NEP BASED

SYLLABUS AND REGULATIONS

FOR

B.Sc. (Honors) CHEMISTRY

[1 TO 4 SEMESTERS]

[AFFILIATED COLLEGES]

[FOR THE YEAR **2023-24** ONWARDS]

PONDICHERRY UNIVERSITY
PUDUCHERRY - 605 014

PONDICHERRY UNIVERSITY
UG BOS in CHEMISTRY

TITLES: **B.Sc. Chemistry – 3 Yrs (or) B.Sc. (Hons.) Chemistry – 4 Yrs**

[With **Chemistry** major and 2 minors – **Physics** & **Mathematics / Botany / Zoology** (any one of the three)]

REGULATIONS

1. Learning outcomes/Employability/Skill focus of the Programme:

1.	On completion of the course, students can design and carry out scientific experiments and also accurately record and analyze the data/results of such experiments. They can explain why chemistry is an integral activity for addressing environmental problems.
2.	Graduates of B.Sc. Chemistry may pursue a career path in pharmaceuticals, food and beverage companies, cosmetics companies, oil and petroleum companies, mineral companies, chemical manufacturing companies, clinical facilities etc.
3.	They may get placed as a process chemist, industrial chemist, agricultural chemist, analytical chemist, clinical biochemist, cosmetic chemist, chemical analyst, or a chemistry teacher.
4.	Students can develop skills in problem solving, critical thinking and analytical reasoning as applied to scientific problems. They can develop ability to communicate the results of scientific work in oral, written, and electronic formats to both scientific community and the public community at large.
5.	Students will acquire skills to explore new areas of research in chemistry and allied fields of science and technology.

2. Titles of the Certificates/Diplomas for exiting students (2 to 3 Certificates/Diplomas based on specialized internship undergone by the students)

1.	Certificate in Chemistry
2.	Diploma in Chemistry
3.	B.Sc. Chemistry
4.	B.Sc. (Hons.) Chemistry

3. Value-added certificate/skill certification/certificates based on Indian Traditional Knowledge

1.	Understanding India
2.	Environmental Science/Education
3.	Health & Wellness, Yoga Education, Sports, and Fitness
4.	Digital and Technological Solutions

4. Basic Eligibility for Admission of Students (Required subjects at +2 level and % of Marks)

1.	Chemistry with minimum of 60% marks at +2 level
2.	Physics and Mathematics subjects are mandatory at +2 level who are opting for Mathematics and Physics minor
3.	Physics and Biology subjects are mandatory at +2 level who are opting for Zoology/Botany and Physics minor

5. Total number of Teachers required to handle different subjects (along with their qualification/specialization)

Sl. No	**Cadre**	**No of faculty members required**	**Qualifications Required**	**Specialization Required**
1.	Professors	As per UGC Guideline	As per UGC Guideline	As per UGC Guideline
2.	Associated Professor	7 for 3 years B.Sc. course + 2 for 4th year B.Sc.(Hons.)	As per UGC Regulations	Chemistry
3.	Assistant professor			
4.	Tutors/Teaching Assistants/Lab Demonstrators	1	As per UGC Regulations	Chemistry
5.	Technical Staff	1	As per UGC Regulations	Science

6. Bridge courses to be organized for other Disciplinary students (Max 10 sessions with zero credits)

NIL

7. Number of classrooms, number of Science/Engineering/Computer Labs and Equipment Required for each lab (including English Lab and ICT Labs for conducting Practicals/Number of computers/Computer labs required)

S. No.	**Class Rooms**	**Labs**
1.	4 Nos. (I, II, III, and IV year class rooms)	Major Chemistry Lab –2 Nos.
2.		Minor Chemistry Lab – 1 No.
3.		Project Chemistry Lab – 1 No.

8. Software or Databases for conduct Computer Lab practicals/major stores for science labs:

1.	Computers required: 4 Nos (For project work &report preparation)
2.	Windows Operating System
3.	MS Office Software
3.	Anti-Virus Software
4.	CHEM DRAW software

9. Lab running Expenses/Stores:

a) Budget for conducting Science labs --- Rs. 1,00,000 per year

b) Budget for conducting Engineering practicals: --- NA

c) Budget for computer lab running expenses: --- Rs. 10,000 (for computer maintenance)

d) Budget for conducting IVs/Field works/ Internships, etc. --- Rs. 50,000 per year

10. List of basic Text Books for the entire course (At least one per subject)

a) List of Basic textbooks (for all subjects) --- As per the references cited in the syllabus

b) List of Journals to be Subscribed --- As per the references cited in the syllabus

c) List of Magazines/Newspaper needed --- As per the references cited in the syllabus

d) Approximate Library Budget --- Rs. 50,000 per year

11. Essential knowledge/Skills required: (Maths/Basic Computer knowledge/Coding/English communication/Programming skills/Typing, etc.)

Mathematics, Basic Computer Knowledge and chemistry practical skills

12. List of Major/Minor and other courses

Major Courses (Compulsory)		**Credits**
3 Year UG	1. General Chemistry-I	4
	2.General Chemistry-II	
	3. Inorganic Chemistry-I	
	4. Physical Chemistry-I	
	5. Organic Chemistry-I	
	6. Physical Chemistry-II	
	7. Basic Analytical Chemistry	
	8. Inorganic Chemistry-II	
	9. Organic Chemistry-II	
	10. Organic Chemistry Practical	
	11. Analytical Chemistry	
	12. Polymer Chemistry/Green Methods in Chemistry (Any one of the two)	
	13. Industrial Chemicals and Environment/ Organometallic, Bioinorganic Chemistry & Polynuclear hydrocarbons (Any one of the two)	
	14. Analytical Chemistry Practical	
	15. Summer Internship	
	16. Inorganic Chemistry-III	
	17. Organic Chemistry-III	
	18. Physical Chemistry-III	

4 Year UG Hons. in place of Research Project	1. Advanced Topics in Inorganic Chemistry	4
	2. Advanced Topics in Organic Chemistry	
	3. Advanced Topics in Physical Chemistry	
	4. Computational Chemistry	
	5. Molecular modeling and Drug Design	
	6. Manipulation of Organic molecules	
	7. Environmental Chemistry	

Minor Disciplinary Courses (students may choose any one stream)

Chemistry	1. Basic Chemistry-I	4
	2. Basic Chemistry Practical-I	
	3.Basic Chemistry-II	
	4. Basic Chemistry Practical-II	
	5. Business Skills for Chemists/Analytical and Clinical Biochemistry (Any one of the two)	
	6. Applied Chemistry/Applications of Computer in Chemistry (Any one of the two)	
	7. Introduction to Green Chemistry/Pharmaceutical Chemistry (Any one of the two)	
	8. Chemistry in Agriculture/Food and Medicinal Chemistry (Any one of the two)	

Other Courses

Multidisciplinary Course (MDC)

S.No	Category	Title of Theory	Credits
1.	Natural Science		
2.	Physical Science	Chemistry in Everyday Life (or) Essentials of Chemistry	3
3.	Social Science		

Ability Enhancement Courses (AEC)

S.No	Category	List of Courses	Credits
I.	English	A. Basic Language& Literature	2
		B. Functional Language	2
		C. Spoken communication	2
II.	Indian Language	A. Basic Language & Literature	2
		B. Functional Language	2
		C. Spoken communication	2

13. Students Activities: (Project work/Internships/Field Studies/Tours/Training/Programs required to be conducted)

1.	Project Work
2.	Internships
3.	Field Studies
4.	Industrial Visit
5.	Training program
6.	Workshops

14. Breakup Evaluation/Passing Minimum:

Break up of Internal Assessment marks:

Total Internal Assessment mark for a theory subject is **25 marks**.

The breakup is:

a)	Mid Semester Exam (one)	20 Marks
b)	Percentage of Attendance	5 Marks
	Total	**25 marks**

Method of Exam: Tests/Quizzes/Presentations/assignments/projects reports/etc,

Internal Assessment marks for Practicals/Project work/Internships subjects:

The break up is as follows:

a)	Observation note/Demo note/ Work dairy	20 Marks
b)	Practical Record/Internship Report	30 Marks
	Total	**50 marks**

End-Semester pattern of QP:

The breakup of end semester marks:

a) Theory subjects (Sec A, Sec B and Sec C pattern with Questions from all units of syllabus)	75 marks
b) Practical/Internship Project Work subjects (Based on Practical Exams/ Presentation/Viva)	50 marks

15. Entry/Exit Specifications (Basic eligibility/Subjects studied)

1.	Certificate in Major Disciplinary course for exiting students after 1 year with no arrears provided that they undergo 4 credits Internship during Summer Vacation in the given stream of skill training.
2.	UG Diploma in Major Disciplinary course for exiting students after 2 years with no arrears provided that they complete 4 Cr Summer Internship for 45 Days.
3.	A Bachelor Degree in Major Disciplinary course after completing 3 Years (6 Semesters) of Programme of Study without any arrears.
4.	A 4 year Bachelor Degree with Honors after completion of 8 Semesters (4 Years) of Programme of Study and a Research Project in final semester or 3 theory papers in lieu of Research Project, without any arrears.

Passing Minimum: The passing minimum is 40% marks (Internal Assessment + End semester put together)

16. Approved list of SWAYAN/MOOCS courses (for substituting the courses)/(Maximum number of credits Transferable) :

NIL

17. List of value-added courses/certificates/Diploma co-exists with the main program and add-ons to be completed by students for qualifying for the degree:

1.	Understanding India
2.	Environmental Studies
3.	Health & Wellness, Yoga Education, Sports, and Fitness:
4.	Digital Technologies

18. List of Institutions/organizations to collaborate for joint degree/dual degree/training arrangement under internationalization of education:

NIL

19. Field of specializations for which Professors of practice needed to be invited :

NIL

20. Evaluation procedure of Research Project Report at the VIII semester of UG (Hons) degree:

	Internal	**External**
Project Report Submission	40%	40%
Project Presentation/Viva	10%	10%
Total	50%	50%

B.Sc.ChemistryCurriculum (4 years / 3 years)

NEP COURSE STRUCTURE

Semester-wise Course & Credit Distribution Scheme

Semester I (20Credits)

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Major Disciplinary Course -1	UCHMJ 1101	General Chemistry-I	T	4	5
Minor Disciplinary Course -1	*	Mathematics-I / Zoology-I / Botany-I (anyone of the three)	T	4	5
Multi-Disciplinary Course -1	*	Course from other department (Natural Science / Physical Science / Humanities & Social science) (anyone of the three in each semester)	T	3	4
Ability Enhancement Course -1	*	English or Indian Languages	T	2	4
Skill Enhancement Course -1	UCHSE 1100	General Chemistry Practical	**P**	3	4
Value Added Course I	*	VAC-1 Environmental Studies	T	2	4
Value Added Course II	*	VAC-2 -Understanding India	T	2	4
			Total	**20**	30

*** Other Department Courses** – Course Code to be given by the respective Boards.

Semester II (20 Credits)

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Major Disciplinary Course -2	UCHMJ 1201	General Chemistry-II	T	4	5
Minor Disciplinary Course -2	*	Mathematics-II / Zoology-II / Botany-II(anyone of the three)	T	4	5
Multi-Disciplinary Course -2	*	Course from other department (Natural Science / Physical Science / Humanities& Social Science) (anyone of the three in each semester)	T	3	4
Ability Enhancement Course -2	*	English or Indian Languages	T	2	4
Skill Enhancement Course -2	UCHSE 1200	Inorganic Chemistry Practical	**P**	3	4
Value Added Course III	*	VAC-3 – Health &Wellness / Yoga Education, Sports & Fitness	T	2	4
Value Added Course IV	*	VAC-4 – Digital Technologies	T	2	4
			Total	**20**	30

Semester III (20 Credits)

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Major Disciplinary Course -3	UCHMJ 2101	Inorganic Chemistry-I	T	4	5
Major Disciplinary Course -4	UCHMJ 2102	Physical Chemistry-I	T	4	5
Minor Disciplinary Course -3	*	Physics-I	**T**	4	5
Multi-Disciplinary Course -3	*	Course from other department (Natural Science / Physical Science / Humanities& social science) (anyone of the three in each semester)	T	3	4
Ability Enhancement Course -3	*	English or Indian Languages	T	2	4
Skill Enhancement Course -3	UCHSE 2100	Physical Chemistry Practical	**P**	3	4
			Total	**20**	27

*** Other Department Courses** – Course Code to be given by the respective Boards.

Semester IV (20 Credits)

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Disciplinary Course	UCHMJ 2201	Organic Chemistry-I	T	4	5
Major Disciplinary Course -6	UCHMJ 2202	Physical Chemistry-II	T	4	5
Major Disciplinary Course -7	UCHMJ 2203	Basic Analytical Chemistry	T	4	5
Minor Disciplinary Course -4	*	Physics-II	**T**	4	5
Ability Enhancement Course -4	*	English or Indian Languages	T	2	4
Project / Internship - I	UCHWP 2200	Winter Project/ Internship	**O**	2	6
			Total	**20**	30

Semester V (20 Credits)

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Major Disciplinary Course -8	UCHMJ 3101	Inorganic Chemistry-II	T	4	5
Major Disciplinary Course -9	UCHMJ 3102	Organic Chemistry-II	T	4	5
Major Disciplinary Course -10	UCHMJ 3100	Organic Chemistry Practical	**P**	4	5
isciplinary Course -5	*	Course from any other science department	T	4	5
Skill Development Course -1	UCHSD3100	MJD15: Summer Internship	**O**	4	6
			Total	**20**	26

*** Other Department Courses** – Course Code to be given by the respective Boards.

Semester VI (20 Credits)

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Major Disciplinary Course -11	UCHMJ 3201	Analytical Chemistry	T	4	5
Major Disciplinary Course -12 (any one of the two)	UCHMJ 3202	Polymer Chemistry	T	4	5
	UCHMJ 3203	Green Methods in Chemistry			
Major Disciplinary Course -13 (any one of the two)	UCHMJ 3204	Industrial Chemicals and Environment	T	4	5
	UCHMJ 3205	Organometallic, Bioinorganic Chemistry & Polynuclear hydrocarbons			
Major Disciplinary Course -14	UCHMJ 3200	Analytical Chemistry Practical	**P**	4	5
Minor Disciplinary Course -6	*	Course from any other science department	T	4	5
			Total	**20**	25

Semester VII (20 Credits)

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Major Disciplinary Course -16	UCHMJ 4101	Inorganic Chemistry-III	T	4	5
ciplinary Course -17	UCHMJ 4102	Organic Chemistry-III	T	4	5
Major Disciplinary Course -18	UCHMJ 4103	Physical Chemistry-III	T	4	5
Minor Disciplinary Course -7	*	Course from any other science department	T	4	5
Minor Disciplinary Course -8	*	Course from any other science department	T	4	5
			Total	**20**	25

*** Other Department Courses** – Course Code to be given by the respective Boards.

Semester VIII (20 Credits)

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Major Disciplinary Course -19 (any one of the three)	UCHMJ 4201	Supramolecular Chemistry	T	4	5
	UCHMJ 4202	Essentials of Nano Chemistry			
	UCHMJ 4203	Pericyclic & Organic Photo Chemistry			
Major Disciplinary Course -20 (any one of the three)	UCHMJ 4204	Research Methodology	T	4	5
	UCHMJ 4205	Natural Products & Heterocyclic Compounds			
	UCHMJ 4206	Retrosynthetic Analysis			
Research Project [OR] Major Disciplinary Courses -21, 22, 23 (any three out of seven)	UCHRP 4200 [OR] UCHMJ 4207 UCHMJ 4208 UCHMJ 4209 UCHMJ 4210 UCHMJ 4211 UCHMJ 4212 UCHMJ 4213	Research Project [OR] 1. Advanced Topics in Inorganic Chemistry 2. Advanced Topics in Organic Chemistry 3. Advanced Topics in Physical Chemistry 4. Computational Chemistry 5. Molecular modeling and Drug Design 6. Manipulation of Organic molecules 7. Environmental Chemistry	**O** T	12 12 (4 credits each)	15 15 (5 hrs. each)
			Total	**20**	30

Note: Research Methodology is compulsory if Research Project is opted.

