and its application to electrophiles and nucleophiles. Examples of hard and soft nucleophiles/ electrophiles. Identification of hard and soft reactive sites on the basis of MOs. **2.1.3** Application of FMO concepts in (a) SN^2reaction, (b) Lewis acid base adducts (BF3-NH3 complex), (c) ethylene dimerization to Cyclobutane, (d) Diels-Alder cycloaddition, (e) regioselective reaction of allyl cation with allyl anion (f) addition of hydride to formaldehyde. **2.2. Applications of UV and IR spectroscopy: (8L)** **2.2.1 Ultraviolet spectroscopy:** Recapitulation, UV spectra of dienes, conjugated polyenes (cyclic and acyclic), carbonyl and unsaturated carbonyl compounds, substituted aromatic compounds. Factors affecting the position and intensity of UV bands – effect of conjugation, steric factor, pH, and solvent polarity. Calculation of absorption maxima for above classes of compounds by Woodward-Fieser rules (using Woodward-Fieser tables for values for substituents). **2.2.2 Infrared spectroscopy:** Fundamental, overtone and combination bands, vibrational coupling, factors affecting vibrational frequency (atomic weight, conjugation, ring size, solvent and hydrogen bonding). Characteristic vibrational frequencies for alkanes, alkenes, alkynes, aromatics, alcohols, ethers, phenols,

	amines, nitriles and nitro compounds. Detailed study of vibrational frequencies of carbonyl compounds, aldehydes, ketones, esters, amides, acids, acid halides, anhydrides, lactones, lactams and conjugated carbonyl compounds.
3	**Reactions and Rearrangements (15 Lectures)**
	Mechanisms, stereochemistry (if applicable) and applications of the following: **3.1. Reactions:** Baylis-Hillman reaction, McMurry Coupling, Corey-Fuchs reaction, Nef reaction, Passerini reaction. **3.2. Concerted rearrangements:** Hofmann, Curtius, Lossen, Schmidt, Wolff, BoultonKatritzky. **3.3. Cationic rearrangements:** Tiffeneau-Demjanov, Pummerer, Dienone-phenol, Rupe, Wagner-Meerwein. **3.4. Anionic rearrangements:** Brook, Neber, Von Richter, Wittig, Gabriel–Colman, Baker-Venkataraman.
4	**^{1}H and ^{13}C NMR spectroscopy and Mass spectrometry (15 Lectures)**
	4.1. Proton magnetic resonance spectroscopy: Principle, Chemical shift, Factors affecting on chemical shift (Electronegativity, H-bonding, Anisotropy effects). Chemical and magnetic equivalence, Chemical shift values and correlation for protons bonded to carbon and other nuclei as in alcohols, phenols, enols, carboxylic acids, amines, amides. Spin-spin coupling, Coupling constant (J), Factors affecting J, geminal, vicinal, Karplusequation, long range coupling (allylic and aromatic). **4.2. 13C NMR spectroscopy:** Theory and comparison with proton NMR, proton coupled and decoupled spectra, off-resonance decoupling. Factors influencing carbon shifts, correlation of chemical shifts of aliphatic, olefin, alkyne, aromatic and carbonyl carbons. **4.3. Mass spectrometry:** Basic Principle, Molecular ion peak, base peak, isotopic abundance, metastable ions. Nitrogen rule, Determination of molecular formula of organic compounds based on isotopic abundance and HRMS.Fragmentation pattern in various classes of organic compounds (including compounds containing hetero atoms), McLafferty rearrangement, Retro-Diels-Alder reaction, ortho effect. **4.4.** Structure determination involving individual or combined use of the above spectral techniques.

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2. F.A. Carey and R.J. Sundberg, Advanced Organic Chemistry, Part A, page no.713-769,and B, Plenum Press.
3. Michael, B.Smith, Jerry March, Wiley. March‟s Advanced Organic Chemistry: Reactions, Mechanisms and Structure.

4. R.T. Morrison, R.N. Boydand, S.K. Bhattacharjee, Pearson Publication Organic Chemistry, (7th Edition).
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6. R.Bruckner, Academic Press., Advanced Organic Chemistry: Reaction mechanisms.
7. Adams Jacobs, Cambridge University Press., Understanding Organic Reaction Mechanisms.
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9. R.O.C. Norman and J.M Coxon, Nelson Thornes., Principles of Organic Synthesis.
10. L.G. Wade, Jr., Maya Shankar Singh, Pearson Education., Advanced Organic Chemistry: Reactions and mechanism.
11. Mechanism in Organic Chemistry, eter Sykes,6th.
12. Ian Fleming Reference Edition, Wiley, Molecular Orbital and Organic chemical reactions.
13. Donald L. Pavia, Gary M. Lampman, George S. Kriz, Thomson Brooks., Introduction to Spectroscopy.
14. R. Silverstein, G.C Basslerand , T. C. Morrill, John Wiley and Sons., Spectrometric Identification of Organic Compounds.
15. William Kemp, W. H. Freeman andCompany., Organic Spectroscopy.
16. Jagmohan, Narosa Publication., Organic Spectroscopy-Principlesand Applications.
17. V. R. Dani, Tata McGraw Hill Publishing Co., Organic Spectroscopy.
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21. V.K. Ahluwalia, R.K Parasher, Alpha Science International, Organic Reaction Mechanisms, 2011.
22. S.N. Sanyal, Reactions, Rearrangements and Reagents.
23. Bradford P. Mundy, M.G. Ellerd and F.G. Favaloro, John Wiley and Sons., Name reactions and Reagents in Organic Synthesis.
24. P.S. Kalsi, New Age International Publishers., Organic reactions and their Mechanisms.
25. Y. R. Sharma, (S. Chand Publications), Elementary Organic Spectroscopy.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given Semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Analytical Chemistry-II
Course Code	PSCH203
Class	M.Sc.
Semester	II
No of Credits	4
Nature	Theory
Type	Major: Mandatory-III
Relevance with Employability/ Entrepreneurship/ Skill development	Analytical chemistry plays a significant role in employability, entrepreneurship and skill development due to its wide ranging applications and relevance in various industries, such as polymer, pharmaceuticals, cement, ceramics, petrochemicals, agrochemicals, cosmetics, and environmental science. Learner can apply Analytical chemistry knowledge to develop and validate analytical method for particular pharmaceutical product. Learner can work as Quality control chemist in Laboratories of various chemical industry. Entrepreneurs can establish analytical testing laboratory that offer services to various industries including QC, environmental analysis.

Analytical Chemistry-II

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Chromatography	15
2	Instrumental methods – II	15
3	Instrumental methods – III	15
4	Electro analytical Methods	15
	Total	**60**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Able to compare the advantages/disadvantages of SEM, STM and TEM.
2. Able to develop different techniques to separate the components of mixture.
3. Conversant with basic principles and theories of mass spectrometry.
4. Able to apply the electro analytical methods to sample under consideration.
5. Able to elaborate on electrogravimetry and coulometry techniques.

Curriculum:

Sr. No.	Modules / Units
1	**Chromatography (15 Lectures)**
	1.1 Basic concepts and theories of chromatography: [5L] **1.1.1** Introduction and Classification of chromatographic methods. **1.1.2** Concept of plate and rate theories in chromatography, efficiency, resolution, selectivity and separation capability. **1.1.3** Van Deemter equation and broadening of chromatographic peaks. Optimization of chromatographic conditions. **1.2 Gas Chromatography: [5 L]** **1.2.1** Instrumentation –sample injection systems (split/split less), column types (solid/ liquid stationary phases), column switching techniques, temperature programming. **1.2.2** Requirements of an ideal detector and types of detectors in GLC and GSC. **1.2.3** Applications -Qualitative and quantitative analysis. **1.3 High Performance Liquid Chromatography (HPLC):[5 L]** **1.3.1** Normal phase and reversed phase with special reference to types of

	commercially available columns (Use of C8 and C18 columns). **1.3.2** Diode array type and fluorescence detector. **1.3.3** Applications of HPLC.
2	**Instrumental methods - II** **(15 Lectures)**
	2.1 X-ray spectroscopy: [6L] Principle, instrumentation, applications, advantages and limitations of **2.1.1** X-ray absorption spectroscopy. (XAS) **2.1.2** X-ray fluorescence spectroscopy (XRF) **2.1.3** X-ray diffraction spectroscopy. (XRD) **2.2 Mass spectrometry: [6L]** **2.2.1 Instrumentation:** i) Ion sources - electron impact, field ionization, field absorption, chemical ionization and fast atom bombardment sources. ii) Mass analyzers: Quadrupole, time of flight and ion trap. **2.2.2 Applications:** **2.3 Radio analytical Methods –[3 L]** **2.3.1** Neutron Activation Analysis (NAA)- Introduction, Principle, Theory and Applications. **2.3.2** Advantages and Limitations of NAA.
3	**Instrumental methods - III** **(15 Lectures)**
	3.1 Surface Analytical Techniques – [9L] Principle, Instrumentation and Applications of: **3.1.1** Scanning Electron Microscopy (SEM) **3.1.2** Scanning Tunneling Microscopy (STM) **3.1.3** Transmission Electron Microscopy (TEM) **3.2 Atomic Spectroscopy [6L]** **3.2.1** Atomic Spectroscopy based on plasma sources – Introduction, Principle, Instrumentation and Applications. **3.2.2** Advantages and Limitations of AAS.
4	**Electroanalytical Methods** **(15 Lectures)**
	4.1 Ion selective potentiometry and Polarography: [10L] **(Numericals are Expected)** **4.1.1** Ion selective electrodes: Applications of - solid state, precipitate, liquid – liquid, enzyme, gas sensing, bio-catalytic membrane and enzyme-based biosensors electrodes. **4.1.2 Polarography:** Ilkovic equation, Cottrell equation, effect of complex formation on the polarographic waves. **4.2 Electrogravimetry: [2L]** **4.2.1** Introduction, Principle and Instrumentation. **4.2.2** Factors affecting the nature of the deposit. **4.2.3** Applications.

	4.3 Coulometry: [3L] **4.3.1** Introduction, Principle and Instrumentation. **4.3.2** Coulometry at controlled potential and controlled current.

References:

Unit I

1. Skoog, Holler and Crouch, Instrumental Analysis, 7th edition.
2. E.B.Sandell and H.Onishi, HPLC Practical and Industrial Applications; 2 nd Ed., CRC Press.

Unit II

1. H J Arnikar, New Age Publishers, Essentials of Nuclear Chemistry; (2005).
2. D. D. Sood A. V. R. Reddy and N. Ramamoorthy, IANCAS Fundamentals of Radiochemistry; 4th edition, 2010.
3. Skoog, Holler and Nieman, Principles of Instrumental Analysis - 5th Edition, Ch: 12, 20

Unit III

1. Douglas A. Skoog - F. James Holler - Crouch, Publisher:Cengage; Instrumental Analysis; Edition, (2003), ISBN-10: 8131505421, ISBN-13: 978-8131505427.
2. Ray F. Egerton, Physical Principles of Electron Microscopy, An Introduction to TEM, SEM, andAEM ; ISBN: 978-0- 387-25800- 3 (Print) 978-0- 387-26016- 7 (Online).
3. D.P. Woodruff and T.A. Delchar, Cambridge Univ. Press, Modern techniques of surface science; 1994.
4. C. J. Chen, Oxford University Press, Introduction to Scanning Tunneling Microscopy ; New York, 1993.
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6. J.M. Hollas, , John Wiley, New York, Modern Spectroscopy,; 3rd Edition (1996).
7. Skoog, Holler, Nieman, Harcourt College Publishers, Principles of Instrumental Analysis; 5th ed., 1998.

Unit IV

1. Skoog, Holler, Nieman, Harcourt College Publishers, Principles of Instrumental Analysis – ; 5th Edition, 1998. Chapters - 23, 24, 25.
2. John H Kennnedy, Saunders College Publishing, Analytical Chemistry Principles, 2nd edition, (1990).
3. David Harvey; McGraw Hill Higher education publishers, Modern Analytical Chemistry; (2000).
4. Vogel's Text book of quantitative chemical analysis; Pearson Education Limited, 6th edition, (2007).

5. Allen J Bard and Larry R Faulkner, John Wiley and Sons, Electrochemical Methods Fundamentals and Applications; (1980).
6. Willard, Merrit, Dean and Settle, CBS publishers, Instrumental Methods of Analysis; 7th edition.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given Semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Chemistry Practical-II (Organic Chemistry and Analytical Chemistry)
Course Code	PSCH204
Class	M.Sc.
Semester	II
No of Credits	2
Nature	Practical
Type	Major: Mandatory- II
Relevance with Employability/ Entrepreneurship/ Skill development	Practical Skills of organic and analytical chemistry experiments involve wide range of laboratory techniques Synthesis/preparation, distillation, extraction and purification., chromatography, Instrumental analysis Learner who have hands on experience with these techniques are highly sought in industries like pharmaceuticals, polymers, petrochemicals. Product development and analytical method development knowledge can be valuable for entrepreneurs looking for to develop new products and its analytical method development.

Course Outcomes:

At the end of the Course, the Learner will be able to

1. Learn determination of chemical types of different organic binary mixture.
2. Learn to separate solid organic binary mixtures on the basis of solubility.
3. Learn to purify the separated organic compound by recrystallization technique.
4. Learn characterization steps of organic compounds.
5. Handle and get familiar with SOP's of instruments like potentiometer, conductivity meter, colorimeter and spectrophotometer.
6. Understand the concept of complexometric titrations and factors enhancing selectivity of EDTA as a titrant.
7. Apply the theory of FES to fertilizers analysis.
8. Develop scientific temperament and research-based skills accomplish to encountered in the field of research.

Chemistry Practical-II
(Organic Chemistry and Analytical Chemistry)
Modules at a Glance

<table>
<tr><th>Course</th><th>Modules</th><th>No. of Credits</th></tr>
<tr><td>Organic Chemistry</td><td>Separation of Binary mixture using micro-scale technique
1. Separation of binary mixture using physical and chemical methods.
2. Characterization of one of the components with the help of chemical analysis and confirmation of the structure with the help of derivative preparation and its physical constant.
3. Purification and determination of mass and physical constant of the second component.
The following types are expected:
(i) Water soluble/water insoluble solid and water insoluble solid,
(ii) (ii) Non-volatile liquid-Non-volatile liquid (chemical separation)
(iii) Water-insoluble solid-Non-volatile liquid.
(Minimum two mixtures from each type and a total of eight mixtures are expected.)</td><td>01</td></tr>
<tr><td>Analytical Chemistry</td><td>Instrumental Experiments
1. To determine the amount of Fe (II) and Fe (III) in a mixture using 1,10-phenanthroline spectrophotometrically.
2. Simultaneous determination of Cr(VI) and Mn(VII) in a mixture spectrophotometrically.
3. To determine the percentage composition of HCl and H_2SO_4 on weight basis in a mixture of two by conductometric titration with NaOH and $BaCl_2$.
4. To determine amount of potassium in the given sample of fertilizers using flame photometer by standard addition method.
Non-Instrumental Experiments
5. To determine the lead and tin content of a solder alloy by titration with EDTA.
6. To determine amount of Cu (II) present in the given solution containing a mixture of Cu (II) and Fe (II).
7. To determine the break through capacity of a cation exchange resin.
8. Estimation of a mixture of Hydrochloric acid and boric acid by acid base titration.</td><td>01</td></tr>
<tr><td colspan="2">Total</td><td>02</td></tr>
</table>

References:

1. A. I. Vogels, Quantitative Inorganic Analysis including Elementary Instrumental Analysis by ; 3rd Ed. ELBS (1964).
2. Mendham, Denny, Barnes, Thomas, Pearson education, Vogel's textbook of quantitative chemical analysis, Sixth Ed.
3. F. J. Welcher, Standard methods of chemical analysis ; 1975.
4. F. J. Welcher, Standard methods of chemical analysis: Instrumental methods of Analysis; vol. 3, 1966.
5. W. W. Scott, Vol. I, Van Nostrand , Company, "Standard methods of Chemical Analysis"; Inc.,1939.
6. E.B.Sandell and H.Onishi, "Spectrophotometric Determination of Traces of Metals"; ,Part II,4th Ed. ,A Wiley Interscience Publication, New York,1978.

Evaluation Pattern: Practical

Max. Marks: 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Performance during practical session, Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal.	15
04	Overall performance (attendance, punctuality, interaction during Practical session throughout semester	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Analytical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Organic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks

CIE	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Physical Chemistry III
Course Code	PSCH205
Class	M.Sc.
Semester	II
No of Credits	2
Nature	Theory
Type	Major: Elective-III
Relevance with Employability/ Entrepreneurship/ Skill development	Understanding photochemistry and chemical kinetics is essential for chemist working in various industries such as pharmaceuticals, material science. These fields often rely on reactions that are influenced by light (photochemical reaction) or reaction rates (Chemical kinetics). Entrepreneurs with a background in photochemistry and chemical kinetics have opportunities to develop and commercialize innovative technologies.

Physical Chemistry III

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Photochemistry	15
2	Chemical Kinetics and Molecular Reaction Dynamics-II	15
	Total	**30**

Course Outcomes:

1. To develop the skill to solve the problems based on molecular dynamics and quantum Chemistry.
2. Learners will able to distinguish between competitive, Noncompetitive and Uncompetitive Inhibition in enzyme-catalyzed reactions.
3. Learners will get knowledge of advanced chemical kinetics and molecular dynamics.
4. Leathers will able to use advanced concepts of chemical thermodynamics in chemical reactions.

Curriculum:

Sr. No.	Modules / Units
1	**Photochemistry** **(15 Lectures)**
	2.1 Absorption of light, laws of photochemistry, electronic structure of molecules, molecular orbital, electronically excited singlet states, designation based on multiplicity rule, construction of Jablonski diagram, electronic transition, Frank Condon principle, selection rules, intensity of absorption bands, nature of electronic spectra and primary process, photo-dissociation, predissociation. **2.2 Photo physical phenomena:** physical pathways of excited molecular system (radiative and non-radiative), prompt fluorescence, delayed fluorescence, and phosphorescence, fluorescence quenching: concentration quenching, collisional quenching, quenching by excimer and exciplex emission, fluorescence resonance energy transfer between photo-excited donor and acceptor systems. **2.3.** Stern-Volmer relation, critical energy transfer distances, energy transfer efficiency, examples and applications in chemical analysis. Photochemical reactions, photo-oxidation, photoreduction, photo-dimerization, photoisomerization and photosensitized reactions. Photochemistry of environment: Greenhouse effect. **(Ref: 17 and 18)**

2	**Chemical Kinetics and Molecular Reaction Dynamics-II (15 Lectures)**
	2.1. Elementary Reactions in Solution:-Solvent Effects on reaction rates, Reactions between ions- influence of solvent Dielectric constant, influence of ionic strength, Linear free energy relationships Enzyme action **2.2.** Kinetics of reactions catalyzed by enzymes -Michaelis-Menten analysis, Lineweaver-Burk and Eadie Analyses. **2.3.** Inhibition of Enzyme action: Competitive, Noncompetitive and Uncompetitive Inhibition. Effect of pH, Enzyme activation by metal ions, Regulatory enzymes. **2.4.** Kinetics of reactions in the Solid State:-Factors affecting reactions in solids Rate laws for reactions in solid: The parabolic rate law, The first order rate Law, the contracting sphere rate law, Contracting area rate law, some examples of kinetic studies. **(Ref: 7 and 2, 22)**

References:

1. Peter Atkins and Julio de Paula, Atkin's Physical Chemistry, 7th Edn., Oxford University Press, 2002.
2. K.J. Laidler and J.H. Meiser, Physical Chemistry, 2nd Ed., CBS Publishers and Distributors, New Delhi, 1999.
3. Robert J. Silby and Robert A. Alberty, John Wiley and Sons (Asia) Pte. Ltd., Physical Chemistry, 3rd Edn., 2002.
4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.
5. G.W. Castellan, Physical Chemistry, 3rd Edn.,Narosa Publishing House, New Delhi, 1983.
6. S. Glasstone, Text Book of Physical Chemistry, 2nd Edn., McMillan and Co. Ltd., London, 1962.
7. Principles of Chemical Kinetics, 2nd Ed., James E. House, ELSEVIER, 2007.
8. B.K. Sen, Kalyani Publishers, Quantum Chemistry including Spectroscopy, 2003.
9. A.K. Chandra, Tata McGraw – Hill, Introductory Quantum Chemistry, 1994.
10. R.K. Prasad, Quantum Chemistry, 2nd Edn., New Age International Publishers, 2000.
11. S. Glasstone, Thermodynamics for Chemists, Affiliated East-West Press, New Delhi, 1964.
12. W.G. Davis, Introduction to Chemical Thermodynamics – A Non – Calculus Approach, Saunders, Philadelphia, 1972.
13. Peter A. Rock, Chemical Thermodynamics, University Science Books, Oxford University Press, 1983.
14. Ira N. Levine, Quantum Chemistry, 5th Edn., Pearson Education (Singapore) Pte. Ltd., Indian Branch, New Delhi, 2000.
15. Thomas Engel and Philip Reid, Physical Chemistry, 3rd Edn., Pearson EducationLimited 2013.
16. D.N. Bajpai, Advanced Physical Chemistry, S. Chand 1st Edn., 1992.
17. C. H. DePuy, O. L. Chapman, Molecular reactions and photochemistry, Prentice hallof India PVT. LTD. 1988.

