FACULTY OF SCIENCE
Mohanlal Sukhadia University, Udaipur
M.Sc. Chemistry Program as per NEP-2020
(Valid from session 2023-24 onwards)

1. Duration of the Course

The Master of Science Chemistry program will be of four semesters duration as per New Education Policy-2020, which will be conducted in two years. Each semester will be of approximately 5 months (minimum 90 working days in a semester) duration.

2. Eligibility:

Candidates seeking admission to the first semester of M.Sc. Chemistry must have a B.Sc. with Chemistry as one of the optional subjects or as an honor's subject (Level 5.5 or equivalent) with minimum 48% marks from a UGC recognized University.

3. Admissions:

Admissions to the first semester of M.Sc. (Chemistry) will be made as per admission rules for M.Sc.

4. Medium of Instruction

The medium of instruction and examination shall be English.

5. No. of Seats

Total number of normal fee seats: As per information bulletin

6. Curriculum

M.Sc. (Chemistry) program has two years or four semesters prescribed course structure. M.Sc. (Chemistry) program shall have a curriculum and course contents (Table-1) for the courses recommended by the committee of courses in Chemistry and approved by the academic council of the university. The program shall follow NEP and will be governed by the Common Rules and Regulations of Master's program under NEP approved by the Academic Council of the University.

7. Examination of Practical Papers

End of semester (EoS) practical examination will be conducted by a board of examiners (one internal and one external). Internal examination (three hours test) will be conducted at the departmental level.

8. Internal Examination of Theory Papers

Internal examination (one hour test) of theory papers will be conducted at the departmental level.

9. Exit and Lateral Entry Policy

Exit and lateral entry policy shall be as prescribed in course structure and framework approved by academic council held on June 26, 2023.

10. Choice of the DSE Courses

The DSE courses listed in the program shall be offered depending upon the resources available in the department. A minimum of the 15 students should opt the specific DSE.

Table 1: Proposed M.Sc. Chemistry Program: Semester wise course types, Course codes, Course title, Delivery type, Workload, Credits, Marks of Examination, and Remarks if any.

NHEQF Level	Semester	Course Type	Course Code	Course Title	Delivery type per week			Total hours	Credits	Total Credits	Internal marks	EoS Marks	Max. Marks	Remarks
					L	T								
6.0	I	DCC	CHE8000T	Inorganic Chemistry-I	L	T	-	60	4	24	20	80	100	
			CHE8001T	Organic Chemistry-I	L	T		60	4		20	80	100	
			CHE8002T	Physical Chemistry-I	L	T		60	4		20	80	100	
			CHE8003T	Group Theory and Spectroscopy	L	T		60	4		20	80	100	
			CHE8004P	Organic Chemistry Lab-I			P	120	4		20	80	100	
			CHE8005P	Inorganic and Physical Chemistry Lab			P	120	4		20	80	100	
	II	DCC	CHE8006T	Inorganic Chemistry-II	L	T	-	60	4	24	20	80	100	
			CHE8007T	Organic Chemistry-II	L	T		60	4		20	80	100	
			CHE8008T	Physical Chemistry-II	L	T		60	4		20	80	100	
			CHE8009P	Inorganic Chemistry Lab-I			P	120	4		20	80	100	
			CHE8010P	Organic and Physical Chemistry Lab			P	120	4		20	80	100	
		GEC	CHE8100T	Environmental and Green Chemistry	L	T		60	4		20	80	100	
			CHE8101T	Polymer Processing Management	L	T		60	4		20	80	100	
Exit with PG diploma in Chemistry														
6.5	III	DCC	CHE9011T	Advanced Spectroscopic Techniques	L	T		60	4	24	20	80	100	
			CHE9012T	Photochemistry and Supramolecules	L	T		60	4		20	80	100	
		DSE	CHE9102T	Advanced Organometallic Chemistry	L	T		60	4		20	80	100	
			CHE9103T	Chemistry of Heterocyclic Compounds	L	T		60	4		20	80	100	
			CHE9104T	Chemical Kinetics	L	T		60	4		20	80	100	
			CHE9105T	Modern Analytical Methods	L	T		60	4		20	80	100	