***Other Department Courses** – Course Code to be given by the respective Boards.

Semester-wise Chemistry Course Structure and Scheme For Under Graduate Students of Other Departments

(Minor Disciplinary & Multi Disciplinary Courses in CHEMISTRY)

Semester I

Course	Course Code	Title of the Course	Theory/ Practical	Credits	Hrs of Teaching
Minor Disciplinary Course -1	UCHMI 1101	Basic Chemistry-I	T	4	5
Disciplinary Course (any one of the two)	UCHMD 01	Chemistry in Everyday Life	T	3	4
	UCHMD 02	Essentials of Chemistry			

Semester II

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Minor Disciplinary Course -2	UCHMI 1200	Basic Chemistry Practical-I	**P**	4	5
Multi-Disciplinary Course (any one of the two)	UCHMD 01	Chemistry in Everyday Life	T	3	4
	UCHMD 02	Essentials of Chemistry			

Semester III

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Disciplinary Course -	UCHMI 2101	Basic Chemistry-II	T	4	5
Multi-Disciplinary Course (any one of the two)	UCHMD 01	Chemistry in Everyday Life	T	3	4
	UCHMD 02	Essentials of Chemistry			

Note: Multi-Disciplinary courses in chemistry are common for all the three semesters

Semester IV

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Minor Disciplinary Course -4	UCHMI 2200	Basic Chemistry Practical-II	**P**	4	5

Semester V

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
›r Disciplinary Course -5 (any one of the two)	UCHMI 3101	Business Skills for Chemists	T	4	5
	UCHMI 3102	Analytical and Clinical Biochemistry			

Semester VI

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Minor Disciplinary se -6 (any one of the two)	UCHMI 3201	AppliedChemistry	T	4	5
	UCHMI 3202	Applications of Computer in Chemistry			

Semester VII

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Disciplinary Course -7 (any one of the two)	UCHMI 4101	Introduction to Green Chemistry	T	4	5
	UCHMI 4102	Pharmaceutical Chemistry			
Minor Disciplinary Course -8 (any one of the two)	UCHMI 4103	Chemistry in Agriculture	T	4	5
	UCHMI 4104	Food and Medicinal Chemistry			

I Year – Semester-I
GENERAL CHEMISTRY – I

Learning Objectives:

- To study about atomic structure, chemical bonding and molecular structure
- To learn the fundamentals of organic chemistry
- To understand stereochemistry and gaseous state
- To study about gaseous state and kinetic molecular model

Leaning Outcomes:

- Learn the atomic structure, wave particle duality of matter, bonding, and molecular structures
- Understand fundamental concepts in organic chemistry
- Learn the structure, shape and reactivity of organic molecules and stereochemistry
- Understand the kinetic molecular model of a gas and the behaviour of real gases

Unit – I: Atomic Structure (12 Hours)

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydronic wave functions (atomic orbitals) andtheir variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum quantum numbers m_l and m_s. Shapes of s, p and d atomic orbitals, nodal planes. Spin quantum number (s) and magnetic spin quantum number (ms).

Unit II: Chemical Bonding and Molecular Structure (12 Hours)

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, Lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding:VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with the following examples – $BeCl_2$, BF_3, NH_3, SF_4, PCl_5, SF_6 – Concept of resonance and resonating structures in various inorganic compounds.

MO Approach: Rules for the LCAO method, bonding and anti-bonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of O_2 and N_2 and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.

Unit III: Fundamentals of Organic Chemistry (12 Hours)

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Introduction to types of organic reactions: Addition, Elimination and Substitution reactions.

Unit IV: Stereochemistry (12 Hours)

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Unit V: Gaseous State: (12 Hours)

Kinetic molecular model of a gas: Postulates and derivation of the kinetic gas equation - collision frequency - collision diameter - mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degree of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Reference Books:

• Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
• Cotton, F.A., Wilkinson, G. &Gaus, P.L. Basic Inorganic Chemistry, 3rd Ed., Wiley, 2007
• Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons, 2006.
• Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
• Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley &Sons (2014).
• McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
• Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
• Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
• Finar, I.L. Organic Chemistry (1964) (Vol. I & II), E.L.B.S.
• Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
• Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
• Puri B.R., Sharma L.R. and Kalia K.C. Principles of Inorganic Chemistry, Milestone, 2020.
• Arun Bahl, Bahl, B.S. and Tuli G.D. *Essentials of Physical Chemistry,* S. Chand & Co, 2012.
• Peter Atkins and Julio de Paula, *Atkin's Physical Chemistry* 9th Ed., Oxford University Press, 1993.
• Puri B.R., Sharma L.R. and Pathania M.S. *Principles ofof Physical Chemistr,* Vishal Publishing Co., 2008.

SEC–1
Course Code: UCHSE 1100 **Credits: 3**

I Year – Semester-I

GENERAL CHEMISTRY PRACTICAL

Learning Objectives:

To learn how to carry out quanititative analysis of materials by volumetric analysis

Leaning Outcomes:

Able to do different types of titrations and analyze quantitatively the given sample using the technique of volumetric analysis

Volumetric Analysis

1. Preparation of standard solutions of different Molarities and Normalities.
2. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
3. Estimation of oxalic acid by preparing standard FAS and titrating it with $KMnO_4$.
4. Estimation of Fe^{2+} by preparing standard FAS and using $KMnO_4$link solution.
5. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
6. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
7. Estimation of $K_2Cr_2O_7$ iodometricallyby preparing standard $K_2Cr_2O_7$ and link$Na_2S_2O_3$.
8. Estimation of Cu (II) ions iodometricallyby preparing standard $CuSO_4$ and link $Na_2S_2O_3$.
9. Determination of Magnesium or Zinc using EDTA
10. Determination of Hardness of water

Reference Books:

• Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
• Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. &Smith, P.W.G.,2009.
Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
• Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

Major 2 **Credits: 4**

Course Code: UCHMJ 1201

I Year - Semester - II

GENERAL CHEMISTRY-II

Learning Objectives:

- To study chemical energetics
- To understand the Chemical Equilibrium, Ionic Equilibria
- To understand the principles of qualitative inorganic analysis
- To study aboutaliphatic and aromatic hydrocarbons

Leaning Outcomes:

- Learn the important principles of thermochemistry and third law of thermodynamics
- Understand chemical equilibrium and ionic equilibria
- Study the Principles of solubility and Qualitative Inorganic Analysis
- Learn in detail about aliphatic and aromatic hydrocarbons

Unit I: Chemical Energetics (12 Hours)

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry; concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Third law of thermodynamics: Statement of third law; concept of residual entropy; Nernst heat theorem; Evaluation of absolute entropy from heat capacity data.

Unit II: Chemical Equilibrium & Ionic Equilibria: (12 Hours)

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

UNIT-III: Principles of Qualitative Inorganic Analysis (12 Hrs)

(a)Principles of solubility – solubility product – factors affecting solubility –temperature, solvent, common ion effect, effect of complex formation – Separation of metal ions based on solubility differences – sulphide separations. Applications of solubility product principle in qualitative and quantitative analysis.Standard semi micro procedure of identifying common anions and cations in a mixture containing two salts. Spot tests for common cations. Interfering radicals – reason for their interference and method of their removal.

(b)Techniques of separation and purification of mixtures -gravity and suction filtration – centrifugation- drying techniques-melting point and boiling point determinations.

Unit IV: Aliphatic Hydrocarbons (12 Hours)

Alkanes:Preparation – Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Cycloalkanes: Preparation by Dieckman condensation & Baeyer's strain theory. Conformational analysis of mono- and di-substituted cyclohexanes.

Alkenes:Preparation – Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); *cis*-alkenes (Partial catalytic hydrogenation) and *trans*-alkenes (Birch reduction). *Reactions: cis*-addition (alkaline $KMnO_4$) and *trans*-addition (bromine), addition of HX (Markownikoff's and anti-Markownikoff's addition), hydration, ozonolysis, oxymecuration-demercuration, hydroboration-oxidation.

Alkynes:Preparation of acetylene from CaC_2 and conversion into higher alkynes by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: Formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline $KMnO_4$.

Unit V: Aromatic Hydrocarbons (12 Hours)

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Activating and deactivating substituents. Orientation and ortho-para ratio. Addition reactions of benzene - Birch reduction.

Reference Books:

- Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
- Lee, J.D. Concise Inorganic Chemistry, John Wiley & Sons.
- Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
- McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
- Arun Bahl and Bahl, B.S. Advanced Organic Chemistry, S. Chand & Co. Ltd., 2012.
- Arun Bahl, Bahl, B.S. and Tuli G.D. Essentials of Physical Chemistry, S. Chand & Co, 2012.
- Peter Atkins and Julio de Paula, Atkin's Physical Chemistry 9th Ed., Oxford University Press.
- Puri B.R., Sharma L.R. and Pathania M.S. Principles of of Physical Chemistr, Vishal Publishing Co., 2008.
- Hari Jeevan Arnikar, Essentials of Nuclear Chemistry, Revised 4th Ed., New Age International Publishing, 1995.

SEC-2

Course Code: UCHSE 1200 **Credits: 3**

I Year – Semester-II

INORGANIC CHEMISTRY PRACTICAL

Learning Objectives:

To learn how to systematically identify cations and anions present in the given inorganic mixture.

Leaning Outcomes:

Able to identify cations and anions present in the given inorganic mixture, following a systematic semi micro analytical technique and also learns how to eliminate the interfering anion.

Inorganic Semi-micro qualitative Analysis

Systematic semi-micro qualitative analysis of inorganic mixtures - not more than four ionic species (two anions and two cations, excluding insoluble salts) out of which one anion being an interfering radical:

Cations: Lead, antimony, arsenic, tin, bismuth, cadmium, copper, aluminium, chromium, iron, manganese, zinc, nickel, cobalt, calcium, strontium, barium, magnesium, potassium and ammonium.

Anions: Carbonate, sulphide, chloride, bromide, iodide, sulphate, nitrate, phosphate, borate, oxalate, acetate and fluoride.

(using H_2S or other methods. Spot tests should be carried out wherever feasible).

(Combination of mixtures forming insoluble salts should be avoided)

Reference Books:

1. Vogel's Qualitative Inorganic Analysis, Svehla, G. Pearson Education, 2012.
2. An advanced course in Practical Chemistry, Nad, A. K., Mahapatra, B., Ghoshal, A., 3rd ed., New Central Book Agency: Kolkata, 2007.
3. Vogel's Textbook of Quantitative Chemical Analysis, Mendham, J., Denney, R. C., Barnes, J. D., Thomas, M.,Sivasankar, B., 6th ed.; Pearson Education Ltd: New Delhi, 2000.

Major 3 **Credits: 4**

Course Code: UCHMJ 2101

II Year - Semester - III

INORGANIC CHEMISTRY-I

Learning Objectives:

- To learn the chemistry ofhydrogen, hydrides, and s-block elements
- To study in detail aboutp-Block Elements
- To know the theories of acids, bases & non-aqueous solvents
- To learnNuclear Chemistry

Leaning Outcomes:

- Get knowledge about the chemistry of hydrogen, hydrides and s-block elements
- Understand the chemistry ofp-Block Elements
- Know the theories of acids, bases & non-aqueous solvents
- Learn important concepts of nuclear chemistry

Unit -I: Hydrogen, Hydrides, and s-block elements (12 Hrs)

Hydrogen-Isotopes, ortho- and para-hydrogens. Hydrides: ionic, covalent, metallic and interstitial hydrides, Hydrogen bonding.

Alkali metals: Introduction, halides, oxides and hydroxides, salts of oxo-acids, aqueous solution chemistry, complexes and organometallic compounds.

Alkaline Earth metals: Introduction, halides, oxides and hydroxides, salts of oxo-acids, aqueous solution chemistry, complexes and organometallic compounds.

UNIT-II: **p-Block elements –I (Boron, Carbon and Nitrogen group) (12 Hrs)**

(a) General characteristics of Boron group elements - Diagonal relationship between B and Si. Hydrides of Boron – preparation, properties and structure of Diborane. Boron Nitride, Borazine, Sodium Borohydride and Lithium Aluminium hydride,Boric acid

(b) General characteristics of carbon group elements – Allotropy of carbon, structure of Diamond and Graphite, catenation, fullerenes. Fluorochlorocarbons, silicates and carbides.

c) General characteristics of Nitrogen group elements. Allotropy of phosphorus, oxides (N_2O,NO_2, N_2O_3,N_2O_5,P_2O_3,P_2O_5) and Acids of Nitrogen (HNO_2,HNO_3) & Phosphorus (H_3PO_3,H_3PO_4,$H_4P_2O_7$). Preparation and Structure and uses of Hydrazine, Hydrazoic acid and Hydroxylamine.

UNIT-III: p-Block elements –II(Oxygen, Halogens and noble gases group) (12 Hrs)

(a) General characteristics of Oxygen group. Allotropy of sulphur - oxides, halides, oxyhalides of sulphur.Oxyacids (H_2SO_4.H_2SO_3,$H_2S_2O_7$) of sulphur.Persulphuric acids, Dithionic and Thiosulphuricacid (structure, preparation and properties).

(b) General characteristics of halogen group elements, Oxides and oxoacids of halogens, Relative strength of oxo acids of the halogens, inter halogen compounds, Pseudo halogens, Electro positive character of iodine.

c) Chemistry of noble gases:- Position in the periodic table. Occurrence- isolation and separation of noble gases from atmosphere. Physical properties of noble gases, flurides-oxyflurides and oxides of xenon (preparation, properties and structure). Applications of noble gases.

UNIT-IV: Acids, Bases &Non-aqueous Solvents (12 Hrs)

(a) Acids and Bases-Bronsted acids and bases: Lewis acids and bases: definitions, strengths, representative Lewis acids, heterogeneous acid-base reactions.

Hard & soft acids & bases (HSAB) : Classification, Pearson's HSAB concept, acid base-strength& hardness and softness.

(b) Physical properties of a solvent, Types of solvents and their general characteristics. Reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2, THF and Dioxan.

UNIT-V: Nuclear Chemistry (12 Hrs)

Nuclear forces- atomic mass unit- packingfraction – mass defect and binding energy of the nucleus.Stability of nuclei. Nuclear models- the liquid drop model. Nuclear reactions- nuclear fission- fission of uranium- nuclear reactors- types- importance of thorium in India's nuclear energy production. Nuclear fusion.Radio activity- natural radio activity- rate of radio activity disintegration – half life period- transmutation of elements- group displacement law- radio active decay series.Isotopes-separation of isotopes - applications of isotopes in analytical chemistry, medicine, and in reaction mechanism - Carbon dating - Neutron activation analysis.

Reference Books:

1. Cotton, F.A., Wilkinson, G. &Gaus, P.L. Basic Inorganic Chemistry, 3rd Ed., Wiley.
2. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
3. Puri B.R., Sharma L.R. and Kalia K.C. Principles of Inorganic Chemistry, Milestone
4. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
5. Lee, J.D. Concise Inorganic Chemistry, John Wiley & Sons.
6. HariJeevanArnikar, Essentials of Nuclear Chemistry, Revised 4th Ed., New Age International Publishing, 1995.
7. Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
8. Atkin, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).

Major 4 **Credits: 4**

Course Code: UCHMJ 2102

II Year – Semester - III

PHYSICAL CHEMISTRY – I

Learning Objectives:

- To Study the Solid State and X-ray diffraction studies.
- To understand the Chemical Kinetics
- To know about the topics Catalysis, Adsorption and Photochemistry.
- To study aboutDilute Solutions and Colligative Properties.
- To learn about the Phase Equilibrium.