18. K. K. Rohatgi-Mukherjee. Fundamentals of Photochemistry. Reprint 2002. New Age International Publisher, 1978.
19. Marrown and Prutton, Principles of physical Chemistry, 5th edition.
20. Arun Bahl, B. S Bahl, G. D.Tulli, S Chand and Co. Ltd, Essentials of Physical Chemistry, 2012 Edition.
21. L.V Azaroff , Tata McGraw Hill, Introduction of Solids.
22. Dr. Hari chandra A Parbat and Dr. Damodar V. Prabhu, Essence of Chemical Kinetics,Sara Publication, First Edition, Sept. 2022.
23. MacMillan Publishers India Ltd, A Text book of physical Chemistry; Applications of thermodynamics vol III, 2011.
24. C.N.R. Rao and J Gopal Krishnan, Cambridge University Press., New directions in solid state Chemistry.

Evaluation Pattern:

Max. Marks 50

A) Continuous assessment : 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given Semester.	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	05

B) Semester End Examination: 60% (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 two questions each of 10 marks on each unit and one question of 10 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.) Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Chemistry Practical-III (Physical and Inorganic)
Course Code	PSCH206
Class	M.Sc.
Semester	II
No of Credits	2
Nature	Practical
Type	Major: Elective III
Relevance with Employability/ Entrepreneurship/ Skill development	Physical chemistry experiments require precise laboratory skills, such as handling of sensitive instruments. Measuring accurately and executing complex procedures. It enhances ability to design and execute experiments and analyze data. By conducting advance Inorganic chemistry experiments at PG level hones laboratory techniques and analytical skills, making learner suitable for research and industry.

Course Outcomes:

At the end of the Course, the Learner will be able to

Physical Chemistry Practical

1. To use the concept of quantum chemistry to interprete the shape and information about the orbitals like 1s, 2pz and $3dz^2$.
2. To apply the subject fundamentals-principles with practical knowledge to design experiments, analyze and interpret data so as to reach to proper conclusions
3. Learner will train to handle the sophisticated instrument like digital potentiometer, conductivity meter, spectrophotometer.

Inorganic Chemistry Practical

1. The learners will characterize different coordination compounds with the help of conductivity measurements, electronic and magnetic measurements and spectroscopic measurements.
2. Able to calculating the equilibrium constant for Fe^{3-}/SCN^{1-} by slope intercept method
3. Able to determine the electrolytic nature of some inorganic compounds by conductance measurements.

Course	Modules	No. of Credits
Physical Chemistry	**Non – Instrumental:** 1. Polar plots of atomic orbitals such as 1s, Pz and $3dz^2$ orbitals by using angular part of hydrogen atom wave functions. 2. To study the influence of ionic strength on the base catalysed hydrolysis of ethyl acetate. 3. To study phase diagram of three component system water – chloroform/ toluene - acetic acid. 4. To determine the rate constant of decomposition reaction of diacetone alcohol by dialtometric method. **Instrumental:** 5. To determine the formula of silver ammonia complex by potentiometric method. 6. To determine CMC of sodium Lauryl Sulphate from measurement of conductivities at different concentrations. To determine Hammette constant of m- and p- amino benzoic acid/nitro benzoic acid by pH measurement. 7. To determine the Michaelis – Menten‟s constant value (Km) of the enzyme Beta Amylase spectrophotometrically.	01
Inorganic Chemistry	**Inorganic Preparations (Synthesis and Characterization)** 1. Bis-(tetramethylammonium) tetrachloroCuprate (II) $(Me_4N)_2[CuCl_4]$ 2. Bis-(tetramethylammonium) tetrachloroNickelate (II) $(Me_4N)_2[NiCl_4]$ 3. Bis (ethylenediammine) Copper (II) Sulphate $[Cu(en)_2]SO_4$ 4. HexaaamineNi(II) Sulfate $[Ni(NH_3)_6]SO_4$ 5. Potassiumtrioxalato Chromate(III) $K_3[Cr(C_2O_4)_3]$ 6. Tetramminemonocarbanato Cobalt (III) Nitrate $[Co(NH_3)_4CO_3]NO_3$ **Instrumentation :** 1. Determination of equilibrium constant by Slope intercepts method for Fe^{+3}/ SCN system. 2. Determination of Electrolytic nature of inorganic compounds by Conductance measurement.	01
Total		**02**

References:

Physical Chemistry Practical:

1. B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, Practical Physical Chemistry, 2005.
2. A.M. James and F.E. Prichard, Practical Physical Chemistry, 3rd Edn., Longman Group Ltd., 1974.
3. V.D. Athawale and P. Mathur, New Age International Publishers, Experimental Physical Chemistry, 2001.

Inorganic Chemistry Practicals:

1. G. N. Mukherjee., Advanced experiments in Inorganic Chemistry., 1st Edn., 2010., U.N. Dhuri and Sons Pvt. Ltd.
2. William L. Jolly, The Synthesis and Characterization of Inorganic Compounds.
3. Dr. Deepak Pant., Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities.

Evaluation Pattern: Practical   Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, Calculations, graph, result and conclusion. Timely submission of journal.	15
04	Overall performance (attendance, punctuality, interaction during Practical session throughout semester).	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Physical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Inorganic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.)

Programme at Semester II with Effect from the Academic Year 2023-2024

Name of the Course	Physical Chemistry IV
Course Code	PSCH207
Class	M.Sc.
Semester	II
No of Credits	2
Nature	Theory
Type	Major: Elective IV
Relevance with Employability/ Entrepreneurship/ Skill development	Quantum chemistry plays a crucial role in computational chemistry which is used to predict mode of chemical reaction and molecular properties. Learner with knowledge of Chemical thermodynamics and Quantum chemistry are in demand in academia, industries and research institutes.

Physical Chemistry IV

Modules at a Glance

Sr. No.	Modules	No. of Lectures
1	Chemical Thermodynamics II	15
2	Quantum Chemistry II	15
	Total	**30**

Course Outcomes:

At the end of the Course, the Learner will be able to

1. To learn the concept of quantum chemistry and able to solve problems related to 1D box, 2D box, 3D box and to explain the role of operators in quantum chemistry.
2. To understand the use of Schrodinger wave equation in one and two electron systems along with applications of HMO.
3. To develop the skill to solve the problems based on chemical thermodynamics, molecular dynamics and quantum Chemistry.
4. To apply the concept of Jabolonski mechanism in photochemical reactions.

Curriculum:

Sr. No.	Modules / Units
1	**Chemical Thermodynamics II (15 Lectures)**
	1.1. Fugacity of real gases, Determination of fugacity of real gases using graphical method and from equation of state. Equilibrium constant for real gases in terms of fugacity. Gibbs energy of mixing, entropy and enthalpy of mixing. **1.2. Real solutions:** Chemical potential in non-ideal solutions excess functions of non-ideal solutions calculation of partial molar volume and partial molar enthalpy, Gibbs Duhem Margules equation. **1.3.** Thermodynamics of surfaces, Pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), Gibbs adsorption isotherm, BET isotherm (derivations expected). **1.4. Bioenergetics:** standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP. **[Ref 2 and 1,10,11,12]**

2	**Quantum Chemistry II** **(15 Lectures)**
	1.1 Rigid rotor, spherical coordinates Schrödinger wave equation in spherical coordinates, separation of the variables, the phi equation, wave function, quantum number, the theta equation, wave function, quantization of rotational energy, spherical harmonics. **1.2.** Hydrogen atom, the two particle problem, separation of the energy as translational and potential, separation of variables, the Radial (R), Zenith (theta) and Azimuthal (Phi) equations, solution of the equation, introduction of the four quantum numbers and their interdependence on the basis of the solutions of the three equations, total wave function, expression for the energy, probability density function, distances and energies in atomic units, radial and angular plots, points of maximum probability. **1.3.** Application of the Schrödinger equation to two electron system, limitations of the equation, need for the approximate solutions, methods of obtaining the approximate solution of the Schrödinger wave equation. **1.4.** Hückel Molecular Orbitals theory for ethylene, 1,3-butadiene, cyclobutadiene and benzene. **(Derivation expected) [Ref 7, 8 and 9]**

References:

1. Peter Atkins and Julio de Paula, Atkin's Physical Chemistry, 7th Edn., Oxford University Press, 2002.
2. K.J. Laidler and J.H. Meiser, Physical Chemistry, 2nd Ed., CBS Publishers and Distributors, New Delhi, 1999.
3. Robert J. Silby and Robert A. Alberty, Physical Chemistry, 3rd Edn., John Wiley and Sons (Asia) Pte. Ltd., 2002.
4. Ira R. Levine, Physical Chemistry, 5th Edn., Tata McGraw-Hill New Delhi, 2002.
5. G.W. Castellan, Physical Chemistry, 3rd Edn., Narosa Publishing House, New Delhi,1983.
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23. MacMillan Publishers India Ltd, A Text book of physical Chemistry; Applications of thermodynamics vol III, 2011.
24. C.N.R. Rao and J Gopal krishnan, Cambridge University Press., New directions in solid state Chemistry.

Evaluation Pattern:

Max. Marks 50

A) Continuous assessment : 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	15
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	05

B) Semester End Examination: 60% (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 two questions each of 10 marks on each unit and one question of 10 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme at Semester II with Effect from the Academic Year
2023-2024

Name of the Course	Chemistry Practical-IV(Physical and Inorganic)
Course Code	PSCH208
Class	M.Sc.
Semester	II
No of Credits	2
Nature	Practical
Type	Major: Elective
Relevance with Employability/ Entrepreneurship/ Skill development	Physical chemistry experiments require precise laboratory skills, such as handling of sensitive instruments. Measuring accurately and executing complex procedures. It enhances ability to design and execute experiments and analyze data. By conducting advance Inorganic chemistry experiments at PG level hones laboratory techniques and analytical skills, making learner suitable for research and industry.

Course Outcomes:

At the end of the Course, the Learner will be able to

Physical Chemistry Practical

1. To use the concept of quantum chemistry to interpret the shape and information about the orbitals like 1s, 2pz and $3dz^2$.
2. To apply the subject fundamentals-principles with practical knowledge to design experiments, analyze and interpret data so as to reach to proper conclusions
3. Learner will train to handle the sophisticated instrument like digital potentiometer, conductivity meter, and spectrophotometer.

Inorganic Chemistry Practical

1. The learners will characterize different coordination compounds with the help of conductivity measurements, electronic and magnetic measurements and spectroscopic measurements.
2. Able to calculating the equilibrium constant for Fe^{3-}/SCN^{1-} by slope intercept method
3. Able to determine the electrolytic nature of some inorganic compounds by conductance measurements.

Course	Modules	No. of Credits
Physical Chemistry	**Non – Instrumental:** 1. Polar plots of atomic orbitals such as 1s, Pz and 3dz2 orbitals by using angular part of hydrogen atom wave functions. 2. To study the influence of ionic strength on the base catalysed hydrolysis of ethyl acetate. 3. To study phase diagram of three component system water – chloroform/ toluene - acetic acid. 4. To determine the rate constant of decomposition reaction of diacetone alcohol by dialtometric method. **Instrumental:** 5. To determine the formula of silver ammonia complex by potentiometric method. 6. To determine CMC of sodium Lauryl Sulphate from measurement of conductivities at different concentrations. To determine Hammette constant of m- and p- amino benzoic acid/nitro benzoic acid by pH measurement. 7. To determine the Michaelis – Menten"s constant value (Km) of the enzyme Beta Amylase spectrophotometrically.	01
Inorganic Chemistry	**Inorganic Preparations (Synthesis and Characterization)** 1. Bis-(tetramethylammonium) tetrachloroCuprate (II) $(Me_4 N)_2[CuCl_4]$ 2. Bis-(tetramethylammonium) tetrachloroNickelate (II) $(Me_4 N)_2 [NiCl_4]$ 3. Bis (ethylenediammine) Copper (II) Sulphate $[Cu(en)_2]SO_4$ 4. HexaaamineNi(II) Sulfate $[Ni(NH3)_6]SO_4$ 5. Potassiumtrioxalato Chromate(III) $K_3[Cr(C_2O_4)_3]$ 6. Tetramminemonocarbanato Cobalt (III) Nitrate $[Co(NH_3)_4CO_3]NO_3$ **Instrumentation :** 1. Determination of equilibrium constant by Slope intercept method for Fe^{+3}/ SCN system 2. Determination of Electrolytic nature of inorganic compounds by Conductance measurement.	01
Total		**02**

References:

Physical Chemistry Practical:

1. B. Viswanathan and P.S. Raghavan, Viva Books Private Limited, Practical Physical Chemistry, 2005.
2. A.M. James and F.E. Prichard, Practical Physical Chemistry, 3rd Edn., Longman Group Ltd., 1974.
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Inorganic Chemistry Practical:

1. G. N. Mukherjee., U.N. Dhuri and Sons Pvt. Ltd. Advanced experiments in Inorganic Chemistry., 1st Edn., 2010.
2. William L. Jolly, The Synthesis and Characterization of Inorganic Compounds.
3. Dr. Deepak Pant, Inorganic Chemistry Practical Under UGC Syllabus for M.Sc. in all India Universities.

Evaluation Pattern: Practical Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of Journal.	15
04	Overall performance (attendance, punctuality, interaction during Practical session throughout semester).	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Physical Chemistry	Experiment performance as per the practical slip	Three and half hours	25
2.	Inorganic Chemistry	Experiment performance as per the practical slip	Three and half hours	25
	Journal + Viva			5+5
Total				**60**

Practical examination will be of 60 marks at the end of semester which will be converted to 30 Marks.

CIE	Semester End	Total Marks
20	30	50

Revised Syllabus of Courses of Master of Science (M.Sc.)
Programme atSemester II with Effect from the Academic Year
2023-2024

Name of the Course	Industrial Training/Field Project
Course Code	PSCH209
Class	M.Sc.
Semester	II
No of Credits	4
Nature	Practical
Type	Industrial Training/Field Project
Relevance with Employability/ Entrepreneurship/ Skill development	On the job training provides learner with the opportunity to acquire hands on experience and practical skills required for specific job roles. It bridges the gap between theoretical knowledge and the practical requirements of the job. Learner can gain valuable insights into the industry practice, company culture, this experience makes them confident and competent candidate when applying for the position increasing the employability prospects. OTT is instrumental in skill development as it focuses on practical job specific competencies like technical skills, soft skills. Overall OTT enhances employability, foster entrepreneurship by providing valuable industry exposure.

Guidelines and Evaluation pattern for On Job Training/ Field Project (100 Marks)

Introduction:

Inclusion of On Job Training/ Field Project in the course curriculum of the M.Sc. programme is one of the ambitious aspects in the programme structure. The main objective of inclusion of On Job Training/ Field Project is to inculcate ability to interpret particular aspect of the study in his/ her own words.

Guidelines for On Job Training

On-the-Job Training/Field Project: Students will be required to undertake a designated project or tasks in an organization or industry relevant to their field of study. The course aims to provide students with practical exposure and hands-on experience in a professional work environment related to their field of study.

Course Objectives:

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

1. Gain exposure to real-world insights and apply theoretical knowledge to practical situations
2. Enhance skills regarding problem-solving, decision-making, and communication skills.
3. Understand organizational dynamics and work culture.
4. Build industry connections and networking opportunities.

Course Duration:

Minimum 15 days / 120 hours of On Job Training with an Organization /Private firm.

- The theme of the internship should be based on any study area of the Major course.
- Project Report should be of minimum 30 pages.
- Experience Certificate is Mandatory.

Report Structure:

The students will be required to submit a comprehensive report at the end of the On-the-Job Training. A project report has to be brief in content and must include the following aspects:

a) **Title Page:**

   Mentioning the title of the report, name of the student, program, institution, and the period of training.

b) **Certificate of Completion:**

   A certificate issued by the organization or supervisor confirming the successful completion of the training.

c) **Declaration:**

A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) **Acknowledgments:**

Recognizing individuals or organizations that provided support, guidance, or resources during the training.

e) **Table of Contents:**

Providing a clear outline of the report's sections and page numbers.

f) **Executive Summary:**

A bird"s eye view of your entire presentation has to be precisely offered under this category.

g) **Introduction on the Company:**

A concise representation of company/ organization defining its scope, products/ services

h) **Your Role in the Organization during the on Job Training:**

The key aspects handled, the department under which you were deployed and brief Summary report duly acknowledged by the reporting head.

i) **Challenges**:

The challenges confronted while churning out theoretical knowledge into practical world.

j) **Conclusion:**

A brief overview of your experience and suggestions to bridge the gap between theory and practice.

Evaluation Pattern: On Job Training

Evaluation of On Job Training will be done at the end of semester for 100 marks.

Evaluation / Marking Scheme:

Sr. No.	Criteria	Marks
1	OTT Report	30
2	Content Understanding	15
3	Application Learning	15
4	Reflection and Critical thinking	15
5	Writing and presentation	15
6	Overall performance	10
	Total Marks	**100**

Guidelines for Field Project

Course Outcomes:
By the end of the course, learners should be able to:

1. Understand the ethics and research methodology.
2. Do a literature review.
3. Do research.
4. Analyze the research work data.
5. Write research theses.

Course Duration: One Semester Minimum 120 hours of field project work.

Course Outline

1. Identifying problem for project work (2 weeks).
2. Literature survey (2 weeks).
3. Designing and implementing the project through necessary experimental work (4 weeks).
4. Data collection and its analysis and interpretation. (2 weeks).
5. Report writing and presentation (2 weeks).

Format of Project Report

a) **Title Page:**
   Mentioning the title of the report, name of the student, program, institution, and the period of training / project.

b) **Certificate of Completion:**
   A certificate issued by the organization or supervisor confirming the successful completion of the training/project.

c) **Declaration:**
   A statement by the student declaring that the report is their original work and acknowledging any assistance or references used.

d) **Acknowledgments:**
   Recognizing individuals or organizations that provided support, guidance, or resources during the training/project.

e) **Table of Contents:**
   Providing a clear outline of the report's sections and page numbers.

f) Abstract:

A bird‟s eye view of learner‟s entire presentation has to be precisely offered under this category. A brief overview of the project, its objectives and key findings should be mentioned.

g) Introduction

Background information about the field project and its significance. Objectives and scope of the project.

h) Literature Review:

Overview of relevant literature and studies related to the chosen field and development issues.

i) Methodology:

Description of Planning of experimental procedure as per the need of the project. Designing and implementation of the project as per the objectives through theoretical, experimental methods.

j) Observations and data analysis:

Data collection and analysis

k) Conclusion:

Summary of the key findings and outcomes of the project.

l) References and Appendices:

List of all sources cited in the project report. Additional supporting material.

The project report based on 'On Job Training/ Field Project' shall be prepared as per the broad guidelines given below:

- Font type: Times New Roman
- Font size: 12-For content, 14-for Title
- Line Space: 1.5-for content and 1-for in table work
- Paper Size: A4
- Margin: in Left-1.5, Up-Down-Right-1
- The Project Report shall be bounded.

Evaluation Pattern: Field Project

Evaluation of Project will be done at the end of semester for 100 marks.

Evaluation / Marking Scheme:

Sr. No.	Criteria	Marks
1	Research Project theme/objective	10
2	Literature Survey/ References	10
3	Experimental/Theoretical methodology/Working condition of project.	30
4	Depth of knowledge in the subject / Results and Discussion	20
5	Project report	15
6	presentation	15
	Total Marks	**100**

Format

1st page (Main Page)

Title of the problem of the Project

A Project Submitted

to

R. P. Gogate college of Arts and Science and

R.V. Jogalekar College of Commerce Autonomous College

Under

University of Mumbai

For partial completion of the degree

of

Master in Science

(Chemistry)

Under the Faculty of Science

By

Name of Student

Under the Guidance of

Name of the Guiding Teacher

R. P. Gogate college of Arts and Science and

R.V. Jogalekar College of Commerce Autonomous College,

Near District Court, Rtnagiri

Month and Year

Index

DECLARATION BY LEARNER

I the undersigned Miss/Mr. ____ [Name of the learner] here by, declare that work embodied in this project work titled ________________ forms my own contribution to the research work carried out under the guidance of [Name of the guiding teacher]__________________________________is a result of my own research work and has not been previously submitted to any other University for any other Degree/ Diploma to this or any other University.

Wherever reference has been made to previous works of others, it has been clearly indicated as such and included in the bibliography.

I, here by further declare that all information of this document has been obtained and presented in accordance with academic rules and ethical conduct.