		DSE	CHE9106T	Advanced Bioinorganic Chemistry	L	T		60	4		20	80	100	
			CHE9107T	Modern Interfaces of Organic Chemistry	L	T		60	4		20	80	100	
			CHE9108T	Industrial Aspects of Chemistry	L	T		60	4		20	80	100	
			CHE9109T	Fundamentals of Analytical Chemistry	L	T		60	4		20	80	100	
		DSE	CHE9110P	Inorganic Chemistry Lab-II			P	120	4		20	80	100	
			CHE9111P	Organic Chemistry Lab-II			P	120	4		20	80	100	
			CHE9112P	Industrial Chemistry Lab			P	120	4		20	80	100	
			CHE9113P	Analytical Chemistry Lab-I			P	120	4		20	80	100	
		GEC	CHE9114P	Inorganic Chemistry and Spectral Problems			P	120	4		20	80	100	
			CHE9115P	Mechanical Properties and Testing of Rubber			P	120	4		20	80	100	
	IV	DCC	CHE9013T	Special Methods of Analysis	L	T		60	4	24	20	80	100	
		DSE	CHE9116T	Bioinorganic, Bioorganic and Biophysical Chemistry	L	T		60	4		20	80	100	
			CHE9117T	Specialty Polymers	L	T		60	4		20	80	100	
		DSE	CHE9118T	Modern Aspects of Inorganic Chemistry	L	T		60	4		20	80	100	
			CHE9119T	Chemistry of Natural Products	L	T		60	4		20	80	100	
			CHE9120T	Agro Based Chemicals	L	T		60	4		20	80	100	
			CHE9121T	Analytical techniques	L	T		60	4		20	80	100	
		DSE	CHE9122P	Polymer Synthesis and Extraction of Natural Products Lab			P	120	4		20	80	100	
			CHE9123P	Inorganic Chemistry Lab-III			P	120	4		20	80	100	
		DSE	CHE9124T	Solid State Chemistry	L	T		60	4		20	80	100	
			CHE9125T	Inorganic polymers	L	T		60	4		20	80	100	
			CHE9126T	Medicinal Chemistry	L	T		60	4		20	80	100	
			CHE9127T	Applied Analytical Methods	L	T		60	4		20	80	100	
		DSE	CHE9128P	Organic Chemistry Lab-III			P	120	4		20	80	100	

			CHE9129P	Analytical Chemistry Lab-II			P	120	4		20	80	100	

DCC- Discipline Centric Compulsory Course (000 to 099); **DSE**- Discipline Specific Core Course and **GEC-** Generic Elective Course (100 to 199)

NOTE:

1. In the semester III, all the students have to select one elective papers from each DSE/GEC groups (one from each group).
2. In the semester IV, all the students have to select one elective papers from DSE/GEC groups (one from each group.)
3. In the theory paper, 60 Hours includes 40 Hours Lectures and 20 Hours diagnostic and formative assessment.
4. Student may exit with PG diploma in Chemistry after earning 48 credits in I and II semesters.

PROJECT

AIM: To undertake research and development in Chemistry and allied areas.

Description: A student is free to pick up a project in place of one DSE theory and one DSE Lab of Semester IV. For this student has to select a topic for the project at the beginning of Semester III. The student is expected to complete the major literature survey during the Semester III and present a tentative research plan at the end of Semester III in the form Review of Literature. The candidate will do the experimental work during Semester IV under the supervision of a guide and submit the results in the form of a Project Report at the end of Semester IV. The project internally will be evaluated by a three-member examiner panel including concerned guide/mentor duly appointed by departmental research committee.