Learning Outcomes:

- Learn the Solid State and X-ray diffraction studies.
- Understand the kinetics of chemical reactions
- Study the Catalysis, Adsorption and Photochemistry.
- Know about the Dilute Solutions and Colligative Properties.
- Understand the Phase Equilibrium.

UNIT – I Solid State (12 Hours)

(a) Definition of Space lattice , Unit cell , Laws of crystallography –

(i) Law of constancy of interfacial angles

(ii) Law of rationality of indices

(iii) Law of symmetry,symmetry elements in crystals

(b) X-ray diffraction by crystals -– Derivation of Bragg's equation. Determination of structures of NaCl,CsCl, KCl, (Laue's method and powder method).

UNIT-II Chemical Kinetics (12 Hours)

Rate and specific reaction rate; Factors influencing the rate of reaction-concentration, temperature, pressure, catalyst, solvent and light; Order and Molecularity of reactions; Derivation of rate constants-zero, first and second order (with equal and unequal concentrations) reactions; Half-life period; Pseudo order reactions; Determination of order of reactions-differential method, method of integration and method of half-life period.

Effect of temperature on reaction rate; Arrhenius equation; Activation energy and its significance; Theory of reactions-Collision theory and Transition state theory.

UNIT-III Catalysis, Adsorption and Photochemistry (12 Hours)

(a) Catalysis

Catalyst and catalysis: Homogeneous and heterogeneous catalysis with examples; Acid-base catalysis with examples; Enzyme catalysis-general characteristics; Auto catalysis; Derivation of Michaelis-Menten constant. Theories of catalysis-intermediate compound formation theory and adsorption theory.

(b) Adsorption

Adsorption-physisorption and chemisorptions; Factors influencing adsorption; Adsorption Isotherms-Freundlich, Langmuir and BET theories. Application of adsorptions.

(c) Photochemistry

Difference between thermal and photochemical reactions; Laws of photochemistry-Grothus-Drapper and Stark-Einstein laws; Jablonski diagram; qualitative description of fluorescence and phosphorescence; Non-radiative processes –internal conversion and inter system crossing; Quantum yield.

UNIT-IV Dilute Solutions and Colligative Properties (12 Hours)

Method of expressing concentrations of solutions; dilute solutions; colligative properties; Raoult's law; relative lowering of vapour pressure; Molecular weight determination; Law of osmatic pressure; determination molecular weight by osmatic pressure; elevation of boiling point and depression of freezing point; thermodynamic derivation of the relation between molecular weight and elevation of boiling point and the relation between molecular weight and depression of freezing point.

UNIT-V Phase Equilibrium (12 Hours)

Definition of Phase, Component and Degrees of Freedom; Derivation of Gibb's phase rule; Phase equilibria of one component systems – H_2O, CO_2 and sulphur systems; Two component systems – Solid-Liquid equilibria- simple eutectic Bi-Cd and Pb-Ag systems; desilverisation of lead; Solid solutions-compound formation with congruent melting point (Mg-Zn) and incongruent melting point (NaCl-H_2O and $CuSO_4$-H_2O) systems.

Liquid-liquid mixtures-ideal liquid mixtures; Raoult's and Hendry's law; non-ideal solutions; partially miscible liquids-phenol-water; trimethylamine-water and nicotin-water systems. Lower and upper consolute temperature. Effect of impurity on consolute temperature.

Azeotropes-HCl-H_2O and ethanol-water systems.

Nernst distribution law-thermodynamic derivations and applications.

Reference Books

1. S.H. Maron and J.B. Lando, *Fundamentals of Physical Chemistry*, Macmillan limited, New York, 1966.
2. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition,Vishal Publishing Company, New Delhi, 2013.

3. Gurdeep Raj, *Advanced Physical Chemistry*, 35th Edition, Goel Publishing House, Meerut, 2009.
4. P.W. Atkins, *Physical Chemistry*, 7th edition, Oxford university press, 2001.
5. S.K. Dogra and S. Dogra, *Physical Chemistry Through Problems*, New age international, 4th edition 1996.
6. Gilbert. W. Castellan, *Physical Chemistry*, Narosa publishing house, third edition 1985.
7. Irving M. Klotz and Robert M. Rosenberg, *Chemical Thermodynamics*, John Wiley and sons, Inc. 1994.
8. J. Rajaram and J.C. Kuriacose, *Thermodynamics*, Shoban Lal Nagin Chand and CO. 1986.
9. K. L. Kapoor, *A Textbook of Physical chemistry*, (volume-2 and 3) Macmillan, India Ltd, 1994.
10. K. Laidler, Chemical Kinetics, 3rd Edition, Pearson Education, New Delhi, 2004.
11. K.K. Sharma and L.K. Sharma, A Textbook of Physical Chemistry, 5th Edition, Vikas Publishing House, New Delhi, 2012.
12. K.L. Kapoor, Physical Chemistry Vol. 3&5, Macmillan Publishers, Noida, 2004.
13. G.K. Vemula Palli, Physical Chemistry, Prentice Hall of India, New Delhi, 1997.

SEC-3 **Credits: 3**

Course Code: UCHSE 2100

II Year – Semester-III

PHYSICAL CHEMISTRY PRACTICAL

Learning Objectives:

- To learn laboratory experiments in order to understand the concepts of physical changes in chemistry
- To learn how to determine the enthalpy change, distribution co-efficient and colligative properties

Leaning Outcomes:

- Demonstrate laboratory skills for safe handling of the equipment and chemicals
- Experiment set-up and recording the data from the experiments applying the principles learned in physical chemistry theory course

Physical Chemistry Experiments

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of molecular mass by Rast's macro method.
5. Determination of transition temperature of the given substance by thermometric method ($Na_2S_2O_3.5H_2O$; $SrCl_2.6H_2O$; $CH_3COONa.3H_2O$; $MnCl_2.4H_2O$)
6. Distribution coefficient of iodine between water and carbon tetrachloride.
7. Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
8. Determination of the critical solution temperature (CST) and composition of the phenol water system.
9. Effect of added electrolytes on the miscibility temperature of phenol-water system.
10. Determination of rate constant of acid catalysed hydrolysis of esters at room temperature
11. Determination of pH using quinhydrone electrode
12. Determination of solubility and solubility product using e.m.f measurement

Reference Books:

1. Basic Principles of Practical Chemistry, Venkateswaran V, Veeraswamy R, Kulandaivelu, A.R., 2nd ed., Sultan Chand, New Delhi, 2012.
2. An advanced course in Practical Chemistry, Nad, A. K., Mahapatra, B., Ghoshal, A., 3rd ed., New Central Book Agency: Kolkata, 2007.
3. Vogel's Qualitative Inorganic Analysis, Svehla, G. Pearson Education, 2012.
4. Vogel's Textbook of Quantitative Chemical Analysis, Mendham, J., Denney, R. C., Barnes, J. D., Thomas, M.,Sivasankar, B., 6th ed.; Pearson Education Ltd: New Delhi, 2000.
5. Practical Organic Chemistry, Manna, A.K., Books and Allied: India, 2018.
6. Vogel's Textbook of Practical Organic Chemistry, Furniss,B. S., Hannaford, A. J.,Smith, P. W. G., Tatchell, A.R., 5th ed., Pearson: India,1989.

Major 5 **Credits: 4**
Course Code: UCHMJ 2201

II Year – Semester - IV

ORGANIC CHEMISTRY – I

Learning Objective:

- To study about the Alkyl and Aryl Halides
- To learn the chemistry of alcohols and phenols
- To understand about the Carbonyl Compounds
- To study about the Organic Compounds of Nitrogen
- To learn about the Heterocyclics

Learning Outcomes:

- Learn about the chemistry of Alkyl and Aryl Halides
- Understand the chemistry of alcohols and phenols
- Know about the Carbonyl Compounds and their reactions
- Study about the Organic Compounds of Nitrogen
- Learn the chemistry of Heterocyclic compounds

Unit-I: Alkyl and Aryl Halides (12Hrs)

Alkyl halides:Preparation from alkenes and alcohols. Reactions - hydrolysis, nitrite & nitro formation, nitrile and isonitrile formation, Williamson's synthesis, Elimination *vs* Substitution
Aryl halides:Preparation of chloro-, bromo- and iodo-benzenes from phenol, Sandmeyer and Gattermann reactions. Reactions of aryl halides: Aromatic nucleophilic substitution (replacement by –OH group and effect of nitro substituent. Benzyne mechanism: $K(Na)NH_2/NH_3$.
Reactivity and relative strength of Carbon-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Unit-II: Alcohols and Phenols (12 Hrs)

Alcohols:Preparation of primary, secondary and tertiary alcohols using Grignard reagent, ester hydrolysis, reduction of aldehydes, ketones, carboxylic acids and esters. Reactions with sodium, HX (Lucas Test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, Con. HNO_3). Oxidation of diols - Pinacol-Pinacolone rearrangement.
Phenols:Preparation bycumene hydroperoxide method, from diazonium salts. Reactions - Electophilic substitution - nitration, halogenations and sulphonation. Reier-Tiemann reaction, Gattermann-Koch reaction, Houben- Hoesch condensation, Schotten Baumann reaction. Acidic character of phenol, comparative strength of alcohol and phenol.

Unit-III: Carbonyl Compounds (12 Hrs)

Structural significance of the carbonyl function and nomenclature.
***Aldehydes and ketones*:**Formaldehye, acetaldehyde, acetone and benzaldehyde - preparation from acid chlorides & from nitriles. Reactions: reaction with HCN, ROH, $NaHSO_3$, amino derivatives. Iodoform test, aldol condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation, Clemmensen Reduction and Wolff Kishner reduction. Meerwein-Pondorff-Verley reduction.

***Carboxylic acids & their derivatives*:** Preparation of formic, acetic and benzoic acids. Reactions: Hell-Volhardt-Zelinsky reaction, synthetic applications of diethyl malonate & ethyl acetoacetate. Preparation of acid chlorides, anhydrides, esters and amides from acids and their interconversion. Reactions: comparative study of the nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

Unit-IV: Organic Compounds of Nitrogen (12 Hrs)

Nitro compounds:Preparation of nitroalkanes and nitroarenes. Reduction of nitrobenzene under various conditions, nitro-acinitro tautomerism.
Amines (aliphatic and aromatic):Classification, preparation from alkyl halides, Gabriel-Phthalimide synthesis, Hofmann bromamide reaction. Hofmann and Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten-Baumann reaction, Electophilic substitution in aniline: nitration, bromination and sulphonation.
Diazonium salts: Preparation from aromatic amines. Conversion to benzene, phenol and azodyes.

Unit-V: Heterocyclics (12 Hrs)

Molecular Orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with emphasis on the mechanism of electrophilic substitution reaction, mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five- and six-membered heterocyclics. Preparation and reaction of indole, quinoline and isoquinoline with special reference to Bisler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

Reference Books:

• Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
• Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co.: New York (1985).
• Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
• Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 1964.
• Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 1964.
• Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed., W. H. Freeman, 2017.
• Berg, J.M., Tymoczko, J.L. &Stryer, L. Biochemistry, W.H. Freeman, 2015.
• R.T. Morrison & R.N. Boyd: Organic Chemistry, 7th Ed., Prentice Hall, 2010.
• Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, 6th Ed., Orient Longman, 2003.
• ArunBahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand, 2012.

Major 6 **Credits: 4**
Course Code: UCHMJ 2202

II Year - Semester - IV

PHYSICAL CHEMISTRY-II

Learning Objectives:

- To Study about Electrochemistry
- To learn the Elementary Quantum Mechanics
- To understand the molecular spectroscopic methods: microwave, IR, Raman and electronic spectroscopy.
- To use molecular spectroscopy in studying the physical properties and molecular structure of compounds

Learning Outcomes:

- Get good knowledgeabout Electrochemistry
- Learn the Elementary Quantum Mechanics
- Understand the molecular spectroscopic methods: microwave, IR, Raman and electronic spectroscopy.
- Use molecular spectroscopy in studying the physical properties and molecular structure of compounds

UNIT-I Electrochemistry-I (12 Hours)

Electrical transport-conduction in metals and in electrolyte solutions; specific conductance; equivalent conductance; measurement of equivalent conductance; variation of equivalent conductance with dilution; migration of ions and Kohlrausch law; Ostwald dilution law-uses and limiatations; Debye-Huckel-Onsager equation for strong electrolytes (derivation not required).

Transport number; determination by Hittorf method and moving boundary method; determination of degree of dissociation; determination of K_a of acids; determination of solubility product of sparingly soluble salts; conductometric titrations.

UNIT-II Electrochemistry-II (12 Hours)

Types of reversible electrodes- Gas-metal ion, metal-metal ion, metal-insoluble salt and redox electrodes. Electrode reactions; Nernst equation; derivation of cell E.M.F and single electrode potential; sign conventions; electrochemical series and its significance.

Reversible and irreversible cells; conventional representation of electrochemical cells; E.M.F of cell and its measurements; computation of cell E.M.F.; calculation of thermodynamic quantities of cell reactions (ΔG, ΔH and ΔK); concentration cells with and without transport; liquid junction potential; applications of concentration cells.

Definition of pH and pK_a; determination of pH by using hydrogen, quinhydrone and glass electrodes by potentiometric method; potentiometric titrations.

Buffers: mechanism of buffer action; Hendersen-Hazel equation; hydrolysis of salts.

UNIT-III Elementary Quantum Mechanics (12 Hours)

Black body radiation; Plank's radiation law; photoelectric effect; Compton effect; De Broglie hypothesis; Heisenberg's uncertainity principle; Sinusoidal wave equation; Radial and angular wave functions; Probability distribution curves; Hamiltonian operator; Schrodinger wave equation and its significance; physical interpretation of wave function; postulates of quantum mechanics; particle in one dimensional box.

UNIT-IV Molecular Spectroscopy-I (12 Hours)

(a) Microwave Spectroscopy

Electromagnetic radiation; Regions of the spectrum; Diatomic molecules; selection rules; energy levels of rigid rotor (semi-classical principles); spectral intensity; distribution using population distribution (Maxwell-Boltzmann distribution); determination of bond length; isotope effect.

(b) Infrared Spectroscopy

Infrared spectrum; selection rules; energy levels of simple harmonic oscillator; pure vibrational spectrum; intensity; force constant and its determination; qualitative relation between force constant and bond energy; effect of anharmonic motion and isotope on the infrared frequency; vibrational frequencies of different functional groups.

UNIT-V Molecular Spectroscopy-II (12 Hours)

(a) Raman Spectroscopy

Concept of polarisability; selection rules; pure rotational and pure vibrational Raman spectra of diatomic molecules; classical theory of rotational and vibrational Raman spectroscopy, complementaritiesof Raman and IR spectroscopy, mutual exclusion principle, polarized and depolarizedRaman lines.

(b) Electronic Spectroscopy

Concept of potential energy curves for bonding and antibonding molecular orbitals; qualitative description of selection rules; Frank-Condon principle; predissociation; qualitative description of σ, π and *n*molecular orbitals and their energy levels; types of electronic transitions.

(c) Physical Properties And Molecular Structure

Optical activity and polarization (Clausius-Mossotti equation); dipole moment; induced dipole moment; measurement of dipole moment – temperature and refractivity methods; dipole moment and structure of molecules. Magnetic properties-paramagnetism, diamagnetism and ferromagnetism.