Name and Signature of the learner

Certified by

Name and signature of the Guiding Teacher

On separate page
Acknowledgment
(Model structure of the acknowledgement)

To list who all have helped me is difficult because they are so numerous and the depth is so enormous.

I would like to acknowledge the following as being idealistic channels and fresh dimensions in the completion of this project.

I thank the R. P. Gogate college of Arts and Science and R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous) and University of Mumbai for giving me opportunity to dothis project

I would like to thank my Principal,___________for providing the necessary facilities required for completion of this project.

I take this opportunity to thank our HOD_______________, for his moral support and guidance

I would also like to express my sincere gratitude towards my project guide _____________whose guidance and care made the project successful.

I would like to thank my College Library, for having provided various reference books and magazines related to my project.

Lastly, I would like to thank each and every person who directly or indirectly helped me in the completion of the project especially my Parents and Peers who supported me throughout my project.

Date: 03/11/2023

Chairperson BoS
(Dr. M. G. Gore)

R.E. Society's
R.P. Gogate College of Arts & Science
&
R.V. Jogalekar College of Commerce
(Autonomous)
Ratnagiri
(Affiliated to University of Mumbai)

Syllabus for

M.Sc. II

(Analytical Chemistry)

Semester III & IV

Under Choice Based Credit System (CBCS)

With effect from Academic Year- 2023-2024

Name of Programme	**M.Sc.**
Level	PG
No of Semesters	03 and 04
Year of Implementation	**2023-2024**
Programme Specific Outcomes (PSO)	1. Acquire in-depth knowledge of the advance concepts in the specialization of Analytical Chemistry. 2.Apply the skills to do specialized research in the core and applied areas of chemical sciences. 3.The students will become technically sound and aware to handle the sophisticated instruments/equipments. 4.The students will understand good laboratory practices and safety. 5. Explain why Analytical chemistry plays an integral role in addressing social , economic and environmental problems. 6. Ability to design and optimize separation methods for various compounds and analytes,considering actors like selectivity, resolution and efficiency. 7. Understanding of the fundamental principles of separation techniques including chromatography,electrophoresis,and solvent extraction techniques. 8. Demonstrating the developed skills such as problem solving approach, critical thinking, analytical reasoning ,team work and effective communication for solving the applied research problems related to their field. 9. Generate awareness of the benefits and impacts of chemistry related to the environment, society, and other disciplines outside the scientific community. 10. Developing professional skills to work in the industry and go to research facilities for further education.
Relevance of PSOs to the local, regional, national, and global developmental needs (200 words)	• Analytical chemistry is a powerful discipline with a far-reaching impact, addressing issues and challenges at all levels, from local environmental concerns to global health and trade standards. • Its applications are critical for the well-being of communities and nations and the advancement of science and technology. • Analytical techniques are used to confirm product safety and authenticity. • It is used for national security in areas like forensics and defense, providing tools for crime scene investigations, explosives detection, and border control. • Analytical chemistry ensures the safety of food, pharmaceuticals, and consumer products. National regulatory agencies use analytical methods to enforce quality and safety standards. • Apply the skills to do specialized research in the core and applied areas of chemical sciences. • Become professionally skilled for higher studies in research institutions and to work in industries. • Students will be able to integrate chemical concepts and ideas learned in lecture courses with skills learned in

	laboratories to formulate hypotheses, propose and perform experiments, collect data, compile and interpret results and draw reasonable and logical conclusions. • Students will be able to identify and solve chemical problems and explore new areas of research • Be proficient in the use of both classical and modern tools (e.g., instrumentation, techniques, software) for analysis of chemical systems.

Revised Scheme of Examination
Faculty of Science
(Post-graduate Programmes)
Choice Based Credit System (CBCS)
Scheme of Examination
Master of Science (M.Sc.) Programme

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks and by conducting the Semester End Examinations with 60% marks. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

Sr.No.	Particulars	Marks
01	One Periodical Class Test /Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Performance Grading:
Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	0 (Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+ (Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+ (Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C (Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

M.Sc. - II (Analytical Chemistry)

Course Code	Semester III	Credits	Course Code	Semester IV	Credits
PSCHA301	Quality In Analytical Chemistry	**04**	PSCHA401	Quality In Analytical Chemistry	**04**
PSCHA302	Advance Instrumental Techniques	**04**	PSCHA402	Advanced Instrumental Techniques	**04**
PSCHA303	Bioanalytical Chemistry and Food Analysis	**04**	PSCHA403	Selected Topics in Analytical Chemistry	**04**
PSCHAEC-I 304	Environmental and Certain Industrially Important Matrials	**04**	PSCHAOC-I 404	Intellectual Property Rights and Cheminformati cs	**04**
PSCHAEC-II 304	Pharmaceutica l and Organic Analysis	**04**	PSCHAOC- II 404	Research Methodology	**04**
PSCHA3P1	Group – A Practical	**02**	PSCHA4P1	Group – A Practical	**02**
PSCHA3P2	Group – B Practical	**02**	PSCHA4P2	Group – B Practical	**02**
PSCHA3P3	Group – C Practical	**02**	PSCHA4P3	Group – C Practical	**02**
PSCHA3P4	Group – D Practical	**02**	PSCHA4P4	Group – D: Project Evaluation	**02**

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Course Code: PSCHA301

Nomenclature: Quality In Analytical Chemistry

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA301
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--------

Course Outcomes: After completion of course student will able to :

CO1: Explain the concept of sampling and various methods used to prepare and store samples.

CO2: Choose the most effective out of all the methods available for the analysis of samples.

CO3: Describe the sources and different methods employed to improve the signal-to-noise Ratio.

CO4: Evaluate the uncertainty involved in a measurement.

CO5: Apply the parameters involved in method validation for developing a new method for the analysis of a sample.

CO6: Select the best method out of all the methods available for the analysis of samples.

CO7: Explain the basic theory and principle instrumentation and applications involved in Supercritical fluid Chromatography ,Affinity Chromatography and Optimum pressure liquid chromatography (OPLC)

CO8: Learn about the Selection of stationary phases, organic modifiers and additives in Supercritical fluid Chromatography (SFC).

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Quality In Analytical Chemistry – I**	1.1Sampling: Definition, types of sample, sampling plan, quality of sample, Sub sampling, Sampling of raw materials, intermediates and finished products. Sample preparations – dissolution technology and decomposition, storage of Sample. Pre-treatment of samples: soil, food and cosmetics. (8L) 1.2 Selection of the Method: sources of methods, factors to consider when selecting a method, performance criteria for methods used, reasons for Incorrect analytical results, method validation, and quality by design (PAT). (7L)	**15L**
II	**Quality In Analytical Chemistry - II**	2.1 Measurement of uncertainty: Definition and evaluation of uncertainty, putting uncertainty to use, interpretation of results and improving the quality of results. (4L) 2.2 Signal to noise: Signal to noise ratio, sources of noise in instrumental analysis. Signal to noise enhancement, hardware devices for noise reduction, software methods for noise reduction. (6L) 2.3 Pharmaceutical Legislation: introduction to drug acts, drug rules (schedules), concept of regulatory affairs in pharmaceuticals, review of GLP and GMP and their regulations for analytical labs, roles and responsibilities of personnel, appropriate design and placement of laboratory equipment, requirements for maintenance and calibration. (5L)	**15L**
III	**Chromatographic Techniques –I**	3.1 Ion exchange chromatography: Ion exchange equilibria, breakthrough capacity, inorganic ion exchangers, synthetic ion exchangers, chelating resins and their applications for separation of inorganic and organic compounds. (8L) 3.2 Ion chromatography: Principle, instrumentation with special reference to separation and suppressor columns, applications. (2L) 3.3 Exclusion chromatography : Theory, instrumentation and applications of gel permeation chromatography, retention behavior, inorganic molecular sieves, determination of molecular weight of polymers, (5L)	**15L**

IV	**Chromatographic Techniques –II**	4.1 Supercritical fluid Chromatography: Theory, concept of critical state of matter and supercritical state, types of supercritical fluids, instrumentation, applications to environmental, food, pharmaceuticals and polymeric analysis. (8L) 4.2 Affinity Chromatography: principle, instrumentation and applications. (4L) 4.3 Optimum pressure liquid chromatography (OPLC). (3L)	**15L**

References:

1. Quality in the analytical chemistry laboratory, E Prichard, John Wiley and sons N.Y 1997.
2. Quality assurance in analytical Chemistry, W Funk, V Dammann, G. Donnevert VCH Weinheim 1995.
3. Amit S. Patil*et. al.*,Quality by Design (QbD) : A new concept for development of Quality pharmaceuticals, International Journal of Pharmaceutical Quality Assurance; 4(2); 13-19.
4. Lalit Singh and Vijay Sharma, Quality by Design (QbD) Approach in Pharmaceuticals: Status, Challenges and Next Steps, Drug Delivery Letters, 2015, 5, 2-8. Quality in the analytical chemistry laboratory, E Prichard, John Wiley and sons N.Y 1997
5. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West, Saonders, College publication.
6. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
7. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969.
8. Analytical Chemistry, G. D. Christain, Wiley
9. Extraction Chromatography T. Braun, G. Ghersene, Elsevier Publications 1978.
10. Supercritical Fluid Extraction, Larry Taylor Wiley publishers N.Y. 1996
11. Ion exchange separation in analytical chemistry O Samuelson John Wiley 2^{n}ded1963
12. Ion exchange chromatography Ed H.F Walton Howden, Hutchenson and Rossing 1976.
13. Chromatographic and electrophoresis techniques I Smith MenemannInterscience 1960.

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA3P1
Class	M.Sc.-II
Semester	III
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------

Practical:

Course Code: PSCHA3P1

Group – A

Course Outcomes: After completion of course student will able to :

CO1: DeterminethepK_{In} value of an indicator spectrophotometrically.

CO2: Estimate the amount of copper and bismuth in a mixture of sample by photometric titration.

CO3: Determine the amount of strong acid, weak acid and salt in the given mixture conductometrically.

CO4: Estimate amount of carbonate and bicarbonate in the given sample mixture using pH metry.

CO5: Determine % of copper by extractive photometry using diethyldithiocarbamate.

Curriculum:

Unit	Title	Learning Points	No. of Credit
Group A	Spectrophotometry	1. Determination of the pKIn value of an indicator.	02
	Spectrophotometry	2. Determination of copper and bismuth in mixture by photometric titration	
Instrumental	Conductometry	3. Estimation of strong acid, weak acid and salt in the given mixture conductometrically.	
	pHmetry.	4. Analysis of mixture of carbonate and bicarbonate (present in ppm range) using pH metry.	
	Spectrophotometry	5. Determination of copper by extractive photometry using diethyldithiocarbamate.	

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by ; A. I. Vogels, 3rd Ed. ELBS (1964)
2. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
3. Standard methods of chemical analysis ; F. J. Welcher, 1975.
4. Standard methods of chemical analysis :Instrumental methods of Analysis ; F. J. Welcher , vol. 3, 1966.
5. "Standard methods of Chemical Analysis"; W. W. Scott, Vol. I, Van Nostrand Company, Inc.,1939.
6. "Spectrophotometric Determination of Traces of Metals"; E.B.Sandell and H.Onishi, Part II,4th Ed. ,A Wiley Interscience Publication, New York,1978

Evaluation Pattern: Practical

Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Group A	Experiment performance as per the practical slip	Three and half hours	40
2	Journal + Viva			5+5
		Total		**50**

Practical examination will be of 50 marks at the end of semester which will be converted to 30 Marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Course Code: PSCHA302

Nomenclature: Advance Instrumental Techniques

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA302
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-------------------

Course Outcomes: After completion of course student will able to :

CO1: Make use of the surface analytical techniques (such as SIMS,PIXE) for obtaining information about the surfaces while characterizing the samples.

CO2: Learn the basic principle, instrumentation and applications of Rutherforbackscattering.

CO3: Understand the Mossbauer spectroscopy by learning the principle and recording of spectrum including Doppler effect, chemical shift etc. Understand the basic principles, Instrumentation and applications of ESR and AES.

CO4: Select a suitable method of voltammetry for the analysis of a particular sample.

CO5: Explain anodic, cathodic and adsorptive stripping methods in voltammetry.

CO6: Develop a working knowledge of various methods used in polarography.

CO7: Apply the principle underlying spectroelectrochemistryand the use of optically transparent electrodes to carry out the analysis of samples.

CO8: Make use of the phenomenon of chemiluminescence for varied applications.

CO9: Elaborate on the concept of Chiro-optical methods such as ORD and CD.

Curriculum:

Unit	Title	Learning Points	No. of Lecture
I	**Spectral Methods I**	1.1 Surface Analytical Techniques: Preparation of the surface, difficulties involved in the surface analysis.(1L) 1.2 Principle, instrumentation and applications of the following: a. Secondary Ion mass spectroscopy.(4L) b. Particle-Induced X-Ray Emission (5L) c. Low-Energy Ion Scattering and Rutherford Backscattering.(5L)	**15L**
II	**Spectral Methods – II**	Principle, Instrumentation, and Applications of 2.1 Electron Spin Resonance Spectroscopy (ESR) (5L) 2.2 Mossbauer's Spectroscopy. (5L) 2.3 Atomic Emission Spectroscopy- based on plasma and electrical discharge sources (5L)	**15L**
III	**Electroanalytical Methods**	Advanced Electroanalytical Techniques:- 3.1 Current Sampled (TAST) Polarography, Normal and Differential Pulse Polarography (3L) 3.2 Potential Sweep methods- Linear Sweep Voltammetry and Cyclic voltammetry.(3L) 3.3 Potential Step method- Chronoamperomertry (2L) 3.4 Controlled potential technique- Chronopotentiometry (2L) 3.5 Stripping Voltammetry- anodic, cathodic, and adsorption (2L) 3.6 Chemically and electrolytically modified electrodes and ultramicroelectrodes in voltammetry (3L)	**15L**
IV	**Miscellaneous Techniques**	Principle, Instrumentation and Applications of: 4.1Chemiluminesescence techniques (3L) 4.2 Chirooptical Methods : ORD, CD (5L) 4.3 Photoacoustic spectroscopy (3L) 4.4Spectroelectrochemistry (4L)	**15L**

References :

1. Analytical Chemistry, G. D. Christian, 4th Ed. John Wiley, New York (1986)
2. Fundamentals of Analytical Chemistry, D .A. Skoog and D. M. West and F. J. Holler Holt- Saunders 6th Edition (1992)
3. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J.A. Niemann, 5th Edition (1998)
4. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt, Jr. J. A. Dean and F. A. Settle Jr 6th Ed CBS (1986)

5. Instrumental Methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A. Settle Jr 7th Ed CBS (1986)
6. Introduction to Instrumental Analysis, R. D. Braun, McGraw Hill (1987)
7. Electrochemical Methods, A. J. Bard and L.R. Faulkner, John Wiley, New York, (1980)
8. Electroanalytical Chemistry, J.J .Lingane, 2nd Ed Interscience, New York (1958)
9. Modern Polarographic Methods in Analytical Chemistry, A. M. Bond, Marcel Dekker, New York, 1980.
10. Electroanalytical Chemistry, Ed A. J. Bard and Marcel Dekker, New York, (A series of volumes)
11. Techniques and mechanism of electrochemistry, P. A. Christian and A. Hamnett, Blachie Academic and Professional (1994)
12. Wilson and Wilson's Comprehensive Analytical Chemistry, Ed. G. Svehla. (A series of Volumes)
13. Treatise on Analytical Chemistry, Eds. I. M. Kolthoff and Others, Interscience Pub. (A series of volumes).
14. Standard Methods of Chemical Analysis, Eds. F. J. Welcher, Robert E. Krieger Publishing Company, (A series of volumes)
15. Polarographic Methods in Analytical Chemistry, M. G. Arora, Anmol Publications Pvt Ltd
16. Surface Analysis –The Principal Techniques, 2nd Edition Edited by John C. Vickerman and Ian S. Gilmore 2009 John Wiley and Sons, Ltd. ISBN: 978-0-470-01763-0
17. NMR, NQR, EPR, and Mössbauer Spectroscopy in Inorganic Chemistry *R. V. Parish*. Ellis Horwood, Chichester

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA3P2
Class	M.Sc.-II
Semester	III
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--------------

Practical:

Course Code: PSCHA3P2 (Group – B)

Course Outcomes: After completion of course student will able to :

CO1: Estimate the % purity of given drugs by non-aqueous titration.

CO2: Determine the percentage purity of methylene blue indicator.

CO3: Find the amount of cholesterol and Uric acid in the given sample of blood serum.

CO4: Estimate the amount of fluoride in a tooth paste.

CO5: Find the amount of silica by molybdenum blue method.

Curriculum:

Unit	Title	Learning Points	No of Credit
Group B **Non-Instrumental**	Non aqueous titration	Estimation of drugs by non-aqueous titration: Pyridoxine hydrochloride, Sulphamethoxazole.	02
	Redox titration	Determination of percentage purity of methylene blue indicator	
Instrumental	Spectrophotometry	Estimation of cholesterol and Uric acid in the given sample of blood serum	
	Colorimeter	Estimation of fluoride in a tooth paste.	
	Spectrophotometry	Determination of silica by molybdenum blue method.	

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by ; A. I. Vogels, 3rd Ed. ELBS (1964)
2. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
3. Standard methods of chemical analysis ; F. J. Welcher, 1975.
4. Standard methods of chemical analysis :Instrumental methods of Analysis ; F. J. Welcher , vol. 3, 1966.
5. "Standard methods of Chemical Analysis"; W. W. Scott, Vol. I, Van Nostrand Company, Inc.,1939.
6. "Spectrophotometric Determination of Traces of Metals"; E.B.Sandell and H.Onishi, Part II,4th Ed. ,A Wiley Interscience Publication, New York,1978

Evaluation Pattern: Practical

Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Group B	Experiment performance as per the practical slip	Three and half hours	40
2	Journal + Viva			5+5
		Total		**50**

Practical examination will be of 50 marks at the end of semester which will be converted to 30 Marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA303
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----------------------

Nomenclature: Bio analytical Chemistry and Food Analysis

Course Code: PSCHA303

Course Outcomes: After completion of course student will able to :

CO1: Describe the composition of body fluids (blood and Urine).

CO2: To study about detection of abnormal levels of glucose, creatinine, uric acid in blood, protein, ketone bodies and bilirubin in urine.

CO3: Enlist the physiological and nutritional significance of vitamins and biological macromolecules.

CO4: Apply the various analytical (microbiological techniques) learned for the analysis of these vitamins and biological macromolecules which in turn will help them in identification and diagnosis of diseases.

CO5: Explain the mechanism of operation of immune system and Immunological assays.

CO6: Enlist the Biological values of carbohydrates, proteins, essential amino acids and lipids.

CO7: Describe the various food preservation techniques that are widely practiced in food industries as quality control measure.

CO8: Design an experiment to confirm the presence and amount of various components present in Different types of food samples for further label claim studies.

CO9: To study about analyzing everyday items like milk, oil and fats as well as spices.

CO10: Describe the various food packaging and food processing methods.

Curriculum:

Unit	Title	Learning Points	No. of Lecture
I	**Bioanalytical chemistry**	1.1 Body Fluids 1.1.1 Composition of body fluids and detection of abnormal levels of glucose, creatinine, uric acid in blood, protein, ketone bodies and bilirubin in urine leading to diagnosis of diseases.(5L) 1.1.2 Physiological and nutritional significance of vitamins (water soluble and fat soluble) and minerals. (5L) 1.1.3 Analytical techniques (including microbiological techniques) for vitamins. (5L)	**15L**
II	**Immunological Methods**	2.1 General processes of immune response, antigen-antibody reactions,precipitation reactions, radio, enzyme and fluoro-immuno assays.(8L) 2.2 Human Nutrition: Biological values and estimation of enzymes, carbohydrates, proteins, essential amino acids and lipids.(7L)	**15L**
III	**Food Analysis - I**	3.1 Fuel value of food and importance of food nutrients. (2L) 3.2 Food Additives – General idea about Food processing and preservation,Chemical preservatives, fortifying agents, emulsifiers, texturizing agents, flavours, colours, artificial sweeteners, enzymes. Analysis of food products for flavoring agents and colour. (5L) 3.3 Food Contaminants– Trace metals and pesticide residues, contaminants from industrial wastes (polychlorinated polyphenols, dioxins), toxicants formed during food processing (aromatic hydrocarbons, nitrosamines), veterinary drug residues and melamine contaminants.(8L)	**15L**
IV	**Food Analysis – II**	4.1.1 Food packaging – Introduction, types of packing materials, properties and industrial requirements. (2L) 4.1. 2 Processing and Quality requirements of Milk and milk products (cheese, butter and ice cream), vegetables and fruits, meat and meat products. (6L) 4.2 Analysis of Milk – Fat content, proteins, acidity, bacteriological quality and milk adulterants. (2L) 4.3 Analysis of Oils and Fats – acid value, sap value, iodine value. Determination of rancidity and antioxidants. (2L) 4.4 Analysis of spices (cloves, cinnamon, pepper, mustard) Determination of volatile oils and fixed oils.(3L)	**15L**

References:

1. General, organic and biological chemistry, H. Stephen Stoker, Cengage Learning.
2. Advance dairy chemistry, vol 3, P. F. Fox, P. L. H. McSweeney Springer.
3. Physiological fluid dynamics vol 3,Nanjanagud Venkatanarayanasastry Chandrasekhara Swamy Narosa Pub. House, 1992
4. Molecular Biological and Immunological Techniques and Applications for food, edited by Bert Popping, Carmen Diaz-Amigo, KatrinHoenicke, John Wiley and sons.
5. Food Analysis: Theory and practice, YeshajahuPomeranz, Clifton E. Meloan, Springer.
6. Principles of package development, Gribbin et al
7. Modern packaging Encyclopedia and planning guide, MacgraWreyco.
8. Food Analysis, Edited by S. Suzanne Nielsen, Springer
9. Analytical Biochemistry, D, J. Homes and H. Peck, Longman (1983)
10. Bioanalytical Chemistry, S. R. Mikkelesen and E. Corton, John Wiley and sons 2004 Analysis of food and beverages, George Charalanbous, Accademic press 1978

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA3P3
Class	M.Sc.-II
Semester	III
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---------------------------------------

Practical:

Course Code: PSCHA3P3

Group – C

Course Outcomes: After completion of course student will able to :

CO1: Estimate total reducing sugars before and after inversion in honey by redox titration.