ASSESSMENT SCHEME

Review of Literature: 50 Marks
Attendance: 20 Marks
Novelty: 20 Marks
Presentation: 50 Marks
Report evaluation: 60 Marks
Total: 200 Marks
Student will be allowed to appear in the final viva voce examination only if he / she has submitted his / her project work in the form of project report.

SEMESTER-I
DCC: CHE8000T
Inorganic Chemistry-I

Code of the Course: CHE8000T

Title of the Course: Inorganic Chemistry-I

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry.

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of under graduate or equivalent. The students should have knowledge in basic inorganic chemistry, such as coordination chemistry, crystal field theory.*

Course Objectives: *This course provides an introduction to the concepts of bonding in main group compounds. It covers topics such as ligand field theory of coordination compounds, complex equilibrium, and reaction mechanism of transition metal complexes including octahedral and tetrahedral complexes. This course also aims to develop student's understanding of the fundamental principles of electronic spectra and magnetic properties of transition metal complexes.*

Learning Outcomes:

After studying this paper, students would learn-

- *Structure and bonding in covalent inorganic compounds, based on various bonding theories viz. VSEPR theory, bent rule and correlation diagram.*
- *Basics of coordination chemistry and bonding theories in coordination compounds viz. MOT*
- *Stability of metal complexes, with reference to nature of metal and ligand.*
- *Reaction mechanism of transition metal complexes of octahedral and tetrahedral geometry*
- *Basics of electronic spectra and magnetism.*

Syllabus:

UNIT-I

Stereochemistry and Bonding in Main Group Compounds: VSEPR Theory, Walsh diagrams (tri and penta-atomic molecules), dπ-pπ bonds, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules.

Metal-Ligand Bonding: Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral, square planar complexes, π-bonding and molecular orbital theory.

(12 Lecture Hours)

UNIT-II

Metal-Ligand Equilibria in Solution: Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-meter and spectrophotometry.

(12 Lecture Hours)

UNIT-III

Reaction Mechanism of Transition Metal Complexes: Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favor of conjugate mechanism, anation reactions and reactions without metal ligand bond cleavage.

(12 Lecture Hours)

UNIT-IV

Square Planar Complexes: Substitution reactions, trans effect, mechanism of the substitution reaction. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, inner sphere type reactions, outer sphere type reactions, cross reactions and Marcus-Hush theory.

(12 Lecture Hours)

UNIT-V

Electronic Spectra and Magnetic Properties of Transition Metal Complexes: Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

(12 Lecture Hours)

E-resources:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA
2. https://www.slideshare.net/ShivajiBurungale/stereochemistry-in-main-group-compounds
3. https://chempedia.in/metal-ligand-equilibria-in-solution/
4. https://cbpbu.ac.in/userfiles/file/2020/STUDY_MAT/CHEM/Sem-II.pdf
5. https://www.uou.ac.in/lecturenotes/science/MSCCH-17/CHE
6. https://www.youtube.com/playlist?list=PLDjIJRH6sIC75nF-oDbyievkNyz1YAot8

Books Recommended:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, ABP Lever, Elsevier.
5. Magnetochemistry, R.L. Carlin, Springer Verlag.

SEMESTER-I
DCC: CHE8001T
Organic Chemistry-I

Code of the Course: CHE8001T

Title of the Course: Organic Chemistry-I

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry.

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites: *Basics of organic chemistry taught at under graduate level.*

Course Objectives: *This course provides an introduction to the fundamental concepts of organic chemistry, nature of bonding, different types of reactions and their mechanism and formation of carbon-carbon and carbon-hetero multiple bonds. The course aims to develop student's understanding of the fundamental principles underlying chemical bonding and reaction mechanism.*

Learning Outcomes:

After studying this paper, students would-

- *understand the nature of bonding in organic molecules and they will be able to justify the aromatic, anti-aromatic and non-aromatic behaviors of organic molecules.*
- *learn various methods to determine the rate of an organic reaction and the factors affecting the rate of an organic reaction, nature of transition state and intermediates.*
- *have sound knowledge about the types and mechanism of various organic reactions such as substitution reactions, additions reactions and elimination reactions.*
- *receive a good knowledge about the organic reactions and their mechanism occurring on aromatic compounds.*
- *gain detailed knowledge about different name reactions involving carbon-carbon and carbon-hetero multiple bonds.*

Syllabus:

UNIT-I

Nature of Bonding in Organic Molecules: Delocalized chemical bonding-conjugation, cross conjugation, bonding in fullerenes, aromaticity in benzenoid and non-benzenoid compounds, annulenes, ferrocenes and helicenes, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of π-molecular orbitals, anti-aromaticity, Homo-aromaticity.

(12 Lecture Hours)

UNIT-II

Reaction Mechanism, Structure and Reactivity: A review of types of mechanisms and reaction, Methods of determining mechanisms, Kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle, potential energy diagrams, transition states and intermediates, Generation, Structure, stability and reactivity of reactive intermediates, isotope effects, effect of structure on reactivity-resonance and field effects, steric effect, steric inhibition to resonance, substituent and reaction constants, Hammett and Taft equation.

(12 Lecture Hours)

UNIT-III

Aliphatic Reaction Mechanism

Nucleophilic Substitution: The S_N2, S_N1, mixed S_N2 and S_N1, S_Ni and SET mechanisms, Neighbouring group participation. Classical and nonclassical carbocations, phenonium ions, norbornyl system, common carbocation, rearrangements, nucleophilic substitution at allylic, trigonal and vinylic carbon, reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, ambient nucleophile, regioselectivity.

Electrophilic Substitution: S_E2 and S_E1 mechanism, electrophilic substitution accompanied by double bond shift, effect of substrates, leaving group and the solvent polarity on reactivity.

(12 Lecture Hours)

UNIT-IV

Aromatic Reaction Mechanism

Electrophilic Substitution: The arenium ion mechanism, orientation and reactivity, energy profile diagrams, the ortho/para ratio, ipso attack, orientation in other ring systems, diazonium coupling, Vilsmeir-Haak reaction, Bischler-Napieralski reaction, Pechmann reaction.

Nucleophilic Substitution: The S_NAr, S_N1, benzyne and SR_N1 mechanisms, reactivity-effect of substrate structure, leaving group and attacking nucleophile, Von Richter, Sommelet-Hauser and Smiles rearrangements.

Free Radical Reaction: Types of free radical reactions, free radical substitution mechanism, neighboring group assistance, reactivity for aliphatic and aromatic substrate at a bridgehead, reactivity in the attacking radicals, the effect of solvents on reactivity, allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, autooxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction, free radical rearrangement, Hunsdiecker reaction.

(12 Lecture Hours)

UNIT-V

Addition Reaction

Carbon-Carbon Multiple Bonds: Mechanistic and stereochemical aspects of addition reaction involving electrophiles, nucleophiles and free radicals, regio and chemoselectivity, orientation and reactivity, addition to cyclopropane ring, hydrogenation of double bond, triple bonds and aromatic rings, hydroboration, Michael reaction.

Carbon-Hetero Multiple Bonds: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, addition of Grignard reagents, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds, Wittig reaction, mechansim of condensation reaction involving enolates-Aldol, Knoevengel, Mannich, Benzoin, Perkin and Stobbe reactions.

Elimination Reaction: The E2, E1, ElcB and E2cB mechanisms, orientation of the double bond, reactivity-effect of substrate structures, attacking base, the leaving group and the medium, stereochemistry, elimination v/s substitutions, pyrolytic eliminations.