Reference Books:

1. Principles of Physical Chemistry - B.R. Puri and Sharma - Shobanlal Nagin Chand & Co., 2020.
2. P.L. Soni, O.P. Dharmarha and U.N. Dash, Textbook of Physical Chemistry, 23rd Edition, Sultan Chand & Sons, New Delhi, 2011.
3. Physical Chemistry - Negi and Anand – Eastern Wiley Pvt.Ltd. 2007.
4. Physical Chemistry - Kundu and Jain - S. Chand & Co. , 2012.
5. Physical Chemistry - K.L Kapoor - Macmillan –(2004) - 4 volumes.
6. Elements of Physical Chemistry - Glasstone and Lewis – Macmillan, 1963.
7. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, 2017.
   McGraw–Hill Publishing Company Limited, New Delhi, 2002.
8. Gurudeep R. Chatwal and Sham K. Anand, Spectroscopy: Atomic and Molecular, 5th Edition,Himalaya Publishing House, New Delhi, 2013.
9. Text book of Physical Chemistry - S. Glasstone- Macmillan (India) Ltd. 1940.
10. S. Glasstone, *An Introduction to Electrochemistry,* East-West Press Pvt. Ltd., New Delhi, 2007.
11. Fundamentals of Physical Chemistry - Maron and Lando– Macmillan. 1974.
12. Physical Chemistry - G.W. Castellan - Narosa publishing house, 2004.
13. Physical Chemistry - Walter J. Moore - Orient Longman, 1972.
14. Elements of Analytical Chemistry - R. Gopalan, P.S. Subramanian, K. Rengarajan - S. Chand and sons (1997).
15. Principles of Instrumental Methods of Analysis - D.A Skoog and Saunders - College publications - III edition (1985).
16. Instrumental Methods of Chemical Analysis – B.K. Sharma - Goel Publications, 2004.

Major 7 **Credits: 4**
Course Code: UCHMJ 2203

II Year - Semester - IV

BASIC ANALYTICAL CHEMISTRY

Learning Objectives:

- To study about laboratory glasswares, cleaning methods and first aid procedures.
- To learn stoichiometry and concentration systems
- To understand the principles of volumetric analysis
- To learn statistical evaluation of analytical data
- To study gravimetry and thermo analytical methods

Leaning Outcomes:

- Learn about laboratory glasswares, cleaning methods and first aid procedures
- Understand stoichiometry and concentration systems
- Acquire knowledge about the principles of volumetry
- Gain understanding about statistical evaluation of analytical data
- Understand gravimetry and thermo analytical methods

UNIT-I **(12 Hrs)**

(A) Laboratory Glassware:

a) Types, maintenance and cleaning.
b) Calibration of burette, pipette and standard flask; practice of inter-calibration.
c) Laboratory first aids.

(B) Stoichiometry and concentration systems:

Stoichiometry – Mole and equivalent concepts – Stoichiometric calculations -concentration systems – Molarity – Normality – p-functions – percent concentration – ppm and ppb - calculations involving various types of concentration systems.

UNIT-II **(12 Hrs)**

Principles of Volumetric Analysis:

(a) Definition of the terms primary standard and secondary standard solutions — Equivalence point and end point of titrations, — Types of titrations — Calculations involving volumetric titrations.
(b) Acid - Base Titrations : Derivation of titration curves for strong acid Vs strong base and weak acid Vs strong base titrations — Theory of acid-base indicators.
(c) Redox Titrations :Nernst equation — Theory of redox indicators — Types of redox indicators.
(d) Complex Formation Titrations: Chelating agents – EDTA- Theory of metallochyromic indicators – Titrations involing EDTA – Types of EDTA titrations.
(e) Precipitation Titrations: Argentometric titrations – indicators for titrations involving silver nitrate.

UNIT-III **(12 Hrs)**

Statistical Evaluation of Analytical Data :

Mean, median and mode – Accuracy and precision – ways of expressing accuracy and precision and their calculation – Errors – types – determinate, indeterminate and gross errors – minimization of errors – methods of reporting data – significant figures and problems involving significant figures – Statistical treatment of indeterminate errors – confidence limits – criteria for rejection of outliers – Q-test graphing – the least squares principle – linear regression of data.

UNIT-IV **(12 Hrs)**

Gravimetric Methods of Analysis:

Principles of gravimetric analysis – Gravimetric factor – calculations involved – Conditions for precipitation – Theory of precipitation – Types of precipitants - organic precipitants & advantages – Purity of precipitates – Co-precipitation and post-precipitation – Precipitation from homogeneous solution; Crucibles – types and maintenance – washing of the precipitates – Drying and ignition of precipitates.

UNIT-V **(12 Hrs)**

Thermo Analytical Methods:

Principles of TGA and DTA – Honda's Balance – precautions in using thermo balance - Outlines of Instrumentation (block diagrams only) – Application in the analysis of $CaC_2O_4.H_2O$ and $(CH_3COO)_2Ca.H_2O$ – Thermometric titration – Principle and instrumentation – Conditions for thermometric titration - Titration of HCl Vs NaOH – Complexometric titration – applications of thermometric titration.

Reference Books:

1. "Elements of analytical chemistry" by Gopalan R & Subramanian, Sultan chand& Co, 2003.
2. "Analytical chemistry" by Dr. Alka Gupta, Pragati Prakashan, Ed.IX, 2020.
3. "Instrumental methods of analysis" by Willard, Meritt, Dean, Seattle, 7th Ed., 1986.

Pondicherry University

CHEMISTRY SYLLABUS (NEP) FOR OTHER DEPARTMENT STUDENTS

MINOR& MULTI DISCIPLINARY COURSES IN CHEMISTRY

Minor 1

Course Code: UCHMI 1101 **Credits: 4**

I Year – Semester-I

BASIC CHEMISTRY – I

Learning Objectives:

- To Study classification, nomenclature and some fundamentals of organic chemistry.
- To Study isomerism in organic compounds and conformational analysis
- To Study the stoichiometry and some basic concepts of chemical equilibrium
- To Study radioactivity and its applications
- To study carbohydrates

Leaning Outcomes:

- Learn the Classification and IUPAC nomenclature of organic compound
- Understand the hybridization in organic compounds, dipole moments and charged spices
- Acquire knowledge about isomerism in organic compounds and learn how to name them
- Gain understanding about on cepts of chemical equilibrium, acids and bases, pH and buffer
- Understand radioactivity and its applications

Unit I: Fundamentals of Organic Chemistry **(12 Hrs)**

Classification and IUPAC nomenclature of organic compound**,** Hybridization (sp^3, sp^2 and sp) in organic compounds, localized and delocalized chemical bonds, Hydrogen bonding. Dipole moments in organic molecules, homolytic and hetrolytic bond cleavage, electrophiles, nucleophiles and free radicals, carbocations and carbanions.

Unit II: Isomerism in organic compounds **(12 Hrs)**

Structural and Stereo isomerism, Geometrical isomerism, Cis, trans isomers, E and Z nomenclature of simple compounds; Optical isomerism, optical activity, specific rotation, enantiomers, diastereomers, and meso compounds. R, S configuration in organic molecules with single symmetric centre. Conformers, Newman and sawhorse projection formulae, conformational analysis of ethane, n-butane and cyclohexane.

Unit III: Stoichiometry **(12 Hrs)**

Mole and equivalent concepts, concentration units, molarity, molality, percentage, ppm, and ppb. Types of solutions, stoichiometric calculations.

Basic concepts of chemical equilibrium, equilibrium constants. Concepts of acids and bases. Ionisation of weak acids and weak bases. Hydrogen ion concentration, pH of acids and bases. Buffer solutions, Henderson's equation of buffer. Physiological buffers.

Unit-IV: Radioactivity **(12 Hrs)**

Properties of α, β and γ-radiations, rate of disintegration, half life period, nuclear fission and fusion, fertile and fissile nuclei, radioactive isotopes, nuclear reactions and group displacement law, Application in medicine, agriculture, geology and industry. nuclear reactors- working principle. Neutron activation analysis.

Unit V: Carbohydrate **(12 Hrs)**

Classification, preparation, properties and structures of glucose, fructose, and sucrose (structural elucidation not required), mutarotation, epimers and anomers. Polysaccharides, uses of starch and cellulose (structural elucidation not required) test for sugars.

References Books:

1. Text Book of Organic Chemistry by P.S. Soni, 29th Ed., 2012.
2. Principles of Physical Chemistry by Puri and Sharma, 2020.
3. Allied Chemistry – I by K.M.Tajun Meera Begum and N.M.I.Alhaji, 2016.
4. Advanced Organic Chemistry by Bahl and Arun Bahl, 2012.
5. Modern Inorganic Chemistry by R.D. Madan, 1987.
6. Principles of Inorganic Chemistry by Puri and Sharma, 2020.
7. Physical Chemistry by Bahl and Tuli, 28th Ed., 2020.
8. Analytical Chemistry by Gopalan et al, Sultan Chand & sons, 2003.

Minor 2 **Credits: 4**

Course Code: UCHMI 1200

I Year – Semester-II

BASIC CHEMISTRY PRACTICAL– I

Learning Objectives:

- To learn to do titrimetric experiments
- To calculate the concentrations of unknown solutions
- To determine the melting and boiling points of organic compounds

Leaning Outcomes:

- Understand basic principles involved in titrimetric analysis and compare the methodologies of different titrimetric analysis
- Develop the skill to estimate the amount of a substance present in a given solution
- Measure the melting point and boiling points of organic compounds and compare with the literature values

(A) Volumetric Analysis

1. Determination of sodium hydroxide and sodium carbonate in a mixture using selective indicator method (Acidimetry)
2. Determination of sodium carbonate and sodium bi-carbonate in a mixture using selective indicator method (Acidimetry)
3. Determination of oxalic acid (Permanganometry)
4. Determination of FAS (Permanganometry)
5. Determination of iron (Dichrometry)
6. Determination of potassium dichromate (Iodometry)
7. Determination of copper (Iodometry)
8. Determination of Magnesium or Zinc using EDTA
9. Determination of Hardness of water

(B) Other Experiments

1. Determination of melting point of organic compounds using water bath (m.pt.< 100 ^{o}C).
2. Determination of boiling point of organic substances like ethanol, cyclohexane, toluene, benzene etc.,
3. Determination of viscosity of the given liquid using Ostwald's Viscometer.
4. Purification of organic compounds by recrystallisation.
    a) Aromatic substances from hot water; (b) Naphthalene from ethanol

Reference Books:

1. Basic Principles of Practical Chemistry, Venkateswaran, V.,Veeraswamy, R., Kulandivelu, A.R.,2 nd ed., Sultan Chand &Sons: New Delhi, 1997.
2. An advanced course in Practical Chemistry, Nad, A. K.. Mahapatra, B.. Ghoshal, A.., 3rd ed., New Central Book Agency: Kolkata, 2007.
3. Vogel's Textbook of Quantitative Chemical Analysis, Mendham, J., Denney, R. C., Barnes, J. D., Thomas, M.,Sivasankar, B., 6th ed.; Pearson Education Ltd: New Delhi, 2000.

Minor 3
Course Code: UCHMI 2101

Credits: 4

II Year – Semester-III

BASIC CHEMISTRY – II

Learning Objectives:

- To Study thermodynamics and chemical kinetics
- To Study chromatography and solid state
- To Study amino acids, proteins and enzymes
- To Study polymers and dyes
- To study nucleic acids and drugs

Leaning Outcomes:

- Understand the concept of heat, work, Internal energy and enthalpy
- Learn about separation techniques of organic compounds, bonding in metals, semiconductors and conductors
- Gain knowledge on building blocks of proteins and DNA and dyes
- Get an idea about the pharmaceutical drugs analgesics and antipyretics like paracetamol and aspirin and also about pigments and dyes and its applications.

Unit I: Thermodynamics and Chemical Kinetics

(12 Hours)

First Law of Thermodynamics, Statement, concepts of heat, work and internal energy, Enthalpy and heat capacity, exothermic and endothermic reactions, Second Law of Thermodynamics, spontaneous and non spontaneous processes, entropy concept. Chemical Kinetics: Rate of reaction, Factors affecting the rate of reaction, order and molecularity, examples for zero, first and second order reaction.

Unit II: Chromatography and Solid State

(12 Hours)

Separation techniques, Paper, thin layer and column chromatography, Adsorption, physisorption and chemisorptions, factors affecting them. Langmuir Adsorption Isotherm. Bonding in metals and crystal defects, Metallic bond, Band theory of solids, Applications to conductor, semiconductor and insulators, crystal defects - Schottky and Frenkel defect, metal excess and metal deficiency defects.

Unit III: Amino acids, proteins and enzymes

(12 Hours)

Amino acids: Classification, stereochemistry of amino acids, preparation and properties of amino acids, isoelectric point. Tests for amino acids, Proteins, Classification and structure of proterins, Enzymes, Characteristics of enzyme, mechanism of enzyme action, Michaelis Menten equation.

Unit IV: Polymers and Dyes **(12 Hours)**

Polymers, Preparation and uses of nylon (6,6), Terylene, polythene, polyvinyl chloride, natural rubber and synthetic rubber (Buna-S rubber and neoprene) Vulcanization; Dyes, Modern classification and examples (Indigo, congo red, malachite green, Alizarin and Phenolphthalein)

Unit V : Nucleic acid and Drugs **(12 Hours)**

Nucleic acid – Structure of DNA and RNA, brief account of m-RNA, t-RNA and r-RNA – differences between DNA and RNA.
Drugs, Antiseptic (Dettol), Antipyretic (Paracetamol), Analgesic (Aspirin), Antimalarial (Quinine), Antibiotic (Penicillin), Sulfa Drug (Sulfadiazine) - Structural elucidation not required.

Reference Books:

1. Physical Chemistry by Bahl and Tuli, 28th Ed., 2020.
2. Text Book of Organic Chemistry by P.S. Soni, 29th Ed., 2012.
3. Allied Chemistry – II by K.M.Tajun Meera Begum and N.M.I.Alhaji, 2016.
4. Advanced Organic Chemistry by Bahl and Arun Bahl, 2012.
5. Modern Inorganic Chemistry by R.D. Madan, 1987.
6. Principles of Inorganic Chemistry by Puri and Sharma, 2020.
7. Principles of Physical Chemistry by Puri and Sharma, 2020.
8. Analytical Chemistry by Gopalan et al., Sultan Chand & sons, 2003.

Minor 4
Course Code: UCHMI 2200

Credits: 4

II Year – Semester-IV

BASIC CHEMISTRY PRACTICAL– II

Learning Objectives:

- To perform analysis to identify the functional group in an unknown organic compound performing a systematic analysis
- To learn to separate organic compounds using simple methods and chromatographic techniques

Leaning Outcomes:

- Observe the physical state, odour, colour and solubility of the given organic compound.
- Identify the presence of special elements and functional group in an unknown organic compound performing a systematic analysis
- Compare between mono and dicarboxylic acids, primary, secondary and tertiary amines, mono and diamides, mono and polyhydric phenols, aldehyde and ketone, reducing and non-reducing sugars and explain the reactions behind them
- Prepare a solid derivative with respect to the identified functional group
- Learn to separate the organic compounds by simple methods and chromatography

Organic Qualitative Analysis

Systematic analysis of organic compounds containing single functional group:

(i) Phenols
(ii) Carboxylic acids (mono and di)
(iii) Aldehydes
(iv) Ketones
(v) Aromatic Primary Amine
(vi) Aliphatic Diamide
(vii) Reducing sugars

Other Experiments:

1. Separation of the following mixtures:
   a) Naphthalene and Benzoic acid
   b) Benzoic acid and Glucose
   c) Naphthalene and Glucose
2. Separation of mixture by paper chromatography and identification of Rf value
   a) Separation and identification of mixture of two amino acids
   b) Separation and identification of mixture of sugars
   c) Separation of components in a dye

Reference Books:

1. Basic Principles of Practical Chemistry, Venkateswaran V, Veeraswamy R, Kulandaivelu, A.R., 2nd ed., Sultan Chand, New Delhi, 2012.
2. Practical Organic Chemistry, Manna, A.K., Books and Allied: India, 2018.
3. Advanced Experimental Chemistry (Organic), Gurtu, J. N. Kapoor, R., Sultan Chand: New Delhi, 1987.
4. Vogel's Textbook of Practical Organic Chemistry, Furniss,B. S., Hannaford, A. J.,Smith, P. W. G., Tatchell, A.R., 5th ed., Pearson: India,1989.