CO2: Determine the % of lactose in milk sample.

CO3: Determine the % of Caffeine in tea sample.

CO4: Estimate the amount of Vitamin C in lemon Juice/squash.

CO5: Study of alcoholic beverages (Beer) for alcohol content by distillation followed by specific gravity method, acidity by titration, total residue by evaporation.

Curriculum:

Unit	Title	Learning Points	Credit
Group – C	Redox Titration	Total reducing sugars before and after inversion in honey using: (a) Cole's Ferricyanide (b) Lane - Eynon method	02
	Volumetric Titration	Analysis of lactose in milk	
	Gravimetry	Estimation of Caffeine in tea	
Non-Instrumental	Volumetric Titration	Estimation of Vitamin C in lemon Juice/squash by Dichlorophenol-indophenol method	
	Wij's Method	Iodine value of oil / fat	
	Evaporation method	Analysis of alcoholic beverages (Beer) for alcohol content by distillation followed by specific gravity method, acidity by titration, total residue by evaporation	

References:

1. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by ; A. I. Vogels, 3rd Ed. ELBS (1964)
2. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
3. Standard methods of chemical analysis ; F. J. Welcher, 1975.
4. Standard methods of chemical analysis :Instrumental methods of Analysis ; F. J. Welcher , vol. 3, 1966.
5. "Standard methods of Chemical Analysis"; W. W. Scott, Vol. I, Van Nostrand Company, Inc.,1939.
6. "Spectrophotometric Determination of Traces of Metals"; E.B.Sandell and H.Onishi, Part II,4th Ed. ,A Wiley Interscience Publication, New York,1978

Evaluation Pattern: Practical

Max. Marks 50

A) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

B) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Group C	Experiment performance as per the practical slip	Three and half hours	40
2	Journal + Viva			5+5
		Total		**50**

Practical examination will be of 50 marks at the end of semester which will be converted to 30 Marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHAEC-I 304
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-----------------------

Course Code:PSCHA304

Nomenclature: Environmental and Certain Industrially Important Materials

Course Outcomes: After completion of course student will able to :

CO1: To understand the classification of sources of pollution and their permissible limit.

CO2: Employ the sampling techniques to collect samples of these air pollutants.

CO3: Outline the role of pollution control boards in monitoring and controlling pollution.

CO4: Evaluate the quality of potable water based on the guidelines laid down by the regulatory bodies.

CO5: To understand methods to maintain the quality of water.

CO6: Indicate appropriate measures to reduce/or minimize the effects of these pollutants on environment.

CO7: Evaluate the need for sustainable development having studied the adverse effects of present day development on the environment and by Self-reflection on the individual day to day practices.

CO8: Recommend methods for the biodegradation of insecticides and pesticides.

CO9: Judge the quality of the detergents by making use of the various methods which are used in industries for carrying out their analysis.

Curriculum:

Unit	Title	Learning Points	No. of Lectures
I	**Air Pollution**	1.1 Sources, classification, pollutants and permissible limits. (2L) 1.2 Sampling methods for air, flew gas ,Industrial Exhaust, stag samples etc. (2L) 1.3 Importance of automobile exhaust control and its limits. (2L) 1.4 Sampling and analysis of: Particulate matter, aerosols, ammonia and organic vapors. (3L) 1.5 Carbon credit and global issues related to air pollution. (3L) 1.6 Greenhouse gases and their substitutes. (1L) 1.7 Environmental Legislation: role of pollution control boards, article 48A and 51A, Motor Vehicle Act and method of analysis with respect to PUC. (2L)	**15L**
II	**Water Quality Standards**	2.1 Water: quality and requirements of potable water, direct and indirect pollutants for potable water reservoirs, quality of potable water from natural sources. (6L) 2.2 Bore well water quality and analytical parameters. Quality of bottled mineral water (3L) 2.3 Process of purification of bore well water to bottled mineral water. (2L) 2.4 Regulatory requirements for packaged drinking water (4L)	**15L**
III	**Other Types Of Pollution**	3.1 Soil pollution and Soil Analysis : sources of soil pollution and their control, sampling of soil, determination of water holding capacity, determination total nitrogen, ammonia and nitrates, fertility of soil and effect of pollution on it, synthetic fertilizers and their long term effect on soil quality. (6L) 3.2 Noise Pollution : sources, effects, methods of measurements and control measures. (2L) 3.3 Thermal Pollution: definition, source, impact, control measures, working of cooling towers and cooling ponds, involved economy. (3L) 3.4 Radioactive pollutants: source, exposure hazards, precautions in handling and safety, Long term effects. (2L) 3.5 Environmental Audits: concept of audit, authorities, evaluation methodology, benefits and certification. (2L)	**15L**

IV	**Industrial Materials**	4.1 Insecticides, Pesticides: definition, classification of insecticides pesticides. Biodegradation of insecticides and pesticides. (5L) 4.2 Soaps and Detergents: classification and composition, qualitative analysis, quantitative analysis of detergents- alkalinity, active ingredients and oxygen releasing capacity. Biodegradable detergents. (5L) 4.3 Petrochemical products: crude oils, fuels, and calorific values, fractional distillation process and fractions, properties of fuel, composition of fuel, flashpoint, fire point, corrosion test, carbon residue and impact on environment. (5L)	**15L**

References:

1. Environmental Chemistry, A. K. De, 2nd ED. Wiley (1989).
2. Environmental Pollution Analysis, S. M. Khopkar, John Wiely (1993).
3. Air Pollution Sampling And Analysis, SharadGokhale, IIT Guwahati, May 2009.
4. Environmental Pollution Analysis, S. M. Khopkar, New Age International publication (2011).
5. Water And Water Pollution (hand book) Ed., Seonard'lCiacere, Vol I to IV, Marcel Dekker inc.N.York(1972)
6. Water pollution, Arvindkumar, APH publishing (2004)
7. Introduction to Potable Water Treatment Processes Simon Parsons, Bruce Jefferson, Paperback publication.
8. Guidelines for drinking-water quality, Third edition, (incorporating first and second addenda). WHO report.
9. Soil pollution, S.G. Misra and Dinesh Mani, APH Publishing Corporation, (2009).
10. Soil Pollution: origin, monitoring and remediation, AbrahimMirsal, Springer (2010).
11. Noise Pollution, Donald F Anthrop, Lexington Books, (1973)
12. Noise Effects Handbook: A Desk Reference to Health and Welfare Effects of Noise (1981) Available at NCL laboratories e- Library.
13. Chemistry, Emission Control, Radioactive Pollution and Indoor Air Quality Edited by Nicolas Mazzeo, InTech Publications (2011).
14. Environmental Protection Against Radioactive Pollution: N. Birsen, Kairat K. Kadyrzhanov, Springer publication, (2003).
15. Environmental law in India, Mohammad Naseem, Wolters Kluwer.
16. Environmental Protection, Law and Policy in *India* Kailash Thakur google books (1997).
17. Green chemistry An Introductory text, Mzike Lancaster, Royal Society of Chemistry (2002)
18. Pesticide Analysis Ed K. G. Das, Dekker (1981)
19. Analytical, Agricultural Chemistry S. L Chpra J.S KanwarKalyani publication
20. Soil and plant Analysis C.S Piper , Hans Publication

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA3P4
Class	M.Sc.-II
Semester	III
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----------------------------------

Practical:

Course Code: PSCHA3P4

Group – D

Course Outcomes: After completion of course student will able to :

CO1: Determine the metal ions in given Pyrolusite ore.

CO2: Determine the metal ions in given Magnesium alloy.

CO3: Determine the composition of Bauxite ore.

CO4: Determine the chemical properties of water sample such as total hardness and salinity .

Curriculum:

Unit	Title	Learning Points	Credit
Group – D Instrumental	Colorimetry and Volumetry	To analyze Pyrolusite for: Fe by colorimetry and / or Mn by volumetry	02
	Complexometry.	To analyze Magnelium for Mg by complexometry.	
	Colorimetry / Gravimetry / (Volumetry)	Analysis of Bauxite for Ti by colorimetry / Al by gravimetry / Fe (volumetry)	
Non-Instrumental	Complexometry	Analysis of water sample: Total hardness and salinity	
	Precipitation Titration	Analysis of water sample: Acidity and sulphate (Benzidine method).	

References:

7. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by ; A. I. Vogels, 3rd Ed. ELBS (1964)
8. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
9. Standard methods of chemical analysis ; F. J. Welcher, 1975.
10. Standard methods of chemical analysis :Instrumental methods of Analysis ; F. J. Welcher , vol. 3, 1966.
11. "Standard methods of Chemical Analysis"; W. W. Scott, Vol. I, Van Nostrand Company, Inc.,1939.
12. "Spectrophotometric Determination of Traces of Metals"; E.B.Sandell and H.Onishi, Part II,4th Ed. ,A Wiley Interscience Publication, New York,1978

Evaluation Pattern: Practical

Max. Marks 50

C) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

D) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Group D	Experiment performance as per the practical slip	Three and half hours	40
2	Journal + Viva			5+5
		Total		**50**

Practical examination will be of 50 marks at the end of semester which will be converted to 30 Marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHAEC-II 304
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------------------------

Course Code: PSCHAEC-II 304

Nomenclature: Pharmaceutical and Organic Analysis

Course Outcome: After completion of course student will able to :

CO1: Categorize the different types of drugs and dosage forms.

CO2: Outline the role of FDA in pharmaceutical industry.

CO3: Make use of the different methods learned to estimate the amount of drug present in sample.

CO4: Apply the concept of impurity profiling, stability studies, limit test, bioavailability and bioequivalence while insuring the uniformity in the standard of quality, efficacy and safety of pharmaceutical products.

CO5: Elaborate the role of analytical chemistry in forensic science.

CO6: Identify and estimate amount of toxins found at crime scene.

CO7: Evaluate the quality of cosmetic product by carrying out their analysis using the methods learned.

Curriculum:

Unit	Title	Learning Points	No. of Leactures
I	**Pharmaceutical Analysis**	1.1 General idea regarding the Pharmaceutical Industry, definition and classification of drugs, introduction to pharmaceutical formulations, classification of dosage forms. Role of FDA in pharmaceutical industries. (7L) 1.2 Sources of impurities in pharmaceutical products and raw materials. (4L) 1.3 Standardization of finished products and their characteristics, official methods of quality control. (4L)	**15L**
II	**Drugs**	2.1 Analysis of compounds based on functional groups, instrumental methods for analysis of drugs, assays involving chromatographic separations, proximate assays, assays of enzyme containing substances, biological and microbiological assays and tests. (8L) 2.2 Limit tests, solubility tests, disintegration tests, stability studies, impurity profile of drugs, bioequivalence and bioavailability studies. Polymers in pharmaceuticals and novel drug delivery systems. (7L)	**15L**
III	**Forensic Science**	3.1 Analytical Chemistry in Forensic Science: General idea. (2L) 3.2 Forensic Analysis: Blood, DNA profiling, Hair analysis, Alcohol in body fluids, systematic drug identification. (5L) 3.3 Analytical Toxicology: Isolation, identification and determination of: 3.3.1 Narcotics: Heroin, morphine and cocaine. 3.3.2 Stimulants: Amphetamines and caffeine. 3.3.3 Depressants: Benzodiazepines, Barbiturates and Mandrax. 3.3.4 Hallucinogens: LSD and Cannabis. 3.3.5 Metabolites of drugs in blood and urine of addicts. 3.3.6 Viscera, stomach wash, vomit and postmortem blood for poisons like – cyanide, arsenic, mercury, insecticides and pesticides. (8L)	**15L**
IV	**Cosmetic Analysis**	4.1 Cosmetics: Introduction. Evaluation of cosmetic materials, raw materials and additives. Formulation, standards and methods of analysis. (2L) 4.2 Deodorants and antiperspirants: Al, Zn, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea. (3L) 4.3 Face powder: Fats, fatty acids, boric acid, barium sulphate, Ca, Mg, Ti, Fe, oxides of Ti, Fe and Al (total). (3L)	**15L**

		4.4 Hair tonic: 2,5-diaminotoluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers) (3L) 4.5 Creams and Lotions: Types of emulsions, chloroform soluble materials, glycerol, pH emulsion, ash analysis, nonvolatile matter (IR spectroscopy) (2L) 4.6 Lipsticks: General analysis, determination of - nonvolatile matter, lakes and fillers, trichloroethylene-acetone soluble contents. (2L)	

References:

1. Analytical Biochemistry, David J Holmes and Hazel Peck, Longman, 1983.
2. Bioanalytical Chemistry, Susan R Mikkelesen and Eduardo Cotton, John Wiley and Sons, 2004.
3. Analysis of food and beverages, George Charalanbous, Academic press, 1978.
4. Harry's Cosmetology, 7th Ed, Longman Scientific Co.
5. Formulation and Function of Cosmetics, Joseph Stefan Jellinek, Wiley Interscience, 1971.
6. Cosmetic Technology, Edward Sagarin, Interscience Publishers, 1957.
7. Modern Cosmetics, Edgar George Thommsen, Francis Chilson, Drug and Cosmetic Industry, 1947.
8. Encyclopedia of Industrial Chemical Analysis, Foster Dee Snell et al, Interscience Publishers, 1967.
9. Government of India Publications of Food, Drug and Cosmetic Act and Rules.
10. The Handbook of Drug Laws, M L Mehra, University Book Agency, Ahmedabad, 1997.
11. Chemical Analysis of Drugs, Takeru Higuchi, Interscience Publishers, 1995.
12. Text book of Pharmaceutical Analysis, Kenneth Antonio Connors, Wiley, 2001.
13. Food Processing and Preservation, B Sivasankar, Prentice - Hall of India Private Limited, 2007.
14. Food Additives, R M Pandey and S K Upadhyay, INTECH, Open Science/Open Minds.
15. Food Science, B Srilakshmi, New Age International (P) Ltd. Publishers, 2003.
16. Food Contaminants: Sources and Surveillance, Edited by C Creaser, R Purchase, Elseiver, 1991.
17. The Chemical Analysis of Food and Food Products, Morris B Jacobs.
18. FSSAI (Food Safety and Standards Authority of India) Manuals of Methods of Analysis of Foods (Oils and Fats, Milk and Milk Products, Food Additives), Ministry of Health and Family Welfare, Government of India.
19. Fundamentals of Urine and Body Fluid Analysis, Nancy A Brunzel, Elsevier health Sciences, 2013.
20. Lab Manual on Blood analysis and Medical Diagnostics, DrGayatri Prakash, S Chand and Company Ltd, New Delhi.
21. Manual of Medical Laboratory Techniques, S Ramakrishnan and K N Sulochana, JaypeeBrothersMedical Publishers (P) Ltd, 2012. 22) Indian Pharmacopeia, Volume I and II.

22. Forensic Chemistry, Suzanne Bell, Pearson Prentice Hall Publication, 2006.
23. Forensic Chemistry, David E Newton, Infobase Publishing, 2007.
24. Encyclopedia of Analytical Chemistry, Volume 3, Academic Press, 1995.
25. AOAC Volume I and II.

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA401
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-------------------------------

Course Code: PSCHA401

Nomenclature: Quality In Analytical Chemistry

Course Outcomes: After completion of course student will able to:

CO1: Identify and design the suitable membrane separation technique for intended problem.

CO2: To gain knowledge of solvent extraction and their applications.

CO3: Select an appropriate method for the processing, extraction using different techniques and standardization of the herbal materials as per WHO cGMP guidelines.

CO4: To understand about the identification, processing and authentication of herbal materials.

CO5: Acquire awareness of the principles of green chemistry.

CO6: Plan out the synthesis of a sample by incorporating benign and environmentally safe solvents.

CO7: To acquire general awareness on green chemistry, green solvents and green principles of organic synthesis.

CO8: Separate and estimate the amount of biomolecules using appropriate electrophoretic technique. To understand the different types of capillary electrophoresis and its application.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Separation Science**	1.1 Membrane separation processes: operating principles and applications of microfiltration, ultra-filtration, reverse osmosis, dialysis and electro-dialysis. (8L) 1.2 Applications of Solvent extraction in Analytical Chemistry recapitulation of solvent extraction, roles of solvent extraction in analytical chemistry, solvent extraction in sample preparation and pretreatment steps, solvent extraction as a means of analytical Determination. (7L)	**15L**
II	**Separation, Analysis and Standardization of Herbal based products.**	2.1 Herbs as a raw material: Definition of herb, herbal medicine, herbal Medicinal products, herbal drug preparation. Sources of herbs. Selection, identification and authentication of herbal materials, drying and Processing of herbal raw materials, drying and processing of herbal raw material. (6L) 2.2 Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principles involved in extraction. (3L) 2.3Standardization of herbal formulation and herbal extracts: Standardization of herbal extract as per WHO cGMP guidelines, Physical, Chemical, Spectral and toxilogical standardization, qualitative and quantitative esimations. (6L)	**15L**
III	**Green Chemistry**	3.1 Principle and concepts of green chemistry: sustainable development and green chemistry, atom economy, examples of atom economic and atom uneconomic reactions, reducing toxicity. (4L) 3.2 Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents. (4L) 3.3 Emerging Green Technologies: photochemical reactions (advantages and challenges), examples. Chemistry using microwaves, sonochemistry and electrochemical synthesis. (4L) 3.4 Designing Greener Processes: Inherently Safer Designs (ISD), Process intensification (PI) in-process monitoring. (3L)	**15L**

IV	**Advanced Techniques**	4.1 Electrophoresis: introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephedax and thin layers) (2L) 4.2 Techniques of Electrophoresis: low and high voltage, sds-page, continuous electrophoresis, capillary electrophoresis, zone, gel, isoelectric focusing, isotaechophoresis and miceller electro kinetic capillary chromatography, instrumentation, detection and applications. (8L) 4.3 Introduction to Nanotechnology: Analytical techniques in nanotechnology, consequences of the nanoscale, (nanoparticles morphology, electronic structure, optical properties) one dimensional nano materials (nanofilms, nanolayers), two dimensional nanomaterials (nanotubes, nanowires), three dimensional nanomaterials (nanoparticles and quantum dots). (5L)	**15L**

References:

1. Research Methodology: Methods and Techniques by C R Kothari, 2e, Wishwa Publication, New Delhi.
2. Research Methodology by D K Bhattacharyya, 1 e, Excel Books, New Delhi, 2003
3. How to Research by Loraine Blaxter, Christina Hughes and Molcolm Tight, Viva Books Pvt.Ltd., New Delhi.
4. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969.
5. Solvent extraction and ion exchange, J Marcus and A. S. Kertes Wiley INC 1969.
6. Extraction Chromatography, T. Braun, G. Ghersene, Elsevier Publications 1978.
7. Super critical fluid extraction, Larry Taylor Wiley publishers N.Y. 1996.
8. Ion exchange separation in analytical chemistry, O Samuelson John Wiley 2nd ed 1963.
9. Ion exchange chromatography, Ed H.F Walton Howden, Hutchenson and Rossing 1976.
10. Chromatographic and el ectrophoresis techniques, I Smith MenemannInterscience 1960.
11. Green chemistry and catalyst, R. A. Sheldon, Isabella Arends, Ulf Hanefeld Wiley VCH verlagGmBHand co.
12. Sustainable residential development: planning and design for green neighborhoods. Avi Friedman, McGraw Hill professional.

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M.Sc. II (Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA4P1
Class	M.Sc.
Semester	IV
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----------------------------

Course Code: PSCHA4P1

Group – A

Course Outcomes: After completion of course student will able to :

CO1: Determine the pK value of H_3PO_4 potentiometrically.

CO2: Estimate the amount of Na^+ in dairy whitener by flame photometry.