(12 Lecture Hours)

E-resources:

1. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=13G8VouhmrFfuhs6rkiyTA
2. http://www.nou.ac.in/econtent/Msc%20chemistry%20Paper%203/MSc%20Chemistry%20Paper-III%20Unit-1.pdf
3. http://rguir.inflibnet.ac.in/bitstream/123456789/16764/1/9781984665911.pdf
4. https://edisciplinas.usp.br/mod/resource/view.php?id=4580073
5. https://edscl.in/pluginfile.php/2660/mod_resource/content/2/Teachers%20Notes.pdf
6. https://www.bhu.ac.in/Content/Syllabus/Syllabus_30063128202004140356 42.pdf

Books Recommended:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Plenum.
3. A Guide book of Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Modern Organic Reactions, H.O. House, Benjamin.
6. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic and Professional.
7. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh.
8. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
9. Stereochemistry of Organic Compounds, P.S Kalsi, New age International.
10. Organic Reaction and Their Mechanisms, P.S. Kalsi, New Age International.
11. Organic Reaction Mechanism, V.K. Ahluwalia and R.K. Parshar, New Age International.

SEMESTER-I
DCC: CHE8002T
Physical Chemistry-I

Code of the Course: CHE8002T
Title of the Course: Physical Chemistry-I
Level of the Course: NHEQF Level 6.0
Credit of the Course: 4
Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry.
Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Chemistry courses of undergraduate level or equivalent.*
Course Objectives: *This course provides Schrödinger equation, angular momentum theory, Born-Oppenheimer approximation, Perturbation theory. Chemical kinetics part of the course is designed to provide students with the knowledge, theoretical background and modeling tools to understand experimental and theoretical aspects of chemical reaction kinetics reaction. Macromolecules part of the course provides synthesis, characterization, properties and also include discussion on the applications of polymers.*
Learning Outcomes:
After studying this paper, the student would learn -

- *theory of angular momentum theory for orbitals and electrons, and describe both coupled and uncoupled representation.*
- *Born-Oppenheimer approximation and approximation methods such as variational theory and perturbation theory, and explain qualitative differences between these.*
- *numerical problems basis on rates of different reaction.*
- *temperature and pressure effect on reactions.*
- *differentiate between different theories of kinetics.*
- *general concepts, principles, kinetics and methodology of polymerization and kinetics of chain growth and step growth polymerization.*
- *Properties and applications of polymers.*

Syllabus:

UNIT-I

Quantum Chemistry: The Schrodinger equation and the postulates of quantum mechanics, solutions of the Schrodinger equation to some model system viz. particle in a box, the harmonic oscillator.
Approximate Methods: First order time-independent perturbation theory for non-degenerate states. Variation theorem and variational methods. Use of these methods illustrated with some examples (particle in a box with a finite barrier, anharmonic oscillator, and approximate functions for particle in a box and hydrogen atom).

(12 Lecture Hours)

UNIT-II

Angular Momentum: Ordinary angular momentum, generalized angular momentum, eigen functions and eigen values of angular momentum, operators, algebra of operators, ladder operators, addition of angular momenta, spin, antisymmetry and Pauli's exclusion principle.
Electronic Structure of Atoms: Electronic configuration, Russell-Saunder's terms and coupling schemes, molecular orbital theory, Huckel theory of conjugated systems, bond order and charge density calculations, application to ethylene, allyl and cyclobutadiene systems.

(12 Lecture Hours)

UNIT-III

Chemical Dynamics: Methods of determining rate laws and mechanism, collision theory of reaction rates, steric

factor, activated complex theory, Arrhenius equation and thermodynamic parameters, ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, dynamics of unimolecular reactions.

(12 Lecture Hours)

UNIT IV

Catalysis and Chain Reactions: Homogeneous and heterogeneous catalysis, kinetics of enzyme reactions, chain reactions, photochemical chain reactions (Hydrogen-bromine and hydrogen-chlorine reactions) oscillatory reactions (Belousov-Zhabotinsky reaction), fast reactions.

(12 Lecture Hours)

UNIT V

Macromolecules: Definition, types of polymers, electrically conducting, fire resistant and liquid crystal polymers, kinetics of polymerization, mechanism of polymerization, molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion and light scattering methods, GPC), sedimentation.