Multi-Disciplinary
Course Code: UCHMD 01

Credits: 3

Semesters- I, II & III

1. CHEMISTRY IN EVERYDAY LIFE

Learning Objectives:

- To study functional food additives and food adulteration
- To study soaps and detergents, manufacturing process and environmental hazards
- To study chemical composition of cosmetics and perfumes
- To study the chemical nature of glasses, ceramics and plastics in daily use

Leaning Outcomes:

- Learn about food adulteration, food additives and artificial sweeteners, saccharin, cyclomate and aspartate in the food industries
- Understand the chemistry of soaps and detergents and their action
- Know about the ingredients in commonly used cosmetics and perfumes
- Gain knowledge about glasses and ceramics and their properties
- Learn the nature of the plastics used in everyday life and natural substitution for plastic

Unit I: Food additives **(12 Hours)**

Functional food additives and its importance, food adulteration, detection of food adulterations, food safety laws and fssai regulations. Food colours-permitted and non-permitted – Flavours – natural and synthetic, artificial sweeteners, toxic effect of additives.

Unit II: Soaps and Detergents **(12 Hours)**

Soaps and Detergents – saponification, classification, cleansing action of soap, manufacturing process, additives, fillers, flavours, bleaching agents and enzymes used in commercial detergents, environmental hazards.

Unit III: Cosmetics and perfumes **(12 Hours)**

Cosmetics and perfumes – classification, ingredients and regulations, bathing oils, face creams, talcom powder, skin products, hair dyes, shaving cream, shampoo, conditioners, nail polish, deodorants, antiperspirants, oral hygiene products, toxic effect of cosmetics.

Unit IV: Glasses and ceramics **(12 Hours)**

Glasses and ceramics – classification, manufacturing process, composition and properties of glasses,
soda glass, borosilicate glass, coloured glass, photosensitive glass, armoured glass, safety glass, Important clays and fledspar, plasticity of clay, ceramic and its types, white pottery, glazing, applications.

Unit V: Plastics in daily use **(12 Hours)**

Plastics in daily use. Polymerization process (brief). Thermosetting and thermoplastic polymers. Use of PET, HDPE, PVC, LDPE, PP, PS, ABS, and others. Recycling of plastics. Biodegradable plastics. Environmental Hazards of plastics. Paper news print, writing paper, paper boards, cardboards. Organic materials, wood, cotton, Jute, coir – International Universal recycling codes and symbols for identification.

Reference Books:

1. Food – The Chemistry of its components, T.P. Coultate,. Royal Society of Chemistry London, 2001.
2. Engineering Chemistry, Shashi Chowla, DanpatRai & Co., 2017.
3. Industrial Chemistry, B.K. Sharma, Krishna Prakashan Publishers, 2012.
4. Understanding Chemistry, CNR Rao, Universities Press, 1999.
5. Engineering Chemistry, Jain and Jain, Darpat Rai Publication, 17th Ed., 2015.
6. Chemistry of cosmetics, Kumari R, Prestige publications, 2018.

Multi-Disciplinary
Course Code: UCHMD 02

Credits: 3

Semesters-I, II & III

2. ESSENTIALS OF CHEMISTRY

Learning Objectives:

- To learn about structure of atoms and periodic classification of elements
- To study about radiations and nuclear chemistry
- To know the chemistry of polymers
- To study about vitamins and chemistry involved in some important biological process
- To learn about some application oriented chemicals

Leaning Outcomes:

- Learn about atomic structure, periodic properties of elements and periodic classification
- Understand about radiations and the chemistry involved in nuclear reactions
- Know about polymer chemistry and few important polymers
- Gain knowledge about vitamins and chemistry of some important biological process
- Learn the chemistry of some application oriented chemicals

Unit-I: Atomic Structure and Periodic Classification of Elements (12 Hrs)

Structure of atom- Fundamental particles, atomic mass, atomic number, isotopes. Bohr theory of atom. Orbitals- Quantum numbers, aufbau principle, Hund's rule; Pauli's exclusion principle. Electronic configuration of atoms- half and completely filled orbitals. Modern periodic table: Periods, Groups, Periodicity- valency, atomic radius, electronegativity, Ionisation potential, Electronaffinity.

Unit-II:NuclearChemistry (12 Hrs)

Natural radioactivity, Nature and types of radiations, Properties. Group displacement law. Radio active decay series. Decay rate. Half life period, Average life period, Unit of radioactivity. Radiation dose, artificial radioactivity, nuclear structure. Nuclear fission and Nuclear fusion. Rock dating- Radio carbon dating. (elementary idea only)

Unit-III:Polymer Chemistry (12 Hrs)

Classification of polymer: Origin, structure, synthesis, Molecular forces. Commercially important polymers: Application of polyethylene, polystyrene, polyhaloolefines, Nylon-6, Nylon-66, Melamine, Terylene, Bakelite, Natural and synthetic rubber, vulcanization, inorganic polymer: (Examples Only).

Unit-IV:Chemistry inBiologicalProcess (12 Hrs)

Vitamins: Vitamin-A, Vitamin-B2, Vitamin-C, Vitamin-D, Vitamin-E and Vitamin-K- Name, Source, Function and deficiency diseases. Enzymes- Classifications, characteristics, role, examples. Hormones- Sex hormones- Androgens, oestrogens, progesterone, Example, function. Cortical hormones- A few examples with function. Nucleic acid- RNA, DNA: Introduction- role in life process (No structure or chemical reactions needed)

Unit-V: Chemistryinaction (12 Hrs)

Dyes: classification based on constitution, application, examples, uses. Drugs: Antipyretic, analgesic, antiseptic, disinfectants, tranquilisers, antibiotics structure, name and uses only. Soaps and detergents: Hard and soft soaps, anionic, cationic and non-ionic detergents, cleansing action of soaps, Explosives: TNT, TNG, RDX, Gun cotton: name, structure and action. (No structure or chemical reactions needed)

Reference Books:

1. M. C. Day and J. Selbin,“ Theoretical InorganicChemistry”, East West Press, 2nd Edition, 2008.
2. H. J. Arniker,“ Essentials of NuclearChemistry, New Age International Publishers, 2011.
3. B.K. Sharma “EnvironmentalChemistry”, Goel Publishing House, 2014.
4. Solomons- John- Wiley, “Fundamentals of OrganicChemistry” 4th Edition, 1994.
5. F.A. Carey, Mc. Graw Hill ,“Organic Chemistry”, 4th Ed., 2000.
6. I.L Finar,“Organic Chemistry”, Vol. 1Longman, 2002.
7. K. S. Tewari, N. K. Vishnoi,“A Text book of OrganicChemistry” 4th Ed., 2017.
8. M.K. Jain,“ Principles of OrganicChemistry”, S. Nagin publishers, 1978.

NEP BASED SYLLABUS

FOR B.Sc. (Honors) CHEMISTRY
[5 & 6 SEMESTERS]

[AFFILIATED COLLEGES]

(FOR THE YEAR 2023-24 ONWARDS)

Semester V (20 Credits)

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Major Disciplinary Course -8	CHMJ 311	Inorganic Chemistry-II	T	4	5
Major Disciplinary Course -9	CHMJ 312	Organic Chemistry-II	T	4	5
Major Disciplinary Course -10	CHMJ 310	Organic Chemistry Practical	**P**	4	5
Minor Disciplinary Course -5	*	Course from any other science department	T	4	5
Skill Development Course -1	CHSD3100	MJD15: Summer Internship OR Inorganic Chemistry & Gravimetric Analysis Practical	**O**	4	6
Total				**20**	26

Semester VI (20 Credits)

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Major Disciplinary Course -11	CHMJ 321	Analytical Chemistry	T	4	5
Major Disciplinary Course -12 (any one of the two)	CHMJ 322	Polymer Chemistry	T	4	5
	CHMJ 323	Green Chemistry			
Major Disciplinary Course -13 (any one of the two)	CHMJ 324	Industrial Chemicals and Environmental Chemistry	T	4	5
	CHMJ 325	Organometallic, Bioinorganic Chemistry & Polynuclear hydrocarbons			
Major Disciplinary Course -14	CHMJ 320	Analytical Chemistry Practical	**P**	4	5
Minor Disciplinary Course -6	CHMI 321	Analytical Methods in Chemistry	T	4	5
	CHMI 322	Applications of Computers in Chemistry (For Chemistry Students only)			
Total				**20**	25

Semester V

Note : Papers offers to other departments

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Minor Disciplinary Course -5 (any one of the two)	UCHMI 3101	Chemistry in Agriculture	T	4	5
	UCHMI 3102	Analytical and Clinical Biochemistry			

Semester VI

Note : Papers offers to other departments

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Minor Disciplinary Course -6 (any one of the two)	UCHMI 3201	Applied Chemistry	T	4	5
	UCHMI 3202	Food & Medicinal Chemistry			

Semester-wise Chemistry Course Structure and Scheme For Under Graduate Students of Other Departments

(Minor Disciplinary & Multi Disciplinary Courses in CHEMISTRY)

Semester I

Course	Course Code	Title of the Course	Theory/ Practical	Credits	Hrs of Teaching
Minor Disciplinary Course -1	UCHMI 1101	Basic Chemistry-I	T	4	5
Disciplinary Course (any one of the two)	UCHMD 01	Chemistry in Everyday Life	T	3	4
	UCHMD 02	Essentials of Chemistry			

Semester II

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Minor Disciplinary Course -2	UCHMI 1200	Basic Chemistry Practical-I	**P**	4	5
Multi-Disciplinary Course (any one of the two)	UCHMD 01	Chemistry in Everyday Life	T	3	4
	UCHMD 02	Essentials of Chemistry			

Semester III

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Disciplinary Course -	UCHMI 2101	Basic Chemistry-II	T	4	5
Multi-Disciplinary Course (any one of the two)	UCHMD 01	Chemistry in Everyday Life	T	3	4
	UCHMD 02	Essentials of Chemistry			

Note: Multi-Disciplinary courses in chemistry are common for all the three semesters

Semester IV

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Minor Disciplinary Course -4	UCHMI 2200	Basic Chemistry Practical-II	**P**	4	5

Semester V

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Minor Disciplinary Course -5 (any one of the two)	UCHMI 3101	Chemistry in Agriculture	T	4	5
	UCHMI 3102	Analytical and Clinical Biochemistry			

Semester VI

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Minor Disciplinary Course -6 (any one of the two)	UCHMI 3201	Applied Chemistry	T	4	5
	UCHMI 3202	Food and Medicinal Chemistry			

Semester VII

Course	Course Code	Title of the Course	Theory/ Practical/ Other	Credits	Hrs of Teaching
Disciplinary Course -7 (any one of the two)	UCHMI 4101	Introduction to Green Chemistry	T	4	5
	UCHMI 4102	Pharmaceutical Chemistry			
Minor Disciplinary Course -8 (any one of the two)	UCHMI 4103	Applications of Computer in Chemistry	T	4	5
	UCHMI 4104	Business Skills for Chemists			

III - Year – Semester - V

MJD-8: UCHMJ 3101: INORGANIC CHEMISTRY-II

(60 Hrs)

Objective:

- To Study the Chemistry of d-block elements
- To Study the Lanthanides and Actinides
- To Study the basics of Co-ordination Compounds and applications
- To Study the theories of coordination compounds and their applications

UNIT-I: Chemistry of d-block elements - First transition series (12 Hrs)

General characteristics of d-block elements. Properties of the elements of the first transition series. Relative stabilities of their oxidation states. Extraction from ores and refining of Ti, Mn, Cr, Fe, Co, Ni, Cu and Zn and their uses.

UNIT-II: Chemistry of d-block elements –II and III transition series (12 Hrs)

General characteristics – Comparative treatment with their *3d* analogues in respect of ionic radii, oxidation states, magnetic behavior. Metallurgy of silver, gold, platinum and palladium.

UNIT III: Lanthanides and Actinides (12Hrs)

(a) Lanthanides: Position of lanthanides in the periodic table. General characteristics of lanthanides. Occurrence, electronic configuration, oxidation states, atomic & ionic radii, lanthanide contraction – causes & consequences, colour, magnetic properties & complex formation. Extraction of lanthanides from monazite sand & separation of lanthanide elements by ion exchange method. Uses of lanthanides and their compounds.

(b) Actinides: Position of actinides in the periodic table. General characteristics of actinides: occurrence, electronic configuration, oxidation states, ionic radii of tripositive and tetrapositive cations, colour of $M^{3+}$and M^{4+} cations, magnetic properties and complex formation. Comparison between lanthanides and actinides. Th and U (extraction only). Separation of Np, Pu and Am from U.

UNIT IV: Co-ordination compounds-I: (12 Hrs)

Definition of terms used - classification of ligands - chelation and effect of chelation - Co-ordination number and stereo chemistry of complexes –Werner's theory - EAN rule - Nomenclature of mono nuclear and binuclear (bridged) complexes. Isomerism in complexes – ionization isomerism, hydrate isomerism, linkage isomerism, ligand isomerism, co-ordination isomerism, polymerization isomerism, geometrical and optical isomerism in 4 and 6 co-ordinated complexes.

UNIT V: Co-ordination compounds-II: (12 Hrs)

Valence bond theory - hybridisation - geometry and magnetic properties - limitations of VBT. Crystal field theory - splitting of *d*-orbitals in octahedral, tetrahedral and square planar complexes - crystal field stabilisation energy - calculation of CFSE in tetrahedral and octahedral complexes - Low spin and high spin complexes – explanation of magnetic properties, colour and geometry using CFT - Comparison of VBT and CFT.

Basic principles of molecular orbital theory (MOT) of co-ordination compounds as applied to octahedral complexes without π-bonding and its MO correlation diagram of $[Co(NH_3)_6]^{3+}$- The adjusted crystal field theory (ACFT) or the ligand field theory (LFT) - Types of magnetic behavior. Methods of determination of magnetic susceptibility and magnetic moments (Guoy's method only). The electronic spectrum of $[Ti(H_2O)_6]^{3+}$ ion in solution. Spectrochemical series.

Reference Books

• Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd Ed., Wiley.

• Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.

• Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.

•Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.

•Atkin, P. Shriver & Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010)

III Year – Semester - VI

MID-9: CHMJ 312: ORGANIC CHEMISTRY-II

(**60 Lectures)**

Objective:

- To study the Molecular Rearrangements
- To study the Natural Products
- To study the Carbohydrates
- To study Aminoacids, Peptides, Proteins and Nucleic acids
- To study the Application of Spectroscopy to Simple Organic Molecules

UNIT-I: Molecular Rearrangements: (12 Hrs)

Classification – Types of skeletal rearrangements - anionotropic and cationotropic, inter molecular and intra molecular rearrangements - Mechanisms, evidences, migratory aptitude, inter or intra molecular of the following rearrangements: Pinocol-Pinocolone rearrangement, Hofmann rearrangement, Beckmann rearrangement, Benzil-Benzilic acid rearrangement, Baeyer-Villiger, Fries rearrangement, Claisen rearrangement, Benzidine rearrangement, Curtius rearrangement, Wagner-Meerwein rearrangement, and Wolff rearrangement.

UNIT –II: Natural Products: (12 Hrs)

Terpenoids: Classification, nomenclature, occurrence and isolation. Isoprene rule. General method of structure determination and confirmation by synthesis A) α-Terpineol B) Limonene & C) Citrol

Alkaloids: Definition, classification, occurrence and isolation. General method of structure determination and confirmation by synthesis of A) Nicotine B) Coniine & C) Papaverine

An introduction to steroids, poly-phenolics, marine natural products and their biological significance.