CO3: Determine the pH of buffer solution by Spectrophotometrically.

CO4: Determine the amount of Ti^{3+} and V^{5+} in a given sample spectrophotometrically by H_2O_2 method.

CO5: Determine the amount of zinc in Bronze alloy.

Curriculum:

Unit	Title	Learning Points	Credit
Group A **Instrumental**	Potentimetrically	Determination of pK value of H_3PO_4 potentiometrically	02
	flame photometry	Estimation of Na^+ in dairy whitener by flame photometry	
	Spectrophotometry	Spectrophotometric determination of pH of buffer solution	
	Spectrophotometry	Simultaneous determination of Ti^{3+} and V^{5+} spectrophotometrically by H_2O_2 method	
Non-Instrumental	Volumetry	To analyze Bronze for Zn by complexometric method	

References:

13. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by ; A. I. Vogels, 3rd Ed. ELBS (1964)
14. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
15. Standard methods of chemical analysis ; F. J. Welcher, 1975.
16. Standard methods of chemical analysis :Instrumental methods of Analysis ; F. J. Welcher , vol. 3, 1966.
17. "Standard methods of Chemical Analysis"; W. W. Scott, Vol. I, Van Nostrand Company, Inc.,1939.
18. "Spectrophotometric Determination of Traces of Metals"; E.B.Sandell and H.Onishi, Part II,4th Ed. ,A Wiley Interscience Publication, New York,1978

Evaluation Pattern: Practical

Max. Marks 50

E) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

F) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Group A	Experiment performance as per the practical slip	Three and half hours	40
2	Journal + Viva			5+5
		Total		**50**

Practical examination will be of 50 marks at the end of semester which will be converted to 30 Marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for M.Sc. II(Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA402
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----------------------

Course Code:PSCHA402

Nomenclature: Advanced Instrumental Techniques

Course Outcomes: After completion of course student will able to :

CO1: Explain the basic theory of 1H NMR spectroscopy and Raman Spectroscopy.

CO2: Describe the working of the different components of NMR spectrophotometer.

CO3: Apply ^{1}H, ^{13}C, ^{31}P and ^{19}F NMR spectroscopy techniques in combination with other spectroscopic data to carry out structure determination.

CO4: Explain the mechanism of formation and fragmentation of ions in gas phase.

CO5: Interpret the information contained in the mass spectra.

CO6: Describe the working of Raman spectrometer and will be able to explain how the spectrum is recorded.

CO7: Elaborate on the essential principles underlying the applications of thermal methods and radiochemical methods.

CO8: Enlist the advantages of development of hyphenated techniques and will be able to explain the different types of interfaces that are used to achieve this hyphenation.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Spectral Methods III**	NMR Spectroscopy 1.1 Theory and Instrumentation- recapitulation, FTNMR, 2D NMR,- FID signal generation mechanism, Techniques in 2D NMR- homo nuclear correlation spectroscopy (COSY), total correlation spectroscopy (TOCSY), heteronuclear correlation (HETCOR) (9L) 1.2 Radio waves in imaging- principle instrumentation and applications of MRI (3L) 1.3 Application of NMR to other nuclei C_{13}, P_{31} and F_{19}spectroscopy. (3L)	**15L**
II	**Spectral Methods IV**	2.1 Mass spectroscopy: recapitulation, correlation of mass spectra with molecular structure- interpretation of mass spectra, analytical information derived from mass spectra- molecular identification, metastable peaks, Fragmentation Reactions. (9L) 2.2 Raman spectroscopy: Principle Theory Instrumentation , techniques(SERS and Resonance Raman) and Applications of Raman spectroscopy. (6L)	**15L**
III	**Radiochemical And Thermal Methods**	3.1 Activation analysis- NAA, radiometric titrations and radio-release methods. (7L) 3.2 Thermal analysis- Principle, Interfacing , instrumentation and Applications of (a) Simultaneous Thermal Analysis- TG-DTA and TG-DSC (b) Evolved gas analysis- TG-MS and TG-FTIR (8L)	**15L**
IV	**Hyphenated Techniques**	4.1 concept of hyphenation, need for hyphenation, possible hyphenations. (2L) 4.2 Interfacing devices and applications of GC-MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS. (13L)	**15L**

References:

1. Analytical Chemistry, G. D. Christian, 4th Ed. John Wiley, New York (1986).
2. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West and F. J Holler Holt- Saunders 6 th Edition (1998).
3. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J.A. Niemann 5th Ed.
4. Instrumental methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean and F. A.
5. Thermal methods of Analysis, P. J. Haines, Blackie Academic and Professional, London (1995).
6. Thermal Analysis, 3rd Edition W. W. Wendlandt, John Wiley, N.Y. (1986).
7. Principles and Practices of X-ray spectrometric Analysis, 2nd Ed E. P. Bertain, Plenum Press, NY, (1975).

8. Nuclear Analytical Chemistry, D. Bane, B. Forkman, B. Persson, Chartwell - Bratt Ltd (1984).
9. Standard Methods of Chemical Analysis, Eds. F. J. Welcher, Robert E. Krieger Publishing Company, A series of volumes.
10. A Complete Introduction to Modern NMR Spectroscopy 1st Edition by Roger S.Macomber.
11. Spectrometric Identification of Organic Compounds Hardcover – by Robert M.Silverstein Wiley.
12. Tandem Techniques (Separation Science Series) 1st Edition by Raymond P. W. Scott John Wiley and Sons Ltd, 1997.
13. Encyclopedia of Analytical Science, Editors-in-Chief: Paul Worsfold, Alan Townshend, and Colin Poole ISBN: 978-0-12-369397-6.
14. Encyclopedia of Analytical Chemistry: Applications, Theory, and Instrumentation. Meyers Robert A Meyers.
15. Introduction to Thermal Analysis Techniques and Applications Edited by Michael E. Brown.
16. Principles and Applications of Thermal Analysis Edited by Paul Gabbott.

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M.Sc. II(Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA4P2
Class	M.Sc.-II
Semester	IV
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----------------------------------

Course Code: PSCHA4P2

Group – B

Course Outcomes: After completion of course student will able to :

CO1: Determine the % purity of drugs sample by non- aqueous titration.

CO2: Estimate Active detergent matter, alkalinity and Oxygen releasing capacity in detergents.

CO3: Determine the % purity of crystal violet.

CO4: Estimate the % of Ca in pharmaceutical tablets.

Curriculum:

Unit	Title	Learning Points	Credit
Group – B Non-Instrumental	Non- aqueous titration	Analysis of drugs by non- aqueous titration: Glycine , Sodium Benzoate	02
	Volumetric titration	Analysis of detergents: Active detergent matter, alkalinity and Oxygen releasing capacity	
	Volumetric titration	Determination of the purity of crystal violet	
	Complexometric Titration	Estimation of CainCapentathonate/calcium lactate tablets	

References:

19. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by ; A. I. Vogels, 3rd Ed. ELBS (1964)
20. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
21. Standard methods of chemical analysis ; F. J. Welcher, 1975.
22. Standard methods of chemical analysis :Instrumental methods of Analysis ; F. J. Welcher , vol. 3, 1966.
23. "Standard methods of Chemical Analysis"; W. W. Scott, Vol. I, Van Nostrand Company, Inc.,1939.
24. "Spectrophotometric Determination of Traces of Metals"; E.B.Sandell and H.Onishi, Part II,4th Ed. ,A Wiley Interscience Publication, New York,1978

Evaluation Pattern: Practical

Max. Marks 50

G) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

H) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Group B	Experiment performance as per the practical slip	Three and half hours	40
2	Journal + Viva			5+5
		Total		**50**

Practical examination will be of 50 marks at the end of semester which will be converted to 30 Marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for M.Sc. II(Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA403
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---------------------------

Course Code: PSCHA403

Nomenclature: Selected Topics in Analytical Chemistry

Course Outcomes: After completion of course student will able to :

CO1: Elaborate on the various physical, chemical and biological processes which are used in CETP to remove the contaminants from wastewater.

CO2: Discuss the different methods of recovery of metals from effluent treatment such as Electrodialysis, Electrodeposition and Ion Exchange etc.

CO3: Discuss the significance of recycling and reuse of solid wastes.

CO4: Assess the relationships between environmental guidelines, human activities and quality of impacted soil, water and air.

CO5: Make use of the methodologies learned to carry out the analysis of each and every component present in paints.

CO6: Outline the importance of additives in plastic.

CO7: Estimate the amount of metallic impurities in plastics.

CO8: To understand a method for analyzing different elements present in ores and alloys.

CO9: Develop an understanding of zone refining and vacuum fusion and extraction techniques.

CO10: Enlist properties of an ideal fuel. Determine the calorific value of fuels using the methodologies learned.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Effluent Treatment**	1.1 Effluent treatment plant general construction and process flow charts. (3L) 1.2 Treatment and disposal of Sewage. (3L) 1.3. Effluent parameters for metallurgical industry. (2L) 1.4 Permissible limits for metal (example Cr, As, Pb, Cd etc) traces in the effluent. (2L) 1.5 Recovery of metals from effluent, modern methods – Electrodialysis, Electrodeposition and Ion Exchange etc. (3L) 1.6 Recycle and reuse of process and treated (effluent) water. (2L)	**15L**
II	**Solid Waste Management**	2.1 Solid waste management: objectives, concept of recycle, reuse and recovery. (3L) 2.2 Methods of solid waste disposal. (2L) 2.3 Treatment and disposal of sludge / dry cake. (3L) 2.4 Managing non-decomposable solid wastes. (2L) 2.5 Bio- medical waste : Introduction , Classification and methods of disposal. (5L)	**15L**
III	**Plastics and Polymers**	3.1 Classification of plastic, determination of additives, molecular weight distribution, analysis of plastic and polymers based on styrene, vinyl chloride, ethylene, acrylic and cellulosic plastics. (5L) 3.2 Metallic impurities in plastic and their determination. (2L) 3.3 Impact of plastic on environment as pollutant. (2L) 3.4 Paints and pigments: Types of paints pigments, determination of volatile and non - volatile components, Flash point (significance and method of determination), separation and analysis of pigments, binders and thinners. (3L) 3.5 Role of Organo silicones in paints and their impact on environment. (3L)	**15L**
IV	**Metallurgy**	4.1 Ores and minerals: Dressing of ores, pollution due to metallurgical processes (ore dressing, calcination, smelting) (3L) 4.2 Chemical analysis of ores for principal constituents : Galena, Pyrolusite, Bauxite, Hematite, Monazite. (4L) 4.3 Alloys: definition, analysis of Cupronickel, Magnelium, Steel And Stainless Steel, Bronze, Gun metal. (4L) 4.4 Techniques of purification: Zone refining, analysis of high purity materials like s i l i c o n , vacuum fusion and extraction techniques. (4L)	**15L**

References:

1. Environmental Pollution Analysis, S. M. khopkar, New Age International publication (2011).
2. Water and water pollution (hand book) Ed., Seonard'lCiacere, Vol I to IV, Marcel Dekker inc. N.Y.(1972).
3. Water pollution, Arvindkumar, APH publishing (2004).
4. Introduction to Potable Water Treatment Processes Simon Parsons, Bruce Jefferson, Paperback publication.
5. Solid waste management, K Sasikumar and SanoopGopi Krishna PHI publication (2009).
6. Solid waste management, SurendrakumarNorthen Book Center (2009).
7. Handbook of chemical technology and pollution control 3 rdEdn Martin Hocking AP Publication (2005).
8. Fundamental Concepts of Environmental Chemistry, Second Edition G. S. Sodhi , Alpha Science, 2005.
9. Chemical analysis of metals ; Sampling and analysis of metal bearing ores: American Society for Testing and Materials 1980 - Technology and Engineering.
10. Manual of Procedures for Chemical and Instrumental Analysis of Ores, Minerals, and Ore Dressing Products. Government of India Ministry of Steel and Mines, Indian Bureau of Mines, 1979.
11. Alloying: understanding the basics, edited by Joseph R. Davis, ASM International (2001).
12. Zone refining and allied techniques, Norman L. Parr, G. Newnes Technology and Engineering (1960).

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M.Sc. II(Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHA4P3
Class	M.Sc.-II
Semester	IV
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----------------------------

Course Code: PSCHA4P3

Group – C

Course Outcomes: After completion of course student will able to :

CO1: Determine the amount of Calcium, Iron and phosphorous in milk sample by complexometric method.

CO2: Determine the SAP value of given oil sample.

CO3: Estimate the amount of Aldehyde in given oil sample.

CO4: Determine the amount of Glucose in given solution by Folin-Wu method.

CO5: Estimate the amount of Mn2+ present in water sample by colorimetric method.

Curriculum:

Unit	Title	Learning Points	Credit
Group – C **Non-Instrumental**	Complexometric Titration and Spectrophotometry	Analysis of Calcium, Iron and phosphorous in milk	02
	Titrimetric method	Determination of SAP value of oil	
	Titrimetric method	Estimation of Aldehyde in lemon grass oil / Cinnamon oil	
Instrumental	colorimetric method	Estimation of Glucose by Folin-Wu method	
	colorimetric method	Analysis of water sample : Mn2+ by colorimetric method	

References:

25. Quantitative Inorganic Analysis including Elementary Instrumental Analysis by ; A. I. Vogels, 3rd Ed. ELBS (1964)
26. Vogel's textbook of quantitative chemical analysis, Mendham, Denny, Barnes, Thomas, Pearson education, Sixth Ed.
27. Standard methods of chemical analysis ; F. J. Welcher, 1975.
28. Standard methods of chemical analysis :Instrumental methods of Analysis ; F. J. Welcher , vol. 3, 1966.
29. "Standard methods of Chemical Analysis"; W. W. Scott, Vol. I, Van Nostrand Company, Inc.,1939.
30. "Spectrophotometric Determination of Traces of Metals"; E.B.Sandell and H.Onishi, Part II,4th Ed. ,A Wiley Interscience Publication, New York,1978

Evaluation Pattern: Practical

Max. Marks 50

I) Internal Assessment: 40 % (20 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	15
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	05
Total		**20**

J) Semester End Examination: 60% (30 Marks)

Sr. No.	Name of course	Method	Duration	Marks
1.	Group – C	Experiment performance as per the practical slip	Three and half hours	40
2	Journal + Viva			5+5
		Total		**50**

Practical examination will be of 50 marks at the end of semester which will be converted to 30 Marks.

CIE/ Internal	SEE	Total Marks
20	30	50

Syllabus for M.Sc. II(Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHAOC-I 404
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----------------------------------

Course Code: PSCHAOC-I 404

Nomenclature: Intellectual Property Rights andCheminformatics

Course Outcomes: After completion of course student will able to :

CO1: Explain importance of intellectual property.
CO2: Study the concept of trade secrets, economic value of intellectual property and different international agreements.
CO3: Understand the concept of Cheminformatics and its applications.
CO4: Understand the representation of molecules, chemical reactions and chemical structures.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Introduction to Intellectual Property**	Introduction to Intellectual Property:[2L] Historical Perspective, Different types of IP, Importance of protecting IP. Patents:[5L] Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Health care-balancing promoting innovation with public health, Software patents and their importance for India. Industrial Designs:[2L] Definition, How to obtain, features, International design registration. Copyrights:[2L] Introduction, How to obtain, Differences from	**15L**

		Patents. Trade Marks:[2L] Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc. Geographical Indications:[2L] Definition, rules for registration, prevention of illegal exploitation, importance to India.	
II	**Trade Secrets and Different International agreements**	Trade Secrets: [2L] Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. IP Infringement issue and enforcement:[2L] Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property: [2L] Intangible assests and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer. Different International agreements: (a) World Trade Organization (WTO): [5L] (i) General Agreement on Tariffs and Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade Related Services (GATS) Madrid Protocol. (iii) Berne Convention (iv) Budapest Treaty (b) Paris Convention [6L] WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity.	**15L**
III	**Introduction to Cheminformatics**	Introduction to Cheminformatics: [5L] History and evolution of cheminformatics, Use of Cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation. Representation of molecules and chemical reactions: [5L] Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification. Searching Chemical Structures: [5L] Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.	**10L**

IV	**Applications**	Prediction of Properties of Compound, Linear Free Energy Relations, Quantitative Structure – Property Relations, Descriptor Analysis, Model Building, Modeling Toxicity, Structure – Spectra correlations, Prediction NMR, IR and Mass spectra, Computer Assisted Structure elucidations, Computer assisted Synthesis Design, Introduction to drug design, Target Identification and Validation, Lead Finding and Optimization, analysis of HTS data, Virtual Screening, Design of Combinatorial Libraries, Ligand based and Structure based Drug design, Application of Cheminformatics in Drug Design.	**15L**

References:

1. Andrew R. Leach and Valerie J. Gillet (2007) An Introduction to Cheminformatics. Springer: The Netherlands.
2. Gasteiger, J. and Engel, T. (2003) Cheminformatics: A textbook. Wiley–VCH
3. Gupta, S. P. QSAR and Molecular Modeling. Springer-Anamaya Pub.: New Delhi.

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M.Sc. II(Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Code	PSCHOOC-II 404
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---------------------------------------

Course Code :PSCHAOC-I 404

Nomenclature: Research Methodology

Course Outcomes: After completion of course student will able to :

CO1: Understand and comprehend the basics in research methodology and applying them in research/ project work.
CO2:Study the primary, secondary and tertiary sources in research methodology.
CO3: The course will also enable them to collect the data, edit it properly and analyse it accordingly.Thus, it will facilitate students' prosperity in higher education.
CO4: Study the data analysis.
CO5: Understand the concept of methods of scientific research and writing scientific papers.
CO6: Know the concept of chemical safety and ethical handling of chemicals.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Primary, Secondary and Tertiary sources.**	Print: [5L] Primary, Secondary and Tertiary sources. Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. Digital: [5L] Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-databases, ChemSpider, Science Direct, SciFinder, Scopus. Information Technology and Library Resources: [5L] The Internet and World wide web, Internet resources for Chemistry, finding and citing published information.	**15L**
II	**Data Analysis**	The Investigative Approach: Making and recording Measurements, SI units and their use, Scientific methods and design of experiments. Analysis and Presentation of Data: Descriptive statistics, choosing and using statistical tests, Chemometrics, Analysis of Variance (ANOVA), Correlation and regression, curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting, linearizing transformations, exponential function fit, r and its abuse, basic aspects of multiple linear regression analysis.	**15L**
III	**Methods Of Scientific Research And Writing**	Scientific Papers [15L] Reporting practical and project work, Writing literature surveys and reviews, organizing a poster display, giving an oral presentation. Writing Scientific Papers: Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics, avoiding plagiarism.	**15L**
IV	**Chemical Safety and Ethical Handling Of Chemicals**	Safe working procedure and protective environment, protective apparel, emergency procedure, first aid, laboratory ventilation, safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric pressur, safe storage and disposal of waste	**15L**

		chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	

References:

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., and Jones, A., (2011), Practical skills in Chemistry, 2nd Ed., Prentice Hall, Harlow.
2. Hibbert, D. B. and Gooding, J. J. (2006) Data Analysis for Chemistry Oxford University Press.
3. Topping, J., (1984) Errors of Observation and their Treatment 4thEd., Chapman Hill, London.
4. Harris, D. C. (2007) Quantative Chemical Analysis 6th Ed., Freeman Chapters 3-5
5. Levie, R. De. (2001) How to use Excel in Analytical Chemistryand in general scientific data analysis Cambridge Universty Press.
6. Chemical Safety matters – IUPAC-IPCS, (1992) Cambridge University Press.OSU Safety manual 1.01

Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M.Sc. II(Analytical Chemistry) from the year 2023-24

Name of the Course	M.Sc. Analytical Chemistry
Course Cod	PSCHA4P4
Class	M.Sc.-II
Semester	IV
No of Credits	02
Nature	Project
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--------------------------

Course Code : PSCHA4P4

Nomenclature: Project Evaluation

Course Outcomes: After completion of course student will able to :

CO1: Understand the ethics and acquired fundamentals of Research Methodology.
CO2: Do a literature review of existing work in the field of choice.
CO3: Analyze the desire research problem, selecting an appropriate research design, and implementing a research project.
CO4: Students will be able to integrate chemical concepts and ideas learned in lecture courses with skills learned in laboratories to formulate hypotheses, propose and perform experiments, collect data, compile and interpret results and draw reasonable and logical conclusions.
CO6: Write research theses.