(12 Lecture Hours)

E-resources:

1. https://homepages.iitb.ac.in/~shukla/qmech2_chap2.pdf
2. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/02.physical_chemistry-i
3. https://theory.physics.manchester.ac.uk/~xian/qm/chapter2.pdf
4. https://egyankosh.ac.in/bitstream/123456789/72738/3/Unit-14.pdf
5. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000661/M019111/ET/1515650810CHE_P6_M32_etext.pdf

Books Recommended:

1. Lowe, J. P. & Peterson, K. Quantum Chemistry Academic Press (2005).
2. McQuarrie, D. A. Quantum Chemistry Viva Books Pvt. Ltd.: New Delhi (2003).
3. Mortimer, R. G. Mathematics for Physical Chemistry 2nd Ed. Elsevier (2005).
4. Pilar, F. L. Elementary Quantum Chemistry 2nd Ed., Dover Publication Inc.: N.Y. (2001).
5. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 8th Ed., Oxford University Press.
6. Levine, I. L Quantum Chemistry 5th Ed., Prentice-Hall Inc.: New Jersey (2000).
7. Engel, T. & Reid, P. Physical Chemistry Benjamin-Cummings (2005).
8. McQuarrie, D. A. & Simon, J.D. Physical Chemistry: A Molecular Approach 3rd Ed., Univ. Science Books (2001).
9. Chemical Kinetics, K.J. Laidler, Mcgraw-Hill.
10. Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and Kuriacose, McMillan.

SEMESTER-I
DCC: CHE8003T
Group Theory and Spectroscopy

Code of the Course: CHE8003T
Title of the Course: Group Theory and Spectroscopy
Level of the Course: NHEQF Level 6.0
Credit of the Course: 4
Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry.
Delivery type of the Course: 60 lectures (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Chemistry courses of under graduate or equivalent with study of group theory, vibrational spectroscopy, Raman spectroscopy.*
Course Objectives: *This course introduces the symmetry of element, electromagnetic radiation, spin interaction, infrared spectroscopy, Raman Effect, atomic spectroscopy, molecular spectroscopy it covers topics such as Mossbauer Spectroscopy bonding of compounds. This course also aims to develop student's understanding of coordination and oxidation state of molecules.*
Learning Outcomes*:*
After studying this paper, students would learn-

- *the knowledge about the symmetry properties of a molecule, symmetry elements, symmetry operations and representation of symmetry by point group and character table.*
- *to correlate the group theory with the molecular spectroscopy.*
- *the basic principles of electromagnetic radiations and its interaction with matter. Students will also*
- *the knowledge about the rotational spectroscopy.*
- *the basic principles, instrumentation and applications of various spectroscopic techniques including Infrared spectroscopy, Raman spectroscopy, electronic spectroscopy and Mossbauer Spectroscopy.*

Syllabus:

UNIT-I

Symmetry and Group theory in Chemistry: Symmetry elements and symmetry operation, definition of group, subgroup, Conjugacy relation and classes. Point symmetry group, Schoenflies symbols, representation of groups by matrices (representation for the C_nh, C_nv, etc. groups to be worked out explicitly). Characters of a representations, Great orthogonality theorem (without proof) and its importance. Character tables and their use; spectroscopy, Derivation of character table for C_2v and C_3v point group, symmetry aspects of molecular vibrations of H_2O molecule.

(12 Lecture Hours)

UNIT-II

Unifying Principles: Electromagnetic radiations, interaction of electromagnetic radiation with matter, Uncertainty relation and natural line width, factors affecting natural line width.
Rotational Spectroscopy: Classification of molecules, rigid rotator, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor, stark effect, nuclear and electron spin interaction and effect of external field, applications.