Unit – III Carbohydrates (12 Hrs)

Carbohydrates: Definition, classification, configuration of aldoses & ketoses, reactions of monosaccharides (glucose, fructose), inter-conversion of glucose to fructose and vice versa, chain lengthening and chain shortening of aldoses, objections to open chain structure of glucose and fructose, mutarotation, cyclic structure of monosaccharides (glucose, fructose). Determination of ring size in glucose and fructose. Introduction to disaccharide (sucrose and maltose with structure determination) and polysaccharides (starch and cellulose without involving structure determination).

Unit – IV: Amino acids, Peptides, Proteins and Nucleic Acids (12 Hrs)

Amino acids: Classification, structure and stereochemistry of amino acids, isoelectric point of amino acids. Preparation and properties of alpha-amino acids – tests for amino acids**.**
Peptides: Structure and nomenclature, synthesis of polypeptides (general methods). Solid-phase peptide synthesis. Structure determination of polypeptides - end group analysis.
Proteins: - Classification of protein, structure of protein (determination of structure are not required). Protein denaturation, renaturation.
Nucleic acids*:* Introduction, constituents of nucleic acid, RNA and DNA, types of RNA, structure of DNA.

UNIT - V Organic Spectroscopy (12 hrs)

a. UV-Visible Spectroscopy: Basic Principles, application of UV-Visible Spectroscopy to structural elucidation of simple organic molecules, Woodward- Fieser rules, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation, concept of chromophore and auxochrome, bathochromic, hypsochromic, hyper chromic and hypochromic shifts.

b. Infra Red Spectroscopy: Molecular vibrations, Hook's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, finger print region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic molecules.

c. Proton Magnetic Resonance (^1H NMR) **Spectroscopy:** Magnetic and non-magnetic nuclei, nuclear shielding and de-shielding, chemical shift, spin-spin splitting and coupling constants, intensity of signals, Magnetic and non-magnetic nuclei, nuclear shielding and de-shielding, chemical shift, spin-spin splitting and coupling constants, intensity of signals, interpretation of PMR spectra of ethyl bromide, ethanol and acetaldehyde.

References:

- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- ArunBahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand & Company Ltd.,
- Dudley H Williams & Ian Fleming, Spectroscopic Methods in Organic Chemistry, Tata McGraw-Hill Publishing Company Ltd., (New Delhi), Fourth Edition.

MJD 10: CHMJ -310: ORGANIC CHEMISTRY PRACTICAL-II

A. Organic Qualitative Analysis:

(i) Basic idea on the preparation of reagents used in organic analysis. (Borshes reagent, Schiff's reagent, phenolphthalein, Neutral $FeCl_3$, Tollens reagent, Fehling's solution)

(ii) Study of reactions of common functional groups

(iii) Systematic Qualitative Analysis of organic compounds containing the following mono functional groups: Carbohydrate, carboxylic acid, dicarboxylic acid, phenol, aldehyde, ketone, aromatic primary amine, aromatic amide, aliphatic diamide, and nitro compound

a. Detection of nitrogen, sulphur and halogens.
b. Tests to find whether saturated or unsaturated.
c. Tests to find whether aromatic or aliphatic.
d. Tests to find the functional group.
e. Confirmation of functional group by preparation of derivatives.

B. Organic Preparations:

1. Acetylation of salicylic acid.
2. Acetylation of aniline.
3. Benzoylation of aniline / phenol.
4. Preparation of Iodoform from ethanol / acetone.
5. Preparation of S-benzyl isothiouronium chloride
6. Preparation of m-dinitrobenzene.
7. Preparation of benzoic acid from benzaldehyde

Reference Books:

1. Vogel's Textbook of Practical Organic Chemistry, ELBS.
2. B.S.Furnis, A.J.Hannaford, P.W.G.Smith and T.R.Tatchell *Vogel's Text book of Practical Organic Chemistry* ELBS/Longman 1989.
3. S.P. Bhettani & Aruna Chhikara, *Practical organic chemistry* (qualitative analysis) Ane books (India) Pvt Ltd, 2008.
4. O.P. Pandey, D.N Bajpai, S. Gini, *Practical Chemistry*, for I, II & III BSc. Students. S.Chand & Company Ltd reprint 2009.

5. V.K.Ahluwalia, Sunitha Dhingra, Adarsh Gulate, *College Practical Chemistry*, Universities Press (India) Pvt Ltd 2008 (reprint)
6. V.K.Ahluwalia & Aggarwal, R. *Comprehensive Practical Organic Chemistry*, Universities Press
7. P.R.Singh, D.C.Gupta, K.S.Bajpal *Experimental Organic Chemistry* Vol.I and II, 1980.
8. Y.R.Sharma, Elementary Organic Spectroscopy, S. Chand & Company Ltd.,
9. Practical Organic Chemistry by F. G. Mann & B. C. Saunders, Fourth Edition,Orient Longmann.
10. Laboratory Manual of Organic Chemistry by R.K, Bansal, Fifth Edition,New Age International Publishers.

Scheme of Valuation: (Max marks: 50)

1. Record (containing both A, B & C)	--------	10 marks
2. Viva	--------	5 marks
3. Organic Preparation	--------	10 marks
4. Organic Qualitative Analysis	--------	25 marks

SKILL DEVELOPMENT COURSE-1

CHSD 310: SUMMER INTERN SHIP
OR
INORGANIC CHEMISTRY– PRACTICAL - II

(60 Lectures) 0-1-4-2

A. GRAVIMETRIC ANALYSIS

1. Determination of water of hydration.
2. Determination of Lead as Lead chromate (sintered glass crucible).
3. Determination of Copper as cuprous thiocyanate (sintered glass crucible).
4. Determination of Zinc (or Magnesium) as oxinate (sintered glass crucible).
5. Determination of Nickel as Ni-DMG complex (sintered glass crucible).
6. Determination of Calcium as oxalate (sintered glass crucible).
7. Determination of Iron as ferric oxide.
8. Determination of Barium as Barium sulphate (silica crucible).
9. Determination of Barium as Barium chromate (sintered glass crucible).
10. Determination of Fluoride as PbClF.

B. PREPARATION OF INORGANIC COMPLEXES:

1. Preparation of Ni-DMG complex.
2. Preparation of Copper tetrammine complex.
3. Preparation of Lead-thiourea complex.
4. Preparation of Potassium trioxalato chromate complex.
5. Preparation of Sodium trioxalato ferrate (III)

Scheme of Valuation: (Max marks: 50)

1. Internal Marks	--------	10 marks
2. Record (containing both A & B)	--------	5 marks
3. Viva	--------	5 marks
4. Inorganic Preparation	--------	10 marks
5. Gravimetry Experiment (based on error %)	--------	20 marks (see below)
Up to 2% error	--------	20 marks
2% to 3%	--------	16 marks
3% to 4%	--------	12 marks
4% to 5%	--------	8 marks
More than 5% error or expt. is incomplete	--------	4 marks

For calculation mistake: 1 marks to be deduced;
for no calculation: 2 marks to be deduced.

III Year – Semester - VI

MJD-11: CHMJ 321: ANALYTICAL CHEMISTRY

(60 Lectures)

Objective:

- To learn Flame Spectroscopic Techniques
- To learn UV-Vis. Spectroscopy
- To learn Infrared Spectroscopy
- To learn Mass Spectroscopy
- To learn NMR Spectroscopy

UNIT-I **(12 Hrs)**

FLAME SPECTROMETRY

(A) Atomic absorption spectroscopy - Principle – elementary theory - instrumentation – Radiation sources (line sources) – Hollow cathode lamps and discharge lamps, interferences – Analytical techniques for AAS – Calibration curves.- Applications – Determination of Calcium and Magnesium in tap water – Advantages and disadvantages of AAS.

(B) Flame Emission Spectroscopy (Flame photometry) - Principle – Instrumentation – interferences – analytical techniques for Flame Photometry – calibration curves. Determination of Li, Na, K and Ca in water - Applications and advantages of FES - Differences between AAS and FES.

Unit: II **(12 Hrs)**

UV-Visible Spectroscopy: Electromagnetic radiation, interaction of radiation with matter, quantization of different forms of energies in molecules - Definition of spectrum , Origin of spectra, fundamental laws of spectroscopy and selection rules. UV - Visible Spectroscopy - Absorption laws - validity of Beer-Lambert's law - Calculations involving Beer Lambert's law - Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instruments - photo colorimeter and spectrophotometer- block diagrams with description of components - theory - types of electronic transitions - chromophore and auxochromes - Absorption bands and intensity - factors governing absorption maximum and intensity - Basic principles of quantitative analysis: estimation of metal ions from aqueous solution.

Unit: III **(12 Hrs)**

Infrared Spectroscopy: Infrared radiation and modes of vibration of diatomic, triatomic linear (CO_2) and nonlinear triatomic molecules (H_2O) - stretching and bending vibrations - selection rules - functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).

Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Applications of IR Spectroscopy – interpretation of the spectra of alcohols, aldehydes, ketones and esters – aliphatic and aromatic. Hydrogen bonding. Advantages of Fourier Transform (FTIR).

Unit: IV **(12 Hrs)**

Mass spectroscopy - Basic principles - instrumentation - molecular ion peak, base peak, metastable peak, isotopic peak their uses. Fragmentation – Nitrogen rule - determination of molecular formulae – mass spectrum of simple organic compounds – identification – alcohols, aldehydes, aromatic hydrocarbons. Interpretation of mass spectra of simple organic compounds such as Acetone, Anisole, Benzaldehyde, Ethyl acetate, Ethylamine, Ethyl Bromide, Toluene and Isopropyl phenyl ketone. Mc-Lefferty Rearrangement.

Unit: V **(12 Hrs)**

NMR Spectroscopy - principle of nuclear magnetic resonance – basic instrumentation - number of signals - chemical shift - Factors affecting chemical shift - shielding and deshielding - Spin spin coupling and coupling constants. TMS as NMR standard. Interpretation of NMR spectra of simple organic compounds such as Ethanol, Acetaldehyde, Acetone, Anisole, Benzaldehyde, Ethyl acetate, Ethylamine, Ethyl Bromide, Toluene and Isopropyl phenyl ketone.

References:

1. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed.
2. Willard, H.H., Merritt, L.L., Dean, J. & Settle, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3. C.N. Banwell: Fundamentals of Molecular Spectroscopy.
4. Elements of Analytical Chemistry - R. Gopalan, P.S. Subramanian, K. Rengarajan - S. Chand and sons (1997).
5. Fundamentals of Analytical Chemistry - D.A. Skoog and D.M. West - Holt Reinhard and Winston Publication - IV Edition (1982).
6. Principles of Instrumental Methods of Analysis - D.A Skoog and Saunders - College publications

- III edition (1985).

7. Analytical Chemistry - S.M. Khopkar - New Age International.
8. Instrumental Methods of Chemical Analysis - Chatwaal - Anand -Himalaya Publishing House - (2000).
9. Analytical Chemistry S.Usharani, Macmillan.
10. Instrumental Methods of Analysis - Willard Merit Dean and Settle – Saunders College Publication.
11. Physico Chemical Techniques of Analysis - P.B. Janarthanam-Vol- I & II - Asian Publishing.
12. Instrumental Methods of Chemical Analysis – B.K. Sharma - Goel Publications.

MJD 12: CHMJ 322: POLYMER CHEMISTRY

(60 Lectures)

Objective:

- To learn the classification of polymers
- To learn the Polymerization reactions
- To learn the properties of polymers
- To learn polymerization techniques and polymer degradation
- To learn the chemistry of commercial polymers

UNIT-I INTRODUCTION AND CLASSIFICATION OF POLYMERS:

Definition of monomer, oligomer and polymer; Different schemes of classification of polymers – Natural, synthetic - linear, cross linked and network - distinction between plastics, elastomers and fibres; Rate of polymerization; degree of polymerization. Homo and hetero polymers, copolymers, Natural polymers- cellulose, silk, gums and resin . Types of plastics- thermoplastics and thermosetting plastics, functionality concept - Concept of cross linked polymers.

UNIT-II POLYMERIZATION REACTIONS:

Types of polymerization reactions - addition, condensation, ionic, co-ordination.
Addition polymerisation – mechanism, initiation, propagation and termination processes, initiators, inhibitors.
Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and condensation polymerizations, Mechanism and kinetics of copolymerization and emulsion polymerization techniques.
:

UNIT-III PROPERTIES OF POLYMERS:

Physical, thermal, flow & mechanical properties of polymers, glass transition temp. (T_g) - definition, factors affecting T_g, Relationship between T_g and molecular weight. - crystalline melting point and degree of crystallinity – Structure-Property relationships.
Concept of average molecular weight of polymers; molecular weight distribution; Absolute and relative methods of molecular mass determination - number average, weight average, and viscosity average molecular weight; molecular weight determination by osmometry method, light scattering method, sedimentation method, ultra centrifugation, and viscosity method (principles only - No experimental details expected).

UNIT-IV POLYMERIZATION TECHNIQUES AND POLYMER DEGRADATION:

(a) Polymerization techniques: Bulk, solution, suspension & emulsion polymerization - melt polycondensation. Polymer processing - compression moulding, casting, extrusion , fibre spinning, injection moulding, thermoforming, vulcanization of elastomers, Polymer processing.

(b) Polymer degradation: thermal, mechanical, oxidative and chemical methods and biodegradation.

UNIT-V CHEMISTRY OF COMMERCIAL POLYMERS:

General methods of preparation, properties and uses of the following: polyethylene, polystyrene, polyesters, polyamides, Kevlar Polymers, polycarbonates, PVC, Teflon, acrylic polymers – Phenol formaldehyde resins (Bakelite and Novolac), polyurethanes and silicone polymers

- Advances in polymers - Bio-Polymers, biomaterials, polymers in medical field, High temperature and fireresistant polymers – Conducting and semiconducting polymers [polyacetylene, polyaniline, poly(p-phenylenesulphide), polypyrrole, polythiophene)].

Reference Books:

1. Billmeyer, F.W., Textbook of Polymer Science, John Wiley & Sons 1984
2. Gowarikar. V.R. Viswanathan, N.V. Jayader Sreedhar, Polymer Science ,. Wiley Eastern Ltd., New Delhi, 2005
3. Ghosh, P., Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
4. Lenz, R.W. Organic Chemistry of Synthetic High Polymers. Interscience Publishers, New York, 1967.
5. Sharma.B.K, Polymer Chemistry, Goel Publishing House, Meerut- 1989
6. Arora M.G. Vadar M.S, Polymer Chemistry, Anmol publications (p) Ltd., New Delhi 1989
7. Odian, G. Principles of Polymerization, 4th Ed. Wiley, 2004.
8. Stevens M.P., Polymer Chemistry - An introduction, 3rd Ed., Oxford University Press, 1999
9. Gowariker.V.R, Viswanathan.N.V and Sreethan.J., “Polymer Science”, Wiley Eastern Ltd, 1986

MID 12: CHEMJ 323: GREEN CHEMISTRY

(60 Hrs)

Objective:

- To introduce the basic principles of green chemistry.
- To study the green solvents and reagents.
- To learn the green catalysis and reactions.
- To learn the green chemistry synthesis of some real-world cases
- To understand future trends in green chemistry.

UNIT-I

Introduction to the basic principles of Green Chemistry: **(12 Hrs)**

The need for Green Chemistry and its goals. Basic Principles of Green Chemistry -Prevention of Waste, Concept of atom economy, Calculation of atom economy in Rearrangement Reactions, Addition Reactions, Substitution Reactions and elimination Reactions, Prevention or Minimization of Hazardous Products, Designing Safer Chemicals, Energy Requirements for Synthesis, Selection of appropriate Solvent , Selection of Starting Materials, Use of Protecting Groups, Use of Catalyst, Biodegradable Products Design, Designing of Manufacturing Plants, Strengthening of Analytical Techniques.