Curriculum :

Unit	Title	No. of credits
Group – D	Project Evaluation	02

Evaluation Pattern

Oral presentation:15M

Sr No.	Criterion	Factors	Maximum Marks
1	Skill	Technical competence	05
2	Originality	Independeance,Initiative	05
3	Productivity and Achievment	Output, time management	05
		TOTAL	15M

Evaluation of dissertation: 35M

Sr No.	Criterion	Factors	Maximum Marks
1	Background introduction	Quality of coverage context	05
2	Quality of experimental	Volume accuracy	10
3	Understanding analysis	Scientific awareness, justification	10
4	Presentation and clarity of message	Structure, written style, quality of English	10
TOTAL			35M

Chairperson

R.E. Society's
R.P. Gogate College of Arts & Science
&
R.V. Jogalekar College of Commerce
(Autonomous)
Ratnagiri
(Affiliated to University of Mumbai)

Syllabus for

M. Sc. II

(Organic Chemistry)

Semester III and IV

Under Choice Based Credit System (CBCS)

With effect from the academic Year- 2023-2024

Name of Programme	M.Sc. Organic Chemistry
Level	PG
No of Semesters	04
Year of Implementation	2023-24
Programme Specific Outcomes (PSO)	1. Acquire in-depth knowledge of the advance concepts in the branch of organic chemistry specialization. 2. Design and carry out analysis as well as accurately record and analyse the results. 3. Explain the findings and share the results with scientists and nonscientist with the help of the written and oral communication skills acquire during the course. 4. Apply the skills to do specialized research in the core and applied areas of chemical sciences. 5. Explore new areas of research in chemistry and allied fields of science and technology. 6. Demonstrating the developed skills such as problem solving approach, critical thinking, analytical reasoning, team work and effective communication for solving the applied research problems related to their field. 7. Explain why chemistry plays an integral role in addressing social, economic and environmental problems. 8. Become professionally skilled for higher studies in research institutions and to work in industries.
Relevance of PSOs to the local, regional, national, and global developmental needs (200 words)	1. Organic chemistry contributes to the development of pesticides, herbicides, and fertilizers, helping local farmers increase crop yields and reduce environmental impacts. 2. Local pharmaceutical industries rely on organic chemistry to develop essential drugs and medications, improving healthcare access and outcomes. 3. Organic chemistry is fundamental to regional manufacturing industries, such as plastics, textiles, and chemicals, fostering economic growth and providing employment opportunities. 4. Research in organic chemistry aids in developing solutions for regional environmental issues like pollution control and waste management. 5. National investments in organic chemistry education and research institutions enhance scientific knowledge and innovation capacities. 6. Global efforts to combat climate change and reduce pollution heavily depend on advancements in organic chemistry, such as the development of green technologies.

Revised Scheme of Examination
Faculty of Science
(Post-graduate Programmes)
Choice Based Credit System (CBCS)
Scheme of Examination
Master of Science (M.Sc.) Programme

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 40% marks and by conducting the Semester End Examinations with 60% marks. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below-

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	**Particulars**	**Marks**
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Standard of Passing

The learner to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learner shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60) separately, to pass the course and minimum of Letter Grade "P" in the project component, wherever applicable to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

Performance Grading:
Letter Grades and Grade Points

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90.0 -100	0 (Outstanding)
8.00 ≤ 9.00	80.0 ≤ 90.0	A+ (Excellent)
7.00 ≤ 8.00	70.0 ≤ 80.0	A (Very Good)
6.00 ≤ 7.00	60.0 ≤ 70.0	B+ (Good)
5.50 ≤ 6.00	55.0 ≤ 60.0	B (Above Average)
5.00 ≤ 5.50	50.0 ≤ 55.0	C (Average)
4.00 ≤ 5.00	40.0 ≤ 50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)	-	Absent

M.Sc. - II (Organic Chemistry)

Course Code	Semester III	Credits	Course Code	Semester IV	Credits
PSCHO301	Theoretical organic chemistry-I	04	PSCHO401	Theoretical organic chemistry-II	04
PSCHO302	Synthetic Organic Chemistry-I	04	PSCHO402	Synthetic organic chemistry-II	04
PSCHO303	Natural products and Spectroscopy	04	PSCHO403	Natural products and heterocyclic chemistry	04
PSCHOEC-I 304	Medicinal , Biogenesis and green chemistry	04	PSCHOOC-I 404	Intellectual property rights and Cheminformatics	04
PSCHOEC-II 304	Bioorganic chemistry	04	PSCHOOC-II 404	Research Methodology	04
PSCHO3P1	Separation of a ternary mixture and Identification	04	PSCHO4P1	Two steps preparations	04
PSCHO3P2	Single step organic preparation	04	PSCHO4P2	Spectral Interpretation and Project Evolution	04

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHO301
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	--------

Course Code: PSCHO301
Nomenclature: Theoretical Organic Chemistry
Course Outcomes: After completion of course, student will able to:

CO1: Identify and classify the different types of organic reactive intermediates, including carbocations, nitrenes, carbenes, arynes, and ketenes; Explain the structural characteristics of each type of intermediate and discuss their relative stabilities.

CO2: Describe and demonstrate the methods for generating these intermediates in organic reactions: Predict and elucidate the key reactions that involve these intermediates.

CO3: Define and explain the concept of neighboring group participation (NGP) and its significance in organic reactions.

CO4: Apply Woodward Hoffmann rules for different types of pericyclic reactions, predict the products of different pericyclic reactions.

CO5: Understand the basic concepts of molecular symmetry and symmetry elements; analyze the conformations of medium-sized rings, focusing on eight to ten membered rings.

CO6: Understand the fundamental principles of photochemistry, including quantum yield, electronic states and transitions, and the selection rules**; Analyse** photochemical reactions of various classes of compounds like olefins, carbonyl compounds, aromatic compounds and various photochemical oxidation and reduction reactions.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Organic reaction mechanisms**	1.1 Organic reactive intermediates, methods of generation, structure, stability and important reactions involving carbocations, nitrenes, carbenes, arynes and ketenes. [5L] 1.2 Neighbouring group participation: Mechanism and effects of anchimeric assistance, NGP by unshared/ lone pair electrons, π-electrons, aromatic rings, σ-bonds with special reference to norbornyl and bicyclo[2.2.2] octyl cation systems (formation of non-classical carbocation) [3L] 1.3 Role of FMOs in organic reactivity: Reactions involving hard and soft electrophiles and nucleophiles, ambident nucleophiles, ambident electrophiles, the α effect.[2L] 1.4 Pericyclic reactions: Classification of pericyclic reactions; thermal and photochemical reactions. Three approaches: Evidence for the concertedness of bond making and breaking Symmetry-Allowed and Symmetry-Forbidden Reactions : • The Woodward-Hoffmann Rules-Class by Class • The generalised Woodward-Hoffmann Rule Explanations for Woodward-Hoffmann Rules • The Aromatic Transition structures [Huckel and Mobius] • Frontier Orbitals • Correlation Diagrams, FMO and PMO approach Molecular orbital symmetry, Frontier orbital of ethylene, 1, 3 butadiene, 1,3,5 hexatriene and allyl system. [5L]	**15L**
II	**Pericyclic reactions**	2.1 Cycloaddition reactions: Supra and antra facial additions, 4n and 4n+2 systems, 2+2 additions of ketenes. Diels-Alder reactions, 1, 3-Dipolar cycloaddition and cheletropic reactions, ene reaction, retro-Diels-Alder reaction, regioselectivity, periselectivity, torquoselectivity, site selectivity and effect of substituents in Diels-Alder reactions. Other Cycloaddition Reactions- [4+6] Cycloadditions, Ketene Cycloaddition, Allene Cycloadditions, Carbene Cycloaddition, Epoxidation and Related Cycloadditions. Other Pericyclic reactions: Sigmatropic Rearrangements, Electrocyclic Reactions, Alder 'Ene' Reactions. [7L] 2.2 Electrocyclic reactions: Conrotatory and disrotatary	**15L**

		motions, $4n\pi$ and $(4n+2)\pi$ electron and allyl systems. [3L] 2.3 Sigmatropic rearrangements: H-shifts and C-shifts, supra and antarafacial migrations, retention and inversion of configurations. Cope (including oxy- Cope and aza-Cope) and Claisen rearrangements. Formation of Vitamin D from 7-dehydrocholesterol, synthesis of citral using pericyclic reaction, conversion of Endiandric acid E to Endiandric acid A. [5L]	
III	**Stereochemistry-I**	3.1 Classification of point groups based on symmetry elements with examples (nonmathematical treatment). [2L] 3.2 Conformational analysis of medium rings: Eight to ten membered rings and their unusual properties, I-strain, transannular reactions. [3L] 3.3 Stereochemistry of fused ring and bridged ring compounds: decalins, hydrindanes, perhydroanthracenes, steroids, and Bredt's rule. [5L] 3.4 Anancomeric systems, Effect of conformation on reactivity of cyclohexane derivatives in the following reactions (including mechanism): electrophilic addition, elimination, molecular rearrangements, reduction of cyclohexanones (with LiAlH4, selectride and MPV reduction) and oxidation of cyclohexanols. [5L]	**15L**
IV	**Photochemistry**	4.1 Principles of photochemistry: quantum yield, electronic states and transitions, selection rules, modes of dissipation of energy (Jablonski diagram), electronic energy transfer: photosensitization and quenching process. [3L] 4.2 Photochemistry of carbonyl compounds:$\pi\rightarrow\pi^*$, $n\rightarrow\pi^*$ transitions, Norrish- I and Norrish-II cleavages, Paterno Buchi reaction. Photoreduction, calculation of quantum yield, photochemistry of enones, photochemical rearrangements of α, β-unsaturated ketones and cyclohexadienones. Photo Fries rearrangement, Barton reaction. [8L] 4.3 Photochemistry of olefins: cis-trans isomerizations, dimerizations, hydrogen abstraction, addition and Di-π-methane rearrangement including aza-di- π-methane. Photochemical Cross-Coupling of Alkenes, Photodimerisation of alkenes. [2L] 4.4 Photochemistry of arenes: 1, 2- , 1, 3- and 1, 4-additions. Photocycloadditions of aromatic Rings. [1L] 4.5 Singlet oxygen and photo-oxygenation reactions. Photochemically induced Radical Reactions. Chemiluminescence. [1L]	**15L**

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36. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.
37. Organic Chemistry, a problem solving approach, Lakshmy Ravishankar and Gomathi Shridhar, Narosa Publishing House Pvt. Ltd.

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHO302
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-----

Course Code: PSCHO302
Nomenclature: Synthetic Organic Chemistry-I
Course Outcomes: After completion of course student will able to:

CO1: Demonstrate knowledge in rearrangement reactions with respect to mechanism and Applications.

CO2: Explain the generation of free radicals, different types of free radical mechanisms and various reactions which are involved with free radicals.

CO3: Understand the concept of enamines, ylides and α-C-H functionalization.

CO4: Study the important metals / Non-metals in organic synthesis.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Name reactions with mechanism and application**	1.1 Mukaiyama esterification, Mitsonobu reaction, Darzen's Glycidic Ester syntheis, Ritter reaction, Yamaguchi esterification, Peterson olefination. [5L] 1.2 Domino reactions: Characteristics; Nazerov cyclization [3L] 1.3 Multicomponent reactions: Strecker Synthesis, Ugi 4CC, Biginelli synthesis, Hantzsch synthesis, Pictet-Spengler synthesis [5L] 1.4 Click Reactions: Characteristics; Huisgen 1,3-Dipolar Cycloaddition [2L]	**15L**
II	**Radicals in organic synthesis**	2.1 Introduction: Generation, stability, reactivity and structural and stereochemical properties of free radicals, Persistent and charged radicals, Electrophilic and nucleophilic radicals. [3L] 2.2 Radical Initiators: azobisisobutyronitrile (AIBN) and dibenzoyl peroxide. [1L] 2.3 Characteristic reactions - Free radical substitution, addition to multiple bonds. Radical chain reactions, Radical halogenation of hydrocarbons (Regioselectivity),radical cyclizations, autoxidations: synthesis of Cumene	**15L**

		hydroperoxide from cumene. [4L] 2.4 Radicals in synthesis: Inter and intra molecular C-C bond formation via mercuric hydride, tin hydride, thiol donors. Cleavage of C-X, C-Sn, C-Co, C-S, O-O bonds. Oxidative coupling, C-C bond formation in aromatics: SRNAr reactions. [4L] 2.5 Hunsdiecker reaction, Pinacol coupling, McMurry coupling, Sandmeyer reaction, Acyloin condensation. [3L]	
III	**Enamines, Ylides and α-C-H functionalization**	3.1 Enamines: Generation and application in organic synthesis with mechanistic pathways, Stork enamine reaction. Reactivity, comparison between enamines and enolates. Synthetic reactions of enamines including asymmetric reactions of chiral enamines derived from chiral secondary amines. [4L] 3.2 Phosphorus, Sulfur and Nitrogen Ylides: Preparation and their synthetic applications along with their stereochemical aspects. Wittig reaction, Horner-Wadsworth-Emmons Reaction, Barton-Kellogg olefination. [6L] 3.3 α-C-H functionalization: By nitro, sulfoxide, sulfone and phosphonate groups: generation of carbanions by strong bases (LDA/n-butyl lithium) and applications in C-C bond formation. Bamford-Stevens reaction, Julia olefination and its modification, Seyferth–Gilbert homologation, Steven's rearrangement. [5L]	**15L**
IV	**Metals / Non-metals in organic synthesis**	4.1 Mercury in organic synthesis: Mechanism and regiochemistry of oxymercuration and demercuration of alkenes, mercuration of aromatics, transformation of aryl mercurials to aryl halides. Organomercurials as carbene transfer reagents. [3L] 4.2 Organoboron compounds: Mechanism and regiochemistry of hydroboration of alkenes and alkynes, asymmetric hydroboration using chiral boron reagents, 9-BBN hydroboration, oxazaborolidine (CBS catalyst) and functional group reduction by diborane. [3L] 4.3 Organosilicons: Salient features of silicon governing the reactivity of organosilicons, preparation and important bond-forming reactions of alkyl silanes, alkenyl silanes, aryl silanes and allyl silanes. β-silyl cations as intermediates. Iodotrimethylsilane in organic synthesis. [3L] 4.4 Silyl enol ethers: Application: As nucleophiles (Michael reaction, Mukaiyama aldol reaction), in ring contraction reactions. [2L] 4.5 Organotin compounds: Preparation of alkenyl and allyl tin compounds; application in C-C bond formation, in replacement of halogen by H at the same C atom. [2L] 4.6 Selenium in organic synthesis: Preparation of selenols/selenoxide, selenoxide elimination to create unsaturation, selenoxide and seleno acetals as α-C-H activating groups. [2L]	**15L**

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Evaluation pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination:
1. Duration - These examinations shall be of two hours duration.
2. Theory question paper pattern:
a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units.
b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHO303
Class	M.Sc.- II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---------------

Course Code: PSCHO303

Nomenclature: Natural products and Spectroscopy

Course Outcomes: After completion of course student will able to:

CO1: Understand the importance of carbohydrates, general structural features natural pigments, insect pheromones and alkaloids

CO2: Study about the multi-step synthesis of natural products, prostaglandins, lipids, insect growth regulators, plant growth regulators

CO3: Study the fundamentals and applications of advanced spectroscopic techniques such as proton NMR spectroscopy and 13C –NMR spectroscopy.

CO4: Study the advanced NMR techniques such as DEPT experiment, COSY and HETCOR spectra, NOE and NOESY techniques.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Natural products-I**	1.1 Carbohydrates: Introduction to naturally occurring sugars: Deoxysugars,aminosugars, branched sugars. Structure elucidation of lactose and Dglucosamine (synthesis not expected).Structural features and applications of inositol, starch, cellulose, chitin and heparin.[5L] 1.2 Natural pigments: General structural features, occurrence, biological importance and applications of: carotenoids, anthocyanins, quinones,flavones, pterins and porphyrins (chlorophyll). Structure elucidation of β-carotene and Cyanin (with synthesis). Synthesis of ubiquinone from 3, 4, 5-trimethoxyacetophenone.[5L] 1.3 Insect pheromones: General structural features and importance. Types of pheromones (aggregation, alarm, releaser, primer, territorial, trail, sex pheromones etc.), advantage of pheromones over conventional pesticides. Synthesis of bombykol from acetylene, disparlure from 6-methylhept-1-ene,grandisol from 2-methyl-1, 3-butadiene.[3L]	**15L**

		1.4 Alkaloids: Occurrence and physiological importance of morphine and atropine. Structure elucidation, spectral data and synthesis of coniine.[2L]	
II	**Natural products-II**	2.1 Multi-step synthesis of natural products: Synthesis of the following natural products with special reference to reagents used, stereochemistry and functional group transformations:[8L] a) Woodward synthesis of Reserpine from benzoquinone b) Corey synthesis of Longifoline from resorcinol c) Gilbert-Stork synthesis of Griseofulvin from phloroglucinol d) Corey's Synthesis of Caryophyllene from 2-Cyclohexenone and Isobutylene e) Synthesis of Juvabione from Limonene f) Synthesis of Taxol. 2.2 Prostaglandins: Classification, general structure and biological importance. Structure elucidation of PGE1.[2L] 2.3 Lipids: Classification, role of lipids, Fatty acids and glycerol derived from oils and fats.[2L] 2.4 Insect growth regulators: General idea, structures of JH_2 and JH_3. [1L] 2.5 Plant growth regulators: Structural features and applications of arylacetic acids, gibberellic acids and triacontanol. Synthesis of triacontanol (synthesis of stearyl magnesium bromide and 12-bromo-1-tetrahydropyranyloxydodecane expected).[2L]	**15L**
III	**Advanced spectroscopic techniques-I**	3.1 Proton NMR spectroscopy: Recapitulation, chemical and magnetic equivalence of protons, First order, second order, Spin system notations (A2, AB, AX, AB2, AX2, AMX and A2B2-A2X2 spin systems with suitable examples). Long range coupling (Allylic coupling, 'W' coupling and Coupling in aromatic and heteroaromatic systems), Temperature effects, Simplification of complex spectra, nuclear magnetic double resonance, chemical shift reagents. [7L] 3.2 13C –NMR spectroscopy: Recapitulation, equivalent and non-equivalent carbons (examples of aliphatic and aromatic compounds), 13C- chemical shifts, calculation of 13C- chemical shifts of aromatic carbons, heteronuclear coupling of carbon to 19F and 31P. [4L] 3.3 Spectral problems based on UV, IR, 1HNMR and 13CNMR and Mass spectroscopy.	**15L**
IV	**Advanced spectroscopic techniques-II**	4.1 Advanced NMR techniques: DEPT experiment, determining number of attached hydrogens (Methyl/methylene/methine and quaternary carbons), two dimensional spectroscopic techniques, COSY and HETCOR spectra, NOE and NOESY techniques. [10L] 4.2 Spectral problems based on UV, IR, 1HNMR, 13CNMR (Including 2D technique) and Mass	**15L**

		spectroscopy [5L]	

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Evaluation pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHOEC-I 304
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-----------

Course Code: PSCHOEC-I 304

Nomenclature: Medicinal, Biogenesis and Green Chemistry

Course Outcomes: After completion of course student will able to:

CO1: Understand the important terms used in medicinal chemistry.
CO2: Study the modern methods of drug design and their synthesis.
CO3: Understand the general pathway of amino acid biosynthesis.
CO4: Understand the principles of green chemistry and designing the green synthetic routes.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Drug discovery, design and development**	1.1 Introduction, important terms used in medicinal chemistry: receptor, therapeutic index, bioavailability, drug assay and drug potency. General idea of factors affecting bioactivity: Resonance, inductive effect, bioisosterism, spatial considerations. Basic pharmacokinetics: drug absorption, distribution, metabolism (biotransformation) and elimination. Physical and chemical parameters like solubility, lipophilicity, ionization, pH, redox potential, H-bonding, partition coefficient and isomerism in drug distribution and drug-receptor binding. [7] 1.2 Procedures in drug design: Drug discovery without a lead: Penicillin, Librium. Lead discovery: random screening, non-random (or targeted) screening. Lead modification: Identification of the	**15L**

		pharmacophore, Functional group modification. Structure-activity relationship, Structure modification to increase potency and therapeutic index: Homologation, chain branching, ring-chain transformation, bioisosterism, combinatiorial synthesis (basic idea). [8L]	
II	**Drug design, development and synthesis**	2.1 Introduction to quantitative structure activity relationship studies. QSAR parameters: - steric effects: The Taft and other equations; Methods used to correlate regression parameters with biological activity: Hansch analysis- A linear multiple regression analysis.[5L] 2.2 Introduction to modern methods of drug design and synthesis- computeraided molecular graphics based drug design, drug design via enzyme inhibition (reversible and irreversible), bioinformatics and drug design.[3L] 2.3 Concept of prodrugs and soft drugs. (a) Prodrugs: Prodrug design, types of prodrugs, functional groups in prodrugs, advantages of prodrug use. (b) Soft drugs: concept and properties. [3L] 2.4 Synthesis and application of the following drugs: Fluoxetine, cetrizine, esomeprazole, fluconazole, zidovudine, methotrexate, diclofenac, labetalol, fenofibrate. [4L]	**15L**
III	**Biogenesis and biosynthesis of natural products**	3.1 Primary and secondary metabolites and the building blocks, general pathway of amino acid biosynthesis. [3L] 3.2 Acetate pathway: Biosynthesis of malonylCoA, saturated fatty acids, prostaglandins from arachidonic acid, aromatic polyketides. [4L] 3.3 Shikimic Acid pathway: Biosynthesis of shikimic acid, aromatic amino acids, cinnamic acid and its derivatives, lignin and lignans, benzoic acid and its derivatives, flavonoids and isofalvonoids. [4L] 3.4 Mevalonate pathway: Biosynthesis of mevalonic acid, monoterpenes – geranyl cation and its derivatives, sesquiterpenes – farnesyl cation and its derivatives and diterpenes. [4L]	**15L**
IV	**Green Chemistry**	4.1 Introduction, basic principles of green chemistry. Designing a green synthesis: Green starting materials, green reagents, green solvents and reaction conditions, green catalysts. [1L] 4.2 Use of the following in green synthesis with suitable examples: [9L] a) Green reagents: dimethylcarbonate, polymer supported reagents. b) Green catalysts: Acid catalysts, oxidation catalysts, basic catalysts, phase transfer catalysts [Aliquat 336, benzyltrimethyl ammonium chloride (TMBA), Tetra-n-butyl ammonium chloride, crown ethers], biocatalysts.	**15L**

		c) Green solvents: water, ionic liquids, deep eutectic solvents, supercritical carbon dioxide. d) Solid state reactions: solid phase synthesis, solid supported synthesis. e) Microwave assisted synthesis: reactions in water, reactions in organic solvents, solvent free reactions. f) Ultrasound assisted reactions. 4.3 Comparison of traditional processes versus green processes in the syntheses of ibuprofen, adipic acid, 4 aminodiphenylamine, p-bromotoluene and benzimidazole. [3L] 4.4 Green Cataysts: Nanocatalyst, Types of nanoctalysts, Advantages and Disadvantages of Nanocatalysts, Idea of Magnetically separable nanocatalysts. [2L]	

References:

1. Nelson, D. L, and Cox, M. M, (2008) Lehninger principles of Biochemistry 5th Edition, W. H. Freeman and Company, NY., USA.
2. Stryer, Lubert; Biochemistry; W. H. Freeman publishers.
3. Voet, D. and J. G. Voet (2004) Biochemistry, 3rd Edition, John Wiley and sons, Inc. USA.
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5. V. Polshettiwar, R. Luque, A. Fihri, H. Zhu, M. Bouhrara and J-M Basset, Chem. Rev. 2011, 111, 3036-3075;
6. R. B. Nasir Baig and R. S.Varma, Chem. Comm., 2013, 49, 752-770;
7. M. B. Gawande, A. K. Rathi, P. S. Varma, Appl. Sci., 2013, 3, 656-674;
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9. K. Philippot and P. Serp, Nanomaterials in catalysis, First Edition. Edited by P. Serp and K. Philippot; 2013 Wiley –VCH Verlag GmbH and Co. K GaA
10. D. Astruc, Nanomaterials and Catalysis, Wiley-VCH Verlag GmbH and Co. KGaA, 2008, 1-48;
11. C. N. R. Roa, A. Muller and A. K. Cheetham, The chemistry of Nanomaterials, Wiley-VCH Verlag GmbH and Co. KGaA, 2005, 1-11;
12. The organic chemistry of drug design and drug action, Richard B. Silverman, 2nd edition, Academic Press.
13. Medicinal chemistry, D.Sriram and P. Yogeeswari, 2nd edition, Pearson.
14. An introduction to drug design-S. S. Pandeya and J. R. Dimmock (New age international).
15. Burger's medicinal chemistry and drug discovery. by Manfred E. Wolf.
16. Introduction to Medicinal chemistry. by Graham Patrick.
17. Medicinal chemistry-William O. Foye.
18. T. B. of Organic medicinal and pharmaceutical chemistry-Wilson and Gisvold's (Ed. Robert F. Dorge).
19. An introduction to medicinal chemistry-Graham L. Patrick, OUP Oxford, 2009.
20. Principles of medicinal chemistry (Vol. I and II)-S. S. Kadam, K. R. Mahadik and K.G. Bothara , Nirali prakashan.
21. Medicinal chemistry (Vol. I and II)-Burger.
22. Strategies for organic drug synthesis and design - D. Lednicer Wiley.
23. Pharmacological basis of therapeutics-Goodman and Gilman's (McGraw Hill).
24. Enzyme catalysis in organic synthesis, 3rd edition. Edited by Karlheinz Drauz, Harold Groger, and Oliver May, Wiley-VCH Verlag GmbH and Co KgaA, 2012.

25. Biochemistry, Dr U Satyanarayan and Dr U Chakrapani, Books and Allied (P) Ltd.
26. Bioorganic, Bioinorganic and Supramolecular chemistry, P.S. Kalsi and J.P. Kalsi. New Age International Publishers.
27. The Organic Chemistry of Enzyme-Catalysed Reactions, Academic Press, By Richard B. Silverman.
28. Enzymes: Practical Introduction to structure, mechanism and data analysis, By Robert A. Copeland, Wiley-VCH, Inc.
29. The Organic Chemistry of Biological Pathways By John McMurry,Tadhg Begley by Robert and company publishers.
30. Bioorganic Chemistry- A practical approach to Enzyme action, H. Dugas and C. Penny. Springer Verlag,1931.
31. Biochemistry: The chemical reactions in living cells, by E. Metzler. Academic Press.
32. Concepts in biotechnology by D. Balasubrarnanian and others.
33. Principals of biochemistry by Horton and others.
34. Bioorganic chemistry - A chemical approach to enzyme action by Herman Dugas and Christopher Penney.
35. Medicinal Natural Products: A Biosynthetic Approach by Paul M. Dewick. 3rd Edition, Wiley.
36. Natural product chemistry, A mechanistic, biosynthetic and ecological approach, Kurt B. G. Torssell, Apotekarsocieteten – Swedish pharmaceutical press.
37. Natural products Chemistry and applications, Sujata V Bhat, B.A. Nagasampagi and S. Meenakshi, Narosa Publishing House.
38. Natural Products Volume- 2, By O. P. Agarwal.
39. Chemistry of Natural Products, F. F. Bentley and F. R. Dollish, 1974.
40. Natural Product Chemistry Vol.1 and 2, K. Nakanishi J. Goto. S.Ito Majori and S. Nozoo, Academic Press, 1974.
41. Chemistry of natural products, V.K. Ahluwalia, Vishal Publishing Co.
42. Green Chemistry: An Introductory Text, 2nd Edition, Published by Royal Society of Chemistry, Authored by Mike Lancater.
43. Organic synthesis in water. By Paul A. Grieco, Blackie.
44. Green chemistry, Theory and Practical, Paul T. Anastas and John C. Warner.
45. New trends in green chemistry By V. K. Ahulwalia and M. Kidwai, 2nd edition, Anamaya Publishers, New Delhi.
46. An introduction to green chemistry, V. Kumar, Vishal Publishing Co.
47. Organic synthesis: Special techniques. V.K.Ahulwalia and Renu Aggarwal.

Evaluation pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHOEC-II 304
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---------------

Course Code: PSCHOEC-II 304
Nomenclature: Bioorganic Chemistry
Course Outcomes: After completion of course, student will able to:
CO1: Study about amino acids, peptides, proteins, nucleic acids, RNAs and DNA.
CO2: Study about the chemistry of enzymes.
CO3: Understand about the chemistry of coenzymes.
CO4: Study about the various reactions involved with different biomolecules.

Curriculum:

Unit	Title	Learning Points	No of Lectures
Unit-I	**Biomolecules-I**	1.1 Amino acids, peptides and proteins: Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding of secondary structures, α- helix, β-sheets, super secondary structure. Tertiary structure of protein: folding and domain structure. Quaternary structure.[2L] 1.2 Nucleic acids: Structure and function of physiologically important nucleotides (c-AMP, ADP, ATP) and nucleic acids (DNA and RNA), replication, genetic code, protein biosynthesis, mutation. [3L] 1.3 Structure: Purine and pyrimidine bases, ribose, deoxyribose, nucleosides and nucleotides (ATP, CTP, GTP, TTP, UTP) formation of polynucleotides strand with its shorthand representation.[3L] 1.4 RNAs (various types in prokaryotes and eukaryotes) m- RNA and r- RNA – general account ,	**15L**

		t- RNA-clover leaf model, Ribozymes**.**[2L] 1.5 DNA: Physical properties – Effect of heat on physical properties of DNA (Viscosity, buoyant density and UV absorption), Hypochromism, Hyperchromism and Denaturation of DNA. Reactions of nucleic acids (with DPA and Orcinol).[2L] 1.6 Chemical synthesis of oligonucleotides: Phosphodiester, Phosphotriester, Phosphoramidite and H- phosphonate methods including solid phase approach.[3L]	
Unit-II	**Biomolecules-II**	2.1 Chemistry of enzymes: Introduction, nomenclature, classes and general types of reactions catalyzed by enzymes. Properties of enzymes: a) enzyme efficiency/ catalytic power b) enzyme specificity; Fischer's 'lock and key' and Koshland 'induced fit' hypothesis. Concept and identification of active site.[6L] 2.2 Factors affecting enzyme kinetics: Substrate concentration, enzyme concentration, temperature, pH, product concentration etc. Reversible and irreversible inhibition.[4L] 2.3 Mechanism of enzyme action: transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Mechanism of chymotrypsin catalyzed hydrolysis of a peptide bond.[5L]	**15L**
Unit-III	**Biomolecules - III**	3.1 Chemistry of coenzymes. Structure, mechanism of action and bio-modeling studies of the following coenzymes: nicotinamide adenine dinucleotide, flavin adenine dinucleotide, thiamine pyrophosphate, pyridoxal phosphate, Vitamin B12, biotin, lipoic acid, Coenzyme A.[12L] 3.2 Oxidative phosphorylation, chemiosmosis, rotary model for ATP synthesis and role of cytochrome in oxygen activation.[3L]	**15L**
Unit-IV	**Biomolecules – IV**	4.1 Role of main enzymes involved in the synthesis and breakdown of glycogen.[2L] 4.2 Enzyme catalyzed organic reactions: Hydrolysis, hydroxylation, oxidation and reduction.[6L] 4.3 Enzymes in organic synthesis. Fermentation: Production of drugs/drug intermediates by fermentation. Production of chiral hydroxy acids, vitamins, amino acids, β-lactam antibiotics. Synthesis of chemicals via microbial transformation, synthesis of L-ephedrine. Chemical processes with isolated enzymes in free form (hydrocyanation of mphenoxybenzaldehyde) and immobilized form (production of 6- aminopenicillanic acid).[7L]	**15L**

References:

1. Nelson, D. L, and Cox, M. M, (2008) Lehninger principles of Biochemistry 5th Edition, W. H. Freeman and Company, NY., USA.
2. Stryer, Lubert; Biochemistry; W. H. Freeman publishers**.**
3. Voet, D. and J. G. Voet (2004) Biochemistry, 3rd Edition, John Wiley and sons, Inc. USA.
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5. V. Polshettiwar, R. Luque, A. Fihri, H. Zhu, M. Bouhrara and J-M Basset, Chem. Rev. 2011, 111, 3036-3075;
6. R. B. Nasir Baig and R. S.Varma, Chem. Comm., 2013, 49, 752-770;
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9. K. Philippot and P. Serp, Nanomaterials in catalysis, First Edition. Edited by P. Serp and K. Philippot; 2013 Wiley –VCH Verlag GmbH and Co. K GaA.
10. D. Astruc, Nanomaterials and Catalysis, Wiley-VCH Verlag GmbH and Co. KGaA, 2008, 1-48;
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36. Natural product chemistry, A mechanistic, biosynthetic and ecological approach, Kurt B. G. Torssell, Apotekarsocieteten – Swedish pharmaceutical press.
37. Natural products Chemistry and applications, Sujata V Bhat, B.A. Nagasampagi and S. Meenakshi, Narosa Publishing House.
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46. An introduction to green chemistry, V. Kumar, Vishal Publishing Co.
47. Organic synthesis: Special techniques. V.K.Ahulwalia and Renu Aggarwal.

Evaluation pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
	PSCHO3P1
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-----------------

Course Code: PSCHO3P1

Nomenclature: Separation of a ternary mixture of organic compounds and identification including derivative preparations using micro-scale technique**.**

Course Outcomes: After completion of course student will able to:

CO1: Find the chemical type of mixture in the given ternary mixture.

CO2: Decide scheme for separation of components using proper reagents.

CO3: Purify separated organic compound using different purification technique.

CO4: Identify Organic compounds.

Curriculum:

Paper	Title	Learning Points	No of Credits
I and II	Separation of a ternary mixture of organic compounds and identification including derivative preparations using micro-scale technique.	1. Separation of a ternary mixture (S-S-S, S-S-L, S-L-L and L-L-L) (for solid mixture: water insoluble/ soluble including carbohydrates) based upon differences in the physical and the chemical properties of the components. 2. Identification of the two components (indicated by the examiner) using micro-scale technique. 3. Preparation of derivatives (any one of separated compound). (**Minimum 8 experiments**)	**04**

References:

1. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis- V.K. Ahluwalia and Renu Aggarwal, Universities Press India Ltd., 2000.
2. Advanced Practical Organic Chemistry – N. K. Vishnoi, Third Addition, Vikas Publishing House PVT Ltd.
3. Systematic Laboratory Experiments in Organic Synthesis- A. Sethi, New Age International Publications.

4. Systematic Identification of Organic compounds, 6th edition, R. L. Shriner, R. C. Fuson and D.Y. Curtin Wiley, New York.
5. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS.
6. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
7. Macro-scale and Micro-scale Organic Experiments, K. L. Williamson, D. C. Heath.
8. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
9. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark, Adward Arnold.
10. Vogel's Textbook of Practical Organic Chemistry, Fifth edition,2008, B.S.Furniss, A. J.Hannaford, P. W. G. Smith, A. R. Tatchell, Pearson Education.
11. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.
12. Organic structures from spectra, L. D. Field, S. Sternhell, John R. Kalman, Wiley, 4th ed., 2011.

Evaluation Pattern: Practical (I and II)

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	30
04	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	10
Total		**40**

B) Semester End Examination: 60% (60 Marks)

Sr. No.	Name of course	Duration	Expt	Journal	viva	TOTAL
1.	Paper I	Three and half hours	40	05	05	50
2.	Paper II	Three and half hours	40	05	05	50
Total						**100**

Practical examination will be of 100 marks at the end of semester which will be converted to 60 Marks.

CIE/ Internal	Semester End	Total Marks
40	60	100

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
	PSCHO3P2
Class	M.Sc.-II
Semester	III
No of Credits	04
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-----------------

Course Code: PSCHO3P2

Nomenclature: Single step organic preparation (1.0 g scale) involving purification by Steam distillation/Vacuum distillation or Column chromatography.

Course Outcomes: After completion of course student will able to:

CO1: Study the planning of synthesis, effect of reaction parameters including stoichiometry, and safety aspects including MSDS.

CO2: Understand the possible mechanism, expected spectral data (IR and NMR) of starting material and final product.

CO3: Purify the product by steam distillation/vacuum distillation/column chromatography.

CO4: Measure its mass or volume, check the purity by TLC, determine physical constant and calculate percentage yield.

Curriculum:

Paper	Title	Learning Points	No of Credits
III and IV	Single step organic preparation (1.0 g scale) involving purification by Steam distillation / Vacuum distillation or Column chromatography.	1. Preparation of acetanilide from aniline and acetic acid using Zn dust. (Purification by column chromatography) 2. Preparation of 1-nitronaphthalene from naphthalene. (Purification by steam distillation) 3. Preparation of acetyl ferrocene from ferrocene. (Purification by column chromatography) 4. Preparation of 3-nitroaniline from 1,3-dinitrobenzene. (Purification by column chromatography) 5. Preparation of benzyl alcohol from	04

		benzaldehyde. (Purification by vacuum distillation). 6. Preparation of methyl salicylate from salicylic acid. (Purification by vacuum distillation). 7. Preparation of 4-methylacetophenone from toluene. (Purification by vacuum distillation). 8. .Preparation of phenyl acetate from phenol. (Purification by vacuum distillation) 9. Preparation of 2-chlorotoluene from *o*-toluidine. (Purification by steam distillation) 10. Preparation of 4-nitrophenol from phenol. (Purification by steam distillation/ column chromatography) 11. Preparation of fluorenone from fluorene. (Purification by column chromatography) 12. Preparation of dimethylphthalate from phthalic anhydride. (Purification by vacuum distillation) **(Minimum 8 experiments)**	

References:

1. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis- V.K. Ahluwalia and Renu Aggarwal, Universities Press India Ltd., 2000
2. Advanced Practical Organic Chemistry – N. K. Vishnoi, Third Addition, Vikas Publishing House PVT Ltd
3. Systematic Laboratory Experiments in Organic Synthesis- A. Sethi, New Age International Publications.
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10. Vogel's Textbook of Practical Organic Chemistry, Fifth edition,2008, B.S.Furniss, A. J.Hannaford, P. W. G. Smith, A. R. Tatchell, Pearson Education.
11. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.
12. Organic structures from spectra, L. D. Field, S. Sternhell, John R. Kalman, Wiley, 4th ed., 2011.

Evaluation Pattern: Practical (III and IV)

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practicals (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal.	30
02	Overall performance (attendance, punctuality, interaction during Practical session throughout semester).	10
Total		**40**

B) Semester End Examination: 60% (60 Marks)

Sr. No.	Name of course	Duration	Expt.	JOURNAL	viva	TOTAL
1.	Paper III	Three and half hours	40	05	05	50
2.	Paper IV	Three and half hours	40	05	05	50
Total						**100**

Practical examination will be of 100 marks at the end of semester which will be converted to 60 Marks.

CIE/ Internal	Semester End	Total Marks
40	60	100

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHO401
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------------------

Course Code: PSCHO401
Nomenclature: Theoretical Organic Chemistry
Course Outcomes: After completion of course, student will able to:

CO1: Outline fundamental principles of physical organic Chemistry.
CO2: Understand the concepts of supramolecular chemistry
CO3: Understand the concept of racemisation, determination of enantiomers, diastereomer composition, molecular dissymmetry and chiroptical properties
CO4: Understand the basic concepts of asymmetric synthesis.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Physical organic chemistry**	1.1 Structural effects and reactivity: Linear free energy relationship (LFER) in determination of organic reaction mechanism, The Hammett equation, substituent constants, theories of substituent effects, interpretation of σ- values, reaction constants ρ, Yukawa-Tsuno equation. [7L] 1.2 Uses of Hammett equation, deviations from Hammett equation. Dual parameter correlations, Inductive substituent constants. The Taft model, σI and σR scales, steric parameters Es and β. Solvent effects, Okamoto-Brown equation, Swain-Scott equation, Edward and Ritchie correlations, Grunwald-Winstein equation, Dimroth's ET parameter, Solvatochromism Zscale, Spectroscopic Correlations, Thermodynamic Implications. [8L]	**15L**
II	**Supramolecular chemistry**	2.1 Principles of molecular associations and organizations as exemplified in biological macromolecules like nucleic acids, proteins and enzymes. [3L]	**15L**

		2.2 Synthetic molecular receptors: receptors with molecular cleft, molecular tweezers, receptors with multiple hydrogen sites. [3L] 2.3 Structures and properties of crown ethers, cryptands, cyclophanes, calixarenes, rotaxanes and cyclodextrins. Synthesis of crown ethers, cryptands and calixarenes. [5L] 2.4 Molecular recognition and catalysis, molecular self-assembly. Supramolecular Polymers, Gelsand Fibres. [4L]	
III	**Stereochemistry - II**	3.1 Racemisation and resolution of racemates including conglomerates: Mechanism of racemisation, methods of resolution: mechanical, chemical, kinetic and equilibrium asymmetric transformation and through inclusion compounds. [3L] 3.2 Determination of enantiomer and diastereomer composition: enzymatic method, chromatographic methods. Methods based on NMR spectroscopy: use of chiral derivatising agents (CDA), chiral solvating agents (CSA) and Lanthanide shift reagents (LSR). [3L] 3.3 Correlative method for configurational assignment: chemical, optical rotation, and NMR spectroscopy. [4L] 3.4 Molecular dissymmetry and chiroptical properties: Linearly and circularly polarized light. Circular birefringence and circular dichroism. ORD and CD curves. Cotton effect and its applications. The octant rule and the axial α– haloketone rule with applications. [5L]	**15L**
IV	**Asymmetric synthesis**	4.1 Principles of asymmetric synthesis: Introduction, the chiral pool in Nature, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions. [3L] 4.2 Synthesis of L-DOPA [Knowles's Mosanto process]. Asymmetric reactions with mechanism: Aldol and related reactions, Cram's rule, Felkin-Anh model, Sharpless enantioselective epoxidation, hydroxylation, aminohydroxylation, Diels-Alder reaction, reduction of prochiral carbonyl compounds and olefins. [9L] 4.3 Use of chiral auxiliaries in diastereoselective reductions, asymmetric amplification. Use of chiral BINOLs, BINAPs and chiral oxazolines asymmetric transformations. [3L]	**15L**

References:

1. March's Advanced Organic Chemistry, Jerry March, sixth edition, 2007, John Wiley and sons.
2. A guide to mechanism in Organic Chemistry, 6th edition, 2009, Peter Sykes, Pearson education, New Delhi.
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Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHO402
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-----------------

Course Code: PSCHO402
Nomenclature: Synthetic Organic Chemistry-II
Course Outcomes: After completion of course, student will able to:

CO1: Understand about the protecting groups for different functional groups, concept of umpolung and the various termed involved in the retrosynthesis.