UNIT-II

Green Solvents and Reagents: **(12 Hrs)**

***Green Solvents*:** Definition, Reactions in Acidic Ionic Liquids-Friedel-Crafts reaction of Naphthalene, Reactions in Neutral Ionic Liquids-Hydrogenations, Diel's-Alder Reaction, O-Alkylation and N-alkylation, Methylene Insertion Reactions.
Green Reagents: Definition, Dimethylcarbonate, Polymer Supported Reagents-Polymer SupportedPeracids, Polymer Supported Chromic Acid, Poly-N-Bromosuccinimide (PNBS), Polystyrene Wittig Reagent, Polymeric Phenylthiomethyl Lithium Reagent.

UNIT-III

Green catalysis/reactions: **(12 Hrs)**

Green catalysts- Definition, Types of Green catalyst. Catalysis and green chemistry-Comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis. Biocatalysis(Microbial and Enzymes)and phase-transfer catalysis.
Microwave-assisted reaction in water – Hoffmann elimination, hydrolysis of methyl benzoate to benzoic acid, oxidation of toluene to benzoic acid. *Microwave-assisted reactions in organic solvents* – Esterification, Fries rearrangement, Diels-Alder reactions and decarboxylation reaction. *Ultrasound-assisted reactions* – oxidation, reduction and Sinunons-Smith Reaction.

UNIT-IV

Green synthesis and Some real world cases: (12 Hrs)

Green synthesis of the following compounds: Adipic acid, catechol, disodium iminodiacetate,ibuprofen and paracetamol.

Green chemistry in some real world cases: Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.Designing of Environmentally safe marine antifoulant. Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn.Healthier fats and oil by Green Chemistry: Enzymatic interesterification for production of no Trans-Fats and Oils, Development of fully Recyclable Carpet: Cradle to Cradle Carpeting.

UNIT-V

Future Trends in Green Chemistry: **(12 Hrs)**

Oxidation reagents and catalysts, biomimetic and multifunctional reagents. Combinatorial Green Chemistry. Proliferation of solvent-less reactions. Non-covalent derivatization. Green Chemistry in sustainable development.

References

1. V. Kumar, *An Introduction to Green Chemistry-for Graduate and Post-graduate students as per new UGC Syllabus*, Vishal Publishing Co., Jaladhar, India
2. Stanley E. Manahan, *Green Chemistry - and the ten commandments of sustainability,* 2 ed., ChemChar Research, Inc., Columbia, MO 65201 U.S.A.
3. Rs. Sanghi and M.M.Srinivatava, *Green Chemistry: Environmental Friendly Alternatives*, Narosa Publishing House, New Delhi.
4. V.K. Ahluwalia, *Green Chemistry*, Narosa, New Delhi (2011).
5. G. L. Willingham and A. H. Jacobson*Designing an Environmentally Safe Marine Antifoulant***,** *ACS Symposium Series*, Vol. 640, American Chemical Society, (1996).
6. Michael C Cann; Thomas P Umile, *Real-world cases in green chemistry,* Volume II, American Chemical Society, Washington (2008).
7. M Lancaster , *Green Chemistry, An Introductory Text*- RSC Publishing,3rd Edition (2016).
8. Ryan, M.A. &Tinnesand, M. *Introduction to Green Chemistry,* American Chemical Society, Washington (2002).

MID 13: CHMJ 3204: INDUSTRIAL CHEMICALS AND ENVIRONMENTAL CHEMISTRY

(60 Lectures)

Objective:

- To learn about industrial gases and inorganic chemicals
- To learn about air pollution
- To learn about water pollution
- To learn about noise pollution and radioactive pollution
- To learn about environmental Analysis

UNIT – I: INDUSTRIAL GASES AND INORGANIC CHEMICALS 12 Hrs)

Industrial Gases: Large scale production, hazards in storage and handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

Inorganic Chemicals: Hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum and potassium dichromate.

UNIT – II **AIR POLLUTION (12 Hrs)**

(A) Air Pollution: Definition – Sources – General discussion on effects of Air pollution on Animals, Plants, Human beings and Weather.

(B) Air Pollutants: (a) NO_x(b) SOx (c) Hydrocarbons (d) CO (e) Particulates – Sources, Effects on Human -beings, Plants & Materials and their control.

(C) (i) Greenhouse effect – definition – Consequences.

(ii)Acid rain – effects on Human beings, Aquatic ecosystem and Terrestrial ecosystem

(iii)O_3 layer depletion – Mechanism – Causes – Consequences –Abatement of O_3 depletion.

(iv)Photochemical smog – Mechanism – Effects & Control.

(v)Air pollution due to Automobile exhausts.

(D) Sources and Biochemical effects of the following (a) As (b) Hg (c) Cd(d) Pb (e) Ni (f) Se(g) Cr and (h) Asbestos.

(E) Methods for the control of Air pollution.

(F) Bio-geo Chemical Cycles, N, C, P, H_2O.

UNIT-III: WATER POLLUTION (12 Hrs)

(A) Definition – Unique properties of water – Sources.

(B) Eutrophication – Definition – Types – Effects – control.

(C) Hg – Toxicity – Minimata disease.

(D) Pollution of water by soaps and detergents – Classification – Environmental impacts – Abatement procedures.

(E) Thermal pollution – Causes – Effects and control.

(F)Pollution of water by pesticides :

(a) Insecticides – Classification – Characteristics –Environmental implications – Abatement procedures.

Fungicides, Herbicides – Classification – Characteristics – Environmental implications- Abatement procedure.

(b) Biological amplification – Definition – Examples of DDT & Hg.

(D)Marine oil pollution – Sources – Effects – Control.

(E)Sewage treatment – Primary treatment – Secondary treatment (Trickling filter, & Activated sludge process) – Tertiary treatment (Reverse osmosis, Electro dialysis, Ion exchange method); Methods for the control of water pollution.

UNIT IV: Experimental methods of WATER ANALYSIS & AIR ANALYSIS (12 Hrs)

A. WATER ANALYSIS

- Determination of Alkalinity
- Determination of Total hardness of water by EDTA method
- Determination of Cl^- by Mohr's method
- Determination of SO_4^{2-} by Gravimetric method
- Determination of D.O by Winkler's method
- Determination of B.O.D of water sample
- Determination of C.O.D of water sample
- Determination of PO_4^{3-} of water sample (by Spectrophotometric method)

[Simple problems related to Alkalinity, Total hardness, D.O, B.O.D & C.O.D may be discussed.].

B. AIR ANALYSIS

Experimental methods for the Analysis of

(1) NO_x (spectrophotometric method)

(2) SO_x (West – Gaeke spectrophotometric method)

(3) Suspended Particulate matter (by high volume air sampler).

UNIT V: NOISE POLLUTION & RADIO ACTIVE POLLUTION 12 Hrs

(A) NOISE POLLUTION:

Human acoustics –Sound and its general features –Noise and its measurement [dB] – Noise classification – Effect of Noise – Brief discussion on control of Noise pollution

(B)RADIO ACTIVE POLLUTION:

Definitions - Curie – Roentgen – Rad – Gray – Rem – RBE – Sources of radiations Effects of radiations – Somatic effects – Genetic effects — Methods for the disposal of Radio wastes.

Reference Books:

• E. Stocchi: Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
• R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
• J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
• S. S. Dara: A Textbook of Engineering Chemistry, S. Chand & Company Ltd. New Delhi.
• K. De, Environmental Chemistry: New Age International Pvt., Ltd, New Delhi.
• S. M. Khopkar, Environmental Pollution Analysis: Wiley Eastern Ltd, New Delhi.
• S.E. Manahan, Environmental Chemistry, CRC Press (2005).
• G.T. Miller, Environmental Science 11th edition. Brooks/ Cole (2006).
• A. Mishra, Environmental Studies. Selective and Scientific Books, New Delhi (2005).
• Environmental Chemistry -S.E.Manahan, Willard Grant press.
• Environmental Chemistry(Fifth Edition)- A.K.De,New Age International.
• A Text book of Environmental Chemistry and pollution control (Fifth Edition) -S.S.Dara. S.Chand.
• Text book of Environmental Chemistry - G.S.Sodhi, Narosa publishing House.
• Environmental Chemistry(Second Edition)- Banerji,Prentice Hall.
• Environmental Chemistry B.K.Sharma & H.Kaur ,Krishna prakashan.Chemical methods for Environmental Analysis – Ramesh,Macmillan.
• Environmental Chemistry Laboratory Manual - R.Gopalan,Emarald publishers.
• A Text book on Experiments and calculations in Engineering chemistry. S.S.Dara, S. Chand.
• Laboratory manual in Environmental Engineering - P.D.Kulkarni. Jaico publishing House.

MID 13: CHMJ 325: ORGANOMETALLICS, BIOINORGANIC CHEMISTRY AND POLYNUCLEAR HYDROCARBONS

(60 Hrs)

Objective:

- To introduce the chemistry of 3d metals.
- To study the organometallic compounds.
- To learn the Bio-Inorganic chemistry.
- To learn the polynuclear and heteronuclear aromatic compounds
- To study active methylene compounds.

UNIT-I : Chemistry of 3d metals:

(12 Hrs)

Oxidation states displayed by V, Cr, Mn, Fe, Co, Ni and Co.
A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, Potassium dichromate- $K_2Cr_2O_7$, Potassium permanganate- KMnO4, Potassium ferrocyanide- $K_4[Fe(CN)_6]$, Sodium nitroprusside $Na_2[Fe(CN)_5NO]_2H_2O$, Hexaamminecobalt(III) chloride- $[Co(NH_3)_6]\ Cl_3$, Sodium cobaltintrite- $Na_3[Co(NO_2)_6]$.

UNIT-II : Organometallic Compounds: (12 Hrs)

Definition and Classification with appropriate examples based on nature of metal- carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeise's salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behavior of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).

UNIT-III : Bio-Inorganic Chemistry: (12 Hrs)

A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

UNIT-IV : Polynuclear and heteronuclear aromatic compounds: (12 Hrs)

Synthesis & Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole, Thiophene, Pyridine, Quinoline & Isoquinoline.

UNIT-V : Organic Synthesis via Enolates (Active methylene compounds): (12 Hrs)

Preparation: Claisen ester condensation & Dieckmann Cyclisation; Keto-enol tautomerism. Synthetic applications of Ethylacetoacetate, Diethyl malonate preparations & Its Synthetic Applications. Alkylation of 1,3-Dithianes, Alkylation and Acylation of Enamines.

Reference Books:

• James E. Huheey, Ellen Keiter & Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.

• G.L. Miessler & Donald A. Tarr: Inorganic Chemistry, Pearson Publication.

• J.D. Lee: A New Concise Inorganic Chemistry, E.L.B.S.

• F.A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley & Sons.

• I.L. Finar: Organic Chemistry (Vol. I & II), E.L.B.S.

• John R. Dyer: Applications of Absorption Spectroscopy of Organic Compounds, Prentice Hall.

• R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.

•R.T. Morrison & R.N. Boyd: Organic Chemistry, Prentice Hall.

• Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.

• Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.

MJD-14: UCHMJ 320: ANALYTICAL CHEMISTRY: PRACTICAL

6hrs

1. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
2. Verify Lambert-Beer's law and determine the concentration of $CuSO_4/KMnO_4/K_2Cr_2O_7$ in a solution of unknown concentration
3. Estimation of calcium, magnesium, phosphate, nitrate by Spectrophotometric method
4. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ using Spectrophotometry in a mixture.
5. P^Hmetry
   A) Determination of HCl by titration with NaOH
   B) Determination of CH_3CO_2H by titration of NaOH
   C) Determination of the pH of the given aerated drinks fruit juices, shampoos and soaps.
6. Conductometry
   A) Titration of Strong Acid Vs Strong Base
   B) Titration of Weak Acid Vs Strong base
   C) Mixture of Strong Acid & Weak Acid vs Strong base
   D) Determination of Ka value of a Weak Acid.
9. Potentiometric Experiments
   Redox Titrations [$K_2Cr_2O_7$ vs Fe^{2+} (or) Fe^{2+} vs Ce^{4+}]
7. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided)
8. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).
9. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
10. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
11. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.
12. Preparation of acetyl acetanato complexes of Cu^{2+}/Fe^{3+}. Find the λ_{max} of the complex
13. IR Absorption Spectra (Study of Aldehydes and Ketones)

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).
4. Vogel's Text book of *Quantitative Chemical Analysis* ,6 th edition.
5. Vogel's *Qualitative Inorganic Analysis,* Revised by G. Svehla.
6. For IR , NMR Spectral Data of organic Compounds ,the Website https://sdbs.db.aist.go.jp is to be referred.
7. Introduction to Spectroscopy (A Guide For Students of Organic Chemistry) by

Donald L.Pavia , Gary M.Lampman & George S.Kriz.

Scheme of Valuation: (Max marks: 50)

10. Record	--------	10 marks
11. Viva	--------	5 marks
12. Any one experiment from above list	--------	35 marks

III – Year – Semester - V

MID5: UCHMI 311: CHEMISTRY IN AGRICULTURE

(50 Hours)

Module 1: Soil properties and Reactions (10 hrs)

Soil properties: Definition of soil, soil composition, inorganic properties of soil, organic matters of soil - Fertilizers & Manures: Definition – differences between fertilizers and manures.

Soil reactions: Soil acidity, actual acidity, soil pH and its determination, buffer action capacity of soils – effects of pH on availability of N,P,K and Ca – Acid soil, alkaline soil – their formation and reclamation.

Module 2: Nitrogen Fertilizers (10 hrs)

Nitrogen in plant nutrition – importance of nitrogenous fertilizers – classification – ammonia – ammonium fertilizers – ammonium sulphate, ammonium nitrate, ammonium chloride.
Nitrate fertilizers – sodium nitrate, calcium nitrate, calcium ammonium nitrate (CAN), urea (outline of manufacture) and calcium cyanamide.

Module 3: Phosphatic Fertilizers (10 hrs)

Phosphorus in the life of plants-importance of phosphatic fertilizers. types of phosphatic fertilizers – outline of the production of calcium superphosphate, calcium metaphosphate, calcium superphosphate nitrate, triplesuperphosphate, ammoniated superphosphate, DAP, TAP, bone meal and basic slag.

Module 4: Potassium & Complex Fertilizers (10 hrs)

Potassium fertilizers: Potassium in life of plants – Deficiency symptoms – classification of potassium fertilizers – outline of the production of KCl, KNO_3, K_2SO_4 and other slags.

Complex fertilizers: Complete and incomplete fertilizers, manufacture of NPK fertilizers-calculation of fertilizer formula – secondary nutrients and micro nutrients – their function in plants.

Module 5: Bio fertilizers & Plant protection chemicals (10 hrs)

Biofertilizers – Biological control of pests – integrated pest management (IPM) – Genetically modified crops – outline of the process of modifying – their advantages and disadvantages.Plant protection chemicals – definition of toxicity and LD_{50} values.

Pesticides – Insecticides, Fungicides, Herbicides, Acaricides – definition with examples – Preparation and uses of some pesticides: DDT, BHC (Gammexane), Chlordane, Dithiocarbamates, Dalapon, Alachlor, Parathion, Malathion – general methods of application – Safety measures when using pesticides

Reference Books:

1. Soil Science by Dr. A. Shankaran
2. The nature and properties of soil by Nyle Brady
3. Chemistry of insecticides and fungicides by U.S. Sreeramulu
4. Bio fertilizers in agriculture by N.S. Subbara

III – Year – Semester -V

MID 5: UCHM312: ANALYTICAL AND CLINICAL BIOCHEMISTRY

(30 Lectures) (Make the syllabus for 5 Units)

UNIT-I

(10 Hrs)

Biological Chemistry-I:

Elementary treatment of digestion and absorption of carbohydrates, proteins and fats:

Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle.
Proteins: Aminoacids, peptides and proteins: classification of proteins: Digestion and absorption of proteins, Formation of Urea, Transamination, Deamination, Plasma Protein, Liprotropic factors.
Lipids: Definition, Classification, Importance, General Lipid Metabolism, Digestion and Absorption of Fat, Oxidation of Fatty acids, Ketosis, Lipoprotein metabolism classification of lipoprotein, Biological importance of triglycerides and phosphoglycerides and cholesterol.