CO2: Study about the C-C one group and two group disconnections by their applications in different organic reactions.

CO3: Understand the concept of Electro-organic chemistry and Selected methods of Organic synthesis

CO4: Explain the important transition and rare earth metals in organic synthesis with its mechanism and application

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Designing Organic Synthesis-I**	1.1 Protecting groups in Organic Synthesis: Protection and deprotection of the hydroxyl, carbonyl, amino and carboxyl functional groups and its applications. [3L] 1.2 Concept of umpolung (Reversal of polarity): Generation of acyl anion equivalent using 1,3-dithianes, methyl thiomethyl sulfoxides, cyanide ions, cyanohydrin ethers, nitro compounds and vinylated ethers. [3L] 1.3 Introduction to Retrosynthetic analysis and synthetic planning: Linear and convergent synthesis; Disconnection approach: An introduction to synthons, synthetic equivalents, disconnection approach, functional group interconversions (FGI), functional group addition (FGA), functional group removal (FGR) importance of order of events in organic synthesis, one and two group C-X disconnections (1,1; 1,2; 1,3 difunctionalized compounds), selective organic transformations: chemoselectivity, regioselectivity,	**15L**

		stereoselectivity, enantioselectivity. [9L]	
II	**Designing Organic Synthesis-II**	2.1 General strategy: choosing a disconnection-simplification, symmetry, high yielding steps, and recognisable starting material. [3L] 2.2 One group C-C Disconnections: Alcohols (including stereoslectivity), carbonyls (including regioselectivity), Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis. [6L] 2.3 Two group C-C Disconnections: 1, 2- 1, 3- 1, 4- 1, 5- and 1,6- difunctionalized compounds, Diels-Alder reactions, α, β-unsaturated compounds, control in carbonyl condensations, Michael addition and Robinson annelation. [6L]	**15L**
III	**Electro-organic chemistry and Selected methods of Organic synthesis**	3.1 Electro-organic chemistry: [7L] 3.1.1 Introduction: Electrode potential, cell parameters, electrolyte, working electrode, choice of solvents, supporting electrolytes. 3.1.2 Cathodic reduction: Reduction of alkyl halides, aldehydes, ketones, nitro compounds, olefins, arenes, electro-dimerization. 3.1.3 Anodic oxidation: Oxidation of alkylbezene, Kolbe reaction, Non-Kolbe oxidation, Shono oxidation. 3.2 Selected Methods of Organic synthesis [8L] Applications of the following in organic synthesis: 3.2.1 Crown ethers, cryptands, micelles, cyclodextrins, catenanes. 3.2.2 Organocatalysts: Proline, Imidazolidinone. 3.2.3 Pd catalysed cycloaddition reactions: Stille reaction, Saeguse-Ito oxidation to enones, Negishi coupling. 3.2.4 Use of Sc(OTf), and Yb(OTf) as water tolerant Lewis acid catalyst in aldol condensation, Michael reaction, Diels-Alder reaction, Friedel – Crafts reaction.	**15L**
IV	**Transition and rare earth metals in organic synthesis**	4.1 Introduction to basic concepts: 18 electron rule, bonding in transition metal complexes, C-H activation, oxidative addition, reductive elimination, migratory insertion. [3L] 4.2 Palladium in organic synthesis: π-bonding of Pd with olefins, applications in C-C bond formation, carbonylation, alkene isomerisation, cross-coupling of organometallics and halides. Representative examples: Heck reaction, Suzuki-Miayura coupling, Sonogashira reaction and Wacker oxidation. Heteroatom coupling for bond formation between aryl/vinyl groups and N, S, or P atoms. [5L] 4.3 Olefin metathesis using Grubb’s catalyst. [1L] 4.4 Application of Ni, Co, Fe, Rh, and Cr carbonyls in organic synthesis. [4L] 4.5 Application of samarium iodide including reduction of organic halides, aldehydes and ketones, α-functionalised carbonyl and nitro compounds. [1L] 4.6 Application of Ce(IV) in synthesis of heterocyclic quinoxaline derivatives and its role as a de-protecting agent. [1L]	

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2. Modern Methods of Organic Synthesis, 4^{th} Edition, W. Carruthers and Iain Coldham, Cambridge University Press, 2004.
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6. Advanced Organic Chemistry: Reaction Mechanism, R. Bruckner, Academic Press (2002).
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8. Organic Chemistry, 7^{th} Edn, R. T .Morrison, R. N. Boyd, and S. K. Bhattacharjee, Pearson.
9. Strategic Applications of Name Reactions in Organic Synthesis, L. Kurti and B. Czako (2005), Elsevier Academic Press.
10. Advanced Organic Chemistry: Reactions and Mechanisms, 2^{nd} Edn., B. Miller and R. Prasad, Pearson.
11. Organic reactions and their mechanisms, 3rd revisededition, P.S. Kalsi, New Age International Publishers.
12. Organic Synthesis: The Disconnection Approach, Stuart Warren, John Wiley and Sons, 2004.
13. Name Reactions and Reagents in Organic Synthesis, 2^{nd} Edn., Bradford P. Mundy, Michael G. Ellard, and Frank Favoloro, Jr., Wiley-Interscience.
14. Name Reactions, Jie Jack Lie, 3^{rd} Edn., Springer.
15. Organic Electrochemistry, H. Lund, and M. Baizer, 3^{rd} Edn., Marcel Dekker.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHO403
Class	M.Sc.- II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	-------------

Course Code: PSCHO403

Nomenclature: Natural products and heterocyclic Chemistry

Course Outcomes: After completion of course, student will able to:

CO1: Explain the biological importance and synthesis of steroids

CO2: Explain the biological importance and synthesis of different vitamins, antibiotics, naturally occurring insecticides and terpenoids

CO3: Study the chemistry of monocyclic heterocycles, their nomenclature and reactions

CO4: Study the chemistry of bicyclic/tricyclic, fused heterocycles, their nomenclature and reactions

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Natural products-III**	1.1 Steroids: General structure, classification. Occurrence, biological role, important structural and stereochemical features of the following:corticosteroids, steroidal hormones, steroidal alkaloids, sterols and bile acids.[5L] 1.2 Synthesis of 16-DPA from cholesterol and plant sapogenin. [2L] 1.3 Synthesis of the following from 16-DPA: androsterone, testosterone, oestrone, oestriol, oestradiol and progesterone. [5L] 1.4 Synthesis of cinerolone, jasmolone, allethrolone, exaltone and muscone. [3L]	**15L**
II	**Natural products-IV**	2.1 Vitamins: Classification, sources and biological importance of vitamin B1, B2, B6, folic acid, B12, C, D1, E (α-tocopherol), K1, K2, H (β- biotin). [5L] Synthesis of the following: Vitamin A from β-ionone and bromoester moiety.	**15L**

		Vitamin B1 including synthesis of pyrimidine and thiazole moieties Vitamin B2 from 3, 4-dimethylaniline and D(-)ribose Vitamin B6 from: 1) ethoxyacetylacetone and cyanoacetamide, 2) ethyl ester of N-formyl-DL-alanine (Harris synthesis) Vitamin E (α-tocopherol) from trimethylquinol and phytyl bromide Vitamin K1 from 2-methyl-1, 4-naphthaquinone and phytol. 2.2 Antibiotics: Classification on the basis of activity. Structure elucidation, spectral data of penicillin-G, cephalosporin-C and chloramphenicol. Synthesis of chloramphenicol (from benzaldehyde and β-nitroethanol) penicillin-G and phenoxymethylpenicillin from D-penicillamine and t-butyl phthalimide malonaldehyde (synthesis of D-penicillamine and t-butyl phthalimide malonaldehyde expected). [6L] 2.3 Naturally occurring insecticides: Sources, structure and biological properties of pyrethrums (pyrethrin I), rotenoids (rotenone). Synthesis of pyrethrin I. [2L] 2.4 3.4 Terpenoids: Occurrence, classification, structure elucidation, stereochemistry, spectral data and synthesis of zingiberene. [2L]	
III	**Heterocyclic compounds-I**	Heterocyclic compounds: Introduction, classification, Nomenclature of heterocyclic compounds of monocyclic (3-6 membered) (Common, systematic (Hantzsch-Widman) and replacement nomenclature) Structure, reactivity, synthesis and reactions of pyrazole, imidazole, oxazole, isoxazole, thiazole, isothiazole, pyridazines, pyrimidine, pyrazines and oxazines.	**15L**
IV	**Heterocyclic compounds-II**	Nomenclature of heterocyclic compounds of bicyclic/tricyclic (5-6 Membered) fused heterocycles (up to three hetero atoms). (Common, systematic (Hantzsch-Widman) and replacement nomenclature) Nucleophilic ring opening reactions of oxiranes, aziridines, oxetanes and azetidines. Structure, reactivity, synthesis and reactions of coumarins, quinoxalines, cinnolines, indole, benzimidazoles, benzoxazoles, benzothiazoles, Purines and acridines.	**15L**

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2. Natural products chemistry and applications, Sujata V. Bhat, B.A.Nagasampagi and S. Meenakshi, Narosa Publishing House, 2011.
3. Organic Chemistry Natural Products Volume-II, O. P. Agarwal, Krishna Prakashan, 2011.
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47. Biotransformations in Organic Chemistry, 5thEdition, Kurt Faber, Springer
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Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHOOC-I 404
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	----------------

Course Code: PSCHOOC-I 404
Nomenclature: Intellectual Property Rights and Cheminformatics
Course Outcomes: After completion of course, student will able to:
CO1: Explain various forms and importance of intellectual property.
CO2: Study the concept of trade secrets, economic value of intellectual property and different international agreements.
CO3: Understand the concept of Cheminformatics and the representation of molecules, chemical reactions and chemical structures.
CO4: Understand the application of Cheminformatics in drug design.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Introduction to Intellectual Property**	Introduction to Intellectual Property:[2L] Historical Perspective, Different types of IP, Importance of protecting IP. Patents:[5L] Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Health care-balancing promoting innovation with public health, Software patents and their importance for India. Industrial Designs:[2L] Definition, How to obtain, features, International design registration. Copyrights:[2L] Introduction, How to obtain, Differences from Patents. Trade Marks:[2L] Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc. Geographical Indications:[2L] Definition, rules for registration, prevention of illegal	**15L**

		exploitation, importance to India.	
II	**Trade Secrets and Different International agreements**	Trade Secrets: [2L] Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. IP Infringement issue and enforcement:[2L] Role of Judiciary, Role of law enforcement agencies – Police, Customs etc. Economic Value of Intellectual Property: [2L] Intangible assests and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer. Different International agreements: (a) World Trade Organization (WTO): [5L] (i) General Agreement on Tariffs and Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade Related Services (GATS) Madrid Protocol. (iii) Berne Convention (iv) Budapest Treaty (b) Paris Convention [6L] WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity.	**15L**
III	**Introduction to Cheminformatics**	Introduction to Cheminformatics: [5L] History and evolution of cheminformatics, Use of Cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation. Representation of molecules and chemical reactions: [5L] Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification. Searching Chemical Structures: [5L] Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.	**10L**
IV	**Applications**	Prediction of Properties of Compound, Linear Free Energy Relations, Quantitative Structure – Property Relations, Descriptor Analysis, Model Building, Modeling Toxicity, Structure – Spectra correlations, Prediction NMR, IR and Mass spectra, Computer Assisted Structure elucidations, Computer assisted Synthesis Design, Introduction to drug design, Target Identification and Validation, Lead Finding and Optimization, analysis of HTS data, Virtual Screening, Design of Combinatorial Libraries, Ligand based and Structure based Drug design, Application of Cheminformatics in Drug Design.	**15L**

References:

1. Andrew R. Leach and Valerie J. Gillet (2007) an Introduction to Cheminformatics. Springer: The Netherlands.
2. Gasteiger, J. and Engel, T. (2003) Cheminformatics: A textbook. Wiley–VCH.
3. Gupta, S. P. QSAR and Molecular Modeling. Springer-Anamaya Pub.: New Delhi.

Evaluation Pattern:

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHOOE-II 404
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	---------------

Course Code: PSCHOOE-I 404
Nomenclature: Research Methodology
Course Outcomes: After completion of course, student will able to:
CO1: Explain the primary, secondary and tertiary sources in research methodology.
CO2: Explain the data analysis.
CO3: Understand the concept of methods of scientific research and writing scientific papers.
CO4: Understand the concept of chemical safety and ethical handling of chemicals.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Primary, Secondary and Tertiary sources.**	Print: [5L] Primary, Secondary and Tertiary sources. Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. Digital: [5L] Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-databases, ChemSpider, Science Direct, SciFinder, Scopus. Information Technology and Library	**15L**

		Resources: [5L] The Internet and World wide web, Internet resources for Chemistry, finding and citing published information.	
II	**Data Analysis**	The Investigative Approach: Making and recording Measurements, SI units and their use, Scientific methods and design of experiments. Analysis and Presentation of Data: Descriptive statistics, choosing and using statistical tests, Chemometrics, Analysis of Variance (ANOVA), Correlation and regression, curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting, linearizing transformations, exponential function fit, r and its abuse, basic aspects of multiple linear regression analysis.	**15L**
III	**Methods Of Scientific Research And Writing**	Scientific Papers [15L] Reporting practical and project work, Writing literature surveys and reviews, organizing a poster display, giving an oral presentation. Writing Scientific Papers: Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics, avoiding plagiarism.	**15L**
IV	**Chemical Safety and Ethical Handling Of Chemicals**	Safe working procedure and protective environment, protective apparel, emergency procedure, first aid, laboratory ventilation, safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric pressure, safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	**15L**

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1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., and Jones, A., (2011), Practical skills in Chemistry, 2nd Ed., Prentice Hall, Harlow.
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Evaluation Pattern

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	One Periodical Class Test / Written objectives / Assignments/ Short answer Questions / Seminar to be conducted in the given semester.	30
02	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities.	10

B) Semester End Examination: 60% (60 Marks)

60 Marks per paper Semester End Theory Examination: 1. Duration - These examinations shall be of two hours duration. 2. Theory question paper pattern: a. There shall be 04 questions each of 12 marks on each unit and one question of 12 marks on all units. b. All questions shall be compulsory with internal choice within the questions.

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHO4P1
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------------------

Course Code: PSCHO4P1
Nomenclature: Two steps preparations.
Course Outcomes: After completion of course, student will able to:

CO1: Understand the planning of synthesis, effect of reaction parameters including stoichiometry, and safety aspects including MSDS.

CO2: Understand the possible mechanism, expected spectral data (IR and NMR) of starting material and final product.

CO3: Purify the product, Measure its mass or volume, check the purity by TLC, determine physical constant and calculate percentage yield.

Curriculum:

Paper	Title	Learning Points	No of Credits
I and II	**Two steps preparations**	1. Acetophenone → Acetophenone phenyl hydrazine → 2-phenyl indole. 2. 2-naphthol → 1-phenyl azo-2-naphthol → 1-amino-2-naphthol. 3. Cyclohexanone → cyclohexanone oxime → Caprolactum. 4. Hydroquinone → hydroquinone diacetate → 2, 5-dihydroxyacetophenone. 5. 4-nitrotoluene → 4-nitrobenzoic acid → 4-aminobenzoic acid. 6. *o*-nitroaniline → *o*-phenylene diamine → Benzimidazole. 7. Benzophenone → benzophenone oxime → benzanilide. 8. *o*-chlorobenzoic acid → N-phenyl anthranilic acid → acridone. 9. Benzoin → benzil → benzilic acid. 10. Phthalic acid → phthalimide → anthranilic acid. 11. Resorcinol → 4-methyl-7-hydroxy coumarin → 4-methyl-7-acetoxy coumarin. 12. Anthracene → anthraquinone → anthrone. **(Minimum 8 experiments)**	**04**

References:

1. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis- V. K. Ahluwalia and Renu Aggarwal, Universities Press India Ltd., 2000.
2. Advanced Practical Organic Chemistry – N. K. Vishnoi, Third Addition, Vikas Publishing House PVT Ltd.
3. Systematic Laboratory Experiments in Organic Synthesis- A. Sethi, New Age International Publications.
4. Systematic Identification of Organic compounds, 6th edition, R. L. Shriner, R. C. Fuson and D.Y. Curtin Wiley, New York.
5. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS.
6. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
7. Macro-scale and Micro-scale Organic Experiments, K. L. Williamson, D. C. Heath.
8. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
9. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark, Adward Arnold.
10. Vogel's Textbook of Practical Organic Chemistry, Fifth edition,2008, B.S.Furniss, A. J.Hannaford, P. W. G. Smith, A. R. Tatchell, Pearson Education.
11. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.
12. Organic structures from spectra, L. D. Field, S. Sternhell, John R. Kalman, Wiley, 4th ed., 2011.

Evaluation Pattern: Practical (I and II)

Max. Marks 100

A) Internal Assessment: 40 % (40 Marks)

Sr. No.	Particulars	Marks
01	Assessment during practical (Interaction / Performance) Skill, Accuracy, precision of measurement, Record of observation, calculations, graph, result and conclusion. Timely submission of journal	30
04	Overall performance (attendance, punctuality, interaction during Practical session throughout semester)	10
Total		**40**

B) Semester End Examination: 60% (60 Marks)

Sr. No.	Name of course	Duration	Expt.	JOURNAL	viva	TOTAL
1.	Paper I	Three and half hours	40	05	05	50
2.	Paper II	Three and half hours	40	05	05	50
Total						**100**

Practical examination will be of 100 marks at the end of semester which will be converted to 60 Marks.

CIE/ Internal	Semester End	Total Marks
40	60	100

Syllabus for M. Sc. II (Organic Chemistry) from the year 2023-24

Name of the Course	M.Sc. Organic Chemistry
Course Code	PSCHO4P2
Class	M.Sc.-II
Semester	IV
No of Credits	04
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	------------------

Course Code: PSCHO4P2
Nomenclature: Spectral Interpretation and Project Evolution
Course Outcomes: After completion of course, student will able to:

CO1: Explain the theoretical principles of UV, IR, ^{1}H NMR, ^{13}C NMR and Mass spectroscopy.

CO2: Discuss structural elucidation of organic compounds by UV, IR, ^{1}H NMR, ^{13}C NMR and Mass spectral data.

CO3: To develop problem solving, analysis, synthesis, evaluation skills, encourage team work, improve communication skills.

CO4: Understand how to design and plan an experiment including selective variables creating hypothesis

CO5: To develop the ability to conduct research including literature review

Curriculum:

Paper	Title	Learning Points	No of Credits
III and IV	Session-I	**Combined spectral identification: Interpretation of spectral data of organic compounds (UV, IR, PMR, CMR and Mass spectra).** A student will be given UV, IR, PMR, CMR, and Mass spectra of a compound from which preliminary information should be reported within first half an hour of the examination without referring to any book/reference material. The complete structure of the compound may then be elucidated by referring to any standard text-book/reference material etc. (**Minimum 8 spectral analysis).**	04
	Session-II	**Project evaluation**	

References:

1. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis- V. K. Ahluwalia and Renu Aggarwal, Universities Press India Ltd., 2000.
2. Advanced Practical Organic Chemistry – N. K. Vishnoi, Third Addition, Vikas Publishing House PVT Ltd.
3. Systematic Laboratory Experiments in Organic Synthesis- A. Sethi, New Age International Publications.
4. Systematic Identification of Organic compounds, 6th edition, R. L. Shriner, R. C. Fuson and D.Y. Curtin Wiley, New York.
5. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS.
6. Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
7. Macro-scale and Micro-scale Organic Experiments, K. L. Williamson, D. C. Heath.
8. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
9. Handbook of Organic Analysis- Qualitative and Quantitative, H. Clark, Adward Arnold.
10. Vogel's Textbook of Practical Organic Chemistry, Fifth edition,2008, B.S.Furniss, A. J.Hannaford, P. W. G. Smith, A. R. Tatchell, Pearson Education.
11. Laboratory Manual of Organic Chemistry, Fifth edition, R K Bansal, New Age Publishers.
12. Organic structures from spectra, L. D. Field, S. Sternhell, John R. Kalman, Wiley, 4th ed., 2011.

Evaluation Pattern: Practical (III)

Max. Marks 100

Interpretation of organic spectra	Journal	Viva	Total
40	05	05	50

Evaluation Pattern: Practical (IV)

(Project Evaluation)

Presentation	Defence	Project Report	Total
20M	15M	15M	50M

Chairperson