UNIT-2

(10 Hrs)

Biological Chemistry-II:

Enzymes: Elementary treatment of enzymes, cofactors, prosthetic groups and theory of enzyme action. Nomenclature, classification, effect of pH, temperature on enzyme activity, enzyme inhibition.
Hormones: Introduction, General Mechanism of actions - Physiological functions of adrenaline, thyroxin, oxytocin, insulin and sex harmones.

Micronutrients and their biological role in human systems. Iron Metabolism - General consideration of Importance of sodium, potassium, calcium, magnesium, chloride and fluoride - Vitamins: General consideration, clinical importance.
Definition of Health, WHO standard - Balanced diet.

UNIT-3

Biochemical Analysis: (10 Hrs)

Principle of estimation and diagnostic approach by blood and urine analysis:

Blood: Composition, grouping and Rh factor - collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin. significance of HDL and LDL - Important lipid profile tests.
Urine: Collection and preservation of samples, Formation of urine, Composition and estimation of constituents of normal and pathological urine.
Normal and abnormal values of clinical chemistry in relation to human diseases – General consideration and interpretations.

PRACTICALS / FIELD VISIT (FOR INTERNAL ASSESSMENT ONLY):

Students to be taken in small groups to a nearby hospital or clinical laboratory in order to gain a first-hand practical knowledge of the tests they study in this paper and submit a report.

Reference Books:

•T.G. Cooper: Tool of Biochemistry.

•Keith Wilson and John Walker: Practical Biochemistry.

•Alan H Gowenlock: Varley's Practical Clinical Biochemistry.

•Thomas M. Devlin: Textbook of Biochemistry.

•Berg, J.M., Tymoczko, J.L. &Stryer, L. Biochemistry, W.H. Freeman, 2002.

•Talwar, G.P. & Srivastava, M. Textbook of Biochemistry and Human Biology, 3rd Ed. PHI Learning.

• Nelson, D. L. & Cox, M. M. Lehninger's Principles of Biochemistry 7th Ed.,

W. H. Freeman.

• Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.

III – Year – Semester -VI

MID 6: CHMI 321: APPLIED CHEMISTRY

UNIT – I **Water Treatment** (12 Hrs)

Sources of water- Hardness of water – Temporary & permanent hardness of water -Units of hardness of water – Disadvantages of hard water -Scale & Sludge Formation in Boilers – Disadvantages of Scales & Sludge Formations -Prevention methods for scales & Sludge formations (methods such as Phosphate conditioning & Calgon Conditioning) – Caustic Embrittlement- Boiler Corrosion – Priming & Foaming – Softening Methods – Lime – Soda process – Zeolite Process – Ion Exchange method - methods for the Purification of water for Domestic purpose – Break Point Chlorination -Desalination of Brackish water – Electrodialysis – Reverse osmosis . [Numerical Problems related to Hardness of water,Lime – Soda requirement need to be discussed].

UNIT – II **Experimental Methods of Water Analysis** (12 Hrs)

WATER ANALYSIS

- Determination of Alkalinity
- Determination of 2) Temporary hardness of water by O – Hehners Method
  b) Total hardness of water by Soap titration method & c) by EDTA method
- Determination of Cl^- by Mohr's method
- Determination of SO_4^{2-} by Gravimetric method
- Determination of D.O by Winkler's method
- Determination of B.O.D of water sample
- Determination of C.O.D of water sample
- Determination of PO_4^{3-} of water sample (by Spectrophotometric method)

Problems on Alkalinity, Total hardness, D.O, B.O.D & C.O.D

UNIT – III **Fuels & Combustion** (12 Hrs)

Fuels & Combustion: Classification, Calorific value, Types, Determination of calorific value by Bomb calorimeter, Theoretical Calculation of calorific value (LCV & HCV) & Dulong's Formula, Coal & classification of coal, Analysis of Coal, Proximate and Ultimate analysis, Flue gas analysis by Orsat's Apparatus Significance, Carbonization of Coal, Manufacture of metallurgical coke by Otto Hoffman's byproduct oven , Numericals related to the above topics.

Petroleum: Petroleum, cracking, Synthetic petrol, Refining of gasoline, Reforming, Chemical structure and knocking. Octane Rating of fuels, Cetane Rating, Diesel engine fuel, Kerosene, LPG as a fuel.

UNIT – IV **Electrochemistry & Corrosion** (12 Hrs)

A) **Electrochemistry**: Introduction, Conductance-Specific, Equivalent and Molar conductance, Effect of dilution on electrolytic conductance. EMF: Galvanic Cells, Nernst

equation, numerical problems. Concept of concentration cells, electro chemical series-applications. BATTERIES: Primary cells (dry cells) and secondary cells (lead-Acid celll). Applications of batteries. Fuel cells – Hydrogen– Oxygen fuel cell;.

B) **Corrosion**: Definition of Corrosion - Types of Corrosion - Galvanic series – Theories of corrosion: a)Acid, b)Direct Chemical attack, & c) Electrochemical or galvanic or wet theory of Corrosion ; Factors influencing Corrosion – Protection against corrosion -Cathodic protection [(I)Sacrificial anodic protection method (II)Impressed Current Cathodic Protection] Surface coatings: Electroplating(Copper plating), Hotdipping (galvanization & tinning),metal cladding.

Unit – V **Phase Rule & Colloids** (12 Hrs)

Phase Rule: Gibb's phase rule equation. Definition of Terms: Phase, Components and Degrees of Freedom. Significance and limitations of phase rule. Phase diagrams: One component system- Water system & Sulphur System. Two component system- Silver- lead system.

Colloids: Classification of colloids. Properties of colloids- Electrical & optical properties-Applications of colloids.

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Reference Books

1. Engineering Chemistry by PC Jain & Monica Jain, Dhanpatrai Publishing Company. New Delhi

2. Enginering Chemistry by R.Gopalan, Vikas Publishing House, New Delhi.

3)Engineering Chemistry by S.S.Dara ,S.Chand & Co., New Delhi

4) Calculations in Engineering Chemistry by S.S.Dara , S.Chand & Co., New Delhi

5) Environmental Chemistry laboratory manual by R.Gopalan & Amrita Anand , Emerald Publishers.

III – Year – Semester -VI

MID 6: CHMI 322: FOOD AND MEDICINAL CHEMISTRY

(60 Hours)

Unit-I FOOD & FOOD POISONING

Sources of food, types, advantages and disadvantages, constituents of food, carbohydrate, protein, fats and oils, vitamins and minerals, food additives, natural toxicants. Food Poisoning: Sources, causes and remedy – Causes and remedies for acidity, gastritis, indigestion and constipation.

Unit-II FOOD PRESERVATION, PROCESSING & NATURAL FOOD

Food spoilage, courses of food spoilage, types of food spoilage, food preservation - Preservation and processing by heating- sterilization, pasteurization – Importance of Natural Food, Concept of "Food as medicine".

Unit-II DRUGS

Classification of drugs – biological & chemical (Structure not required) - Definition and two examples each (Structure not required): Anesthetics (General and local), Analgesics, Antipyretics and anti- inflammatory agents – Antibiotics – Penicillin, Streptomycin, Antivirals. AIDS – symptoms, prevention & treatment – Drug receptors and biological responses – factors affecting metabolism of drugs. (Basic concepts only)

Unit-IV DRUGS FOR SOME CLINICAL CONDITIONS

Diabetes – Causes, hyper and hypoglycemic drugs – Blood pressure – Systolic & Diastolic Hypertensive drugs – Cardiovascular drugs – depressants and stimulants – Lipid profile – HDL, LDL cholesterol lipid lowering drugs. (Structure not required) - Pharmacologically active constituents in plants, Indian medicinal plants – Tulsi, Neem, Keezhanelli – their importance.

Unit -V HEALTH PROMOTING DRUGS

Vitamins A,B, C, D, E and K, micronutrients – Na, K, Ca, Cu, Zn and I, Medicinally important inorganic compounds of A1, P, As, Hg and Fe, Examples and applications, Agents for kidney function (Aminohippuric acid) - Agents for liver function (Sulfo bromophthalein), antioxidants, treatment of ulcer and skin diseases (Structure not required).

REFERENCE BOOKS:

1. Seema Yadav, Food Chemistry, Anmol publishing (P) Ltd., New Delhi.
2. Car H. Synder, The Extraordinary Chemistry for ordinary things, John Wiley & sons inc., New York, 1992.
3. Sivasankar, Food Processing and Preservation PHI. (Eastern Economy Editions)
4. V.K. Ahluwalia and Madhu Chopra, Medicinal Chemistry, Ane Books, New Delhi, 2008
5. P. Parimoo, A Text Book of Medicinal Chemistry, CBS publishers, New Delhi, 2006
6. S.Lakshmi Pharmaceutical Chemistry, S.Chand & Sons, New Delhi, 2004
7. Ashutosh Kar, Medicinal Chemistry, Wiley Eastern Ltd., New Delhi, 1993
8. Romas Nogrady, Medicinal Chemistry, Oxford Univ. Press
9. David William and Thomas Lemke, Foyes, Principles of Medicinal Chemistry, BI Publishers

III – Year – Semester -VI

MID 6: CHMI 321: ANALYTICAL METHODS IN CHEMISTRY

(60 Hrs) **4-1-0-4**

Objective:

- To Study the colorimetric method
- To Study the radiochemical and thermo analytical method
- To learn Polorography and solvent extraction methods
- To learn Chromatographic methods

UNIT-I COLORIMETRIC METHOD (12 Hrs)

Quantitative aspects of absorption of radiation – Beer-Lambert's Law – derivation of equation – deviation from Beer-Lambert's Law – Methods of doing Colorimetric Analysis – Standard series method, colorimetric titration, Duboscq colorimeter, Photo electric colorimeter and Spectrophotometric method – instrumentation, single beam and double beam instruments, construction of calibration plots for quantitative analysis – Applications of colorimetry : Molar composition of complexes by Job's method and mole ratio method – Determination of Iron and Manganese compounds – Simultaneous determination of metal ions (Cr and Mn).

UNIT-II POLAROGRAPHY (12 Hrs)

Basic principles – DME – migration, residual, limiting and diffusion currents- Use of supporting electrolytes-advantages and disadvantages –The Ilkovic equation (derivation not required) and significance- experimental assembly- current voltage curve- oxygen wave-influence of temperature and agitation on diffusion layer. Half wave potential (E1/2)– Experimental set up – Applications – Polarography as an analytical tool in quantitative and qualitative analysis - Determination of copper and zinc in brass.

UNIT – III SOLVENT EXTRACTION METHODS & RADIO CHEMICAL METHODS (12 Hrs)

A) SOLVEN EXTRACTION

Principles- techniques of solvent extraction – Batch extraction, continuous extraction – continuous extraction of liquids and solids – Soxhlet extraction – counter-current extraction – Factors favouring solvent extraction of inorganic species – Application of Solvent extraction

B) Properties of radioisotopes – Isotopic tracing – Isotopic dilution analysis – Neutron activation analysis – Limitations of radioanalytical methods.

UNIT – IV CHROMATOGRAPHIC METHODS (12 Hrs)

Theory and principles – Classification of chromatographic methods

(a) Column Chromatography: Principles and experimental procedures – Adsorbents and Solvent

systems – Applications.

(b) Thin layer chromatography: Principles and experimental procedures – Adsorbents – preparation of TLC plates – Rf values - Applications – Separation of dyes.

(c) Paper Chromatography: Principles – ascending, descending and radial techniques – Rf values – Applications – Separation of Amino acids.

(d) Gas liquid chromatography: Principles – Instrumentation – Types of Columns – Types of Detectors – Applications.

UNIT-V: REVIEW OF CHEMICAL EQUILIBRIUM (12 Hrs)

Auto protolysis of Water –Acids and Bases. Ionization of weak Acids and Bases –equilibrium constant expressions. Hydrogen ion concentration –**pH**-scale –calculation of **pH** of weak acids and bases. Buffer solutions –**pH** of a buffer solution –Henderson-Hasselbalch equation, Solubility –Solubility product, Calculation of Problems involving Solubility equilibria.

Reference Books:

1. Elements of analytical chemistry by Gopalan R & Subramanian, Sultan chand & Co.
2. Analytical chemistry by Dr. Alka Gupta, Pragati Prakashan
3. Willard, H.H., Merritt, L.L., Dean,J.A. and Settle, F. A., Instrumental Methods of Analysis, CBS Publishers, 7th Edition, 1988.
4. Christian, G.D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
5. Skoog, D. A, Holler, S.J,.Nilman, T.A., Principles of Instrumental Analysis, Cengage Learning India Ed. (Skoog, D.A, Holler, S.J,.Nilman, T.A., Principles of Instrumental Analysis, 5th Edn.,Saunders college publishing .
6. Quantitative Analysis by R. A. Day Jr & A L Underwood, Sixth Edition, Prentice Hall of India Pvt Limited, New Delhi.
7. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989.
8. Willard, H.H., Merritt, L.L., Dean,J.A. and Settle, F. A., Instrumental Methods of Analysis, CBS Publishers, 7th Edition, 1988.
9. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
10. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
10. Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
11. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 19

III – Year – Semester -VI

MID 6: CHMI 322: APPLICATIONS OF COMPUTERS IN CHEMISTRY

(For Chemistry Students)

Unit-I

Basics: (12 Hrs)

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Basic computer organization, processor and memory – main memory, secondary storage devices and storage hierarchy. Software – relationship between hardware and software – types of software. Planning the computer program – algorithm and flowcharts. Basics of operating systems.

Unit-II

Languages: (12 Hrs)

Compiled versus interpreted languages. Debugging. Simple programs using these concepts.

Computer languages – machine language, assembly language, assembler, compiler, interpreter and programming languages –

Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics.

C language – introduction, C compiler, operating systems and preprocessor directives - variables, constants, operators, input and output functions.

Unit-III

Numerical methods: (12 Hrs)

Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi.

Differential calculus: Numerical differentiation.

Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.

Unit-IV

Simultaneous equations & Control structures: (12 Hrs)

Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Seidel method. Interpolation, extrapolation and curve fitting: Handling of experimental data.

Control structures – conditional, looping, go to, break, switch and continue statements, functions, arrays and pointers.

Unit-V

Applications in Chemistry: (12 Hrs)

Calculation of the radius of the first Bohr orbit for an electron, Calculation of electronegativity of an element using Pauling's relation. Calculation of empirical formulae of hydro carbon, calculation of reduced mass of a few diatomic molecules, determination of the wave numbers of spectral lines of hydrogen atom.

Conceptual background of molecular modelling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.

Reference Books:

1. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.

2. Levier. de, *How to use Excel in analytical chemistry and in general scientific data analysis,* Cambridge Univ. Press (2001) 487 pages.

3. Noggle, J. H. *Physical chemistry on a Microcomputer.* Little Brown & Co. (1985).

4. Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

5. McQuarrie, D. A. *Mathematics for Physical Chemistry*, University Science Books (2008).

6. Mortimer, R. *Mathematics for Physical Chemistry*, 3rd Ed. Elsevier (2005).

7. Steiner, E. *The Chemical Maths Book*, Oxford University Press (1996).

8. Yates, P. *Chemical Calculations.* 2nd Ed. CRC Press (2007).