(12 Lecture Hours)

UNIT-III

Vibrational Spectroscopy:
Infrared Spectroscopy: Review of linear harmonic oscillator, vibrational energies of diatomic molecules, Zero Point energy, force constant and bond strength, anharmonicity, Morse Potential energy diagram, vibration-rotation spectroscopy, P.Q.R. branches, breakdown of Oppenheimer approximation, selection rules, finger print region, Group frequencies and intensities, overtones, hot bands, combination bands and Fermi resonance.

Raman Spectroscopy: Classical and quantum theories of Raman effect, Stokes and anti-Stokes lines, Pure rotational, vibrational, rotational-vibrational Raman spectra, Mutual exclusion principle.

(12 Lecture Hours)

UNIT-IV

Electronic Spectroscopy:

Atomic Spectroscopy: Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.

Molecular Spectroscopy: Electronic spectra of diatomic molecules: Born Oppenheimer approximation, vibrational progressions, Franck-Condon principle. Electronic spectra of polyatomic molecules. Emission spectra; radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.

Photoelectron Spectroscopy: Basic principles, photo-electric effect, ionization process, Koopman's theorem, ESCA-theory, Auger emission spectroscopy-Basic idea.

(12 Lecture Hours)

UNIT-V

Mossbauer Spectroscopy: Basic principles, Instrumentation, Mossbauer nuclides, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, (2) Sn^{+2} and Sn^{+4} compounds - nature of M-L bond, coordination number, structure, (3) detection of oxidation state and equivalent MB atoms.

(12 Lecture Hours)

E-resources:

1. http://www.gacariyalur.ac.in/econtent/Chemistry/pg/PG-I-P16CH13.pdf
2. https://www.studocu.com/in/document/sant-gadge-baba-amravati-university/chemistry/competative-chemistry/20797234
3. https://oms.bdu.ac.in/ec/admin/contents/1_P16CH22_2020053003300799.pdf
4. https://www.blogs.uni-mainz.de/fb09akguetlich/files/2017/11/Moessbauer_Lectures.pdf

Books Recommended:

1. Modern Spectroscopy, J.M. Hollas, John Wiley.
2. Chemical Applications of Group Theory, F. A. Cotton.
3. Symmetry and Group theory: Some chemical applications, Ramashankar and Suresh Ameta, Himanshu Publications, Udaipur, Delhi.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Basic Principles of Spectroscopy, R. Chang, McGraw Hill
6. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH- Oxford.
7. Introduction to Photoelectron Spectroscopy, P. K. Ghosh, John Wiley.
8. Introduction to Magnetic Resonance, A Carrington and A.D. Maclachalan, Harper & Row.
9. Physical Methods for Chemistry, R.S. Drago, Saunders Company.
10. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.

SEMESTER-I
DCC: CHE8004P
Organic Chemistry Lab-I

Code of the Course: CHE8004P
Title of the Course: Organic Chemistry Lab-I
Level of the Course: NHEQF Level 6
Credit of the Course: 4
Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry Practical.
Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Separation of Binary Mixture (Minimum-8) **30 Marks**

Purification and identification of compounds in a binary mixture of solid-soild or solid-liquid and preparation of their suitable derivatives.

II. One Step Organic Synthesis (Minimum-5) **10 Marks**

1. Acetylation of salicylic acid using acetyl chloride
2. Benzoylation- Benzoylation of phenol/ aniline/ glycine
3. Oxidation- Phenanthroquinone from phenanthrene
4. Sandmeyer Reaction- o-chlorotoluene from o-toluidine
5. Acetoacetic ester condensation- Synthesis of ethyl-n-butylacetoacetate
6. Bromination Reaction- To prepare dibromoflurorescein from fluorescein
7. Claisen-Schmidt Condensation- Benzalacetophenone/Benzalacetone/ Dibenzalacetone from benzaldehyde

III. Two Step Organic Synthesis (Minimum-3) **20 Marks**

1. Preparation of acetanilide from acetophenone (Beckmann Rearrangement)
2. Preparation of *m*-nitroaniline from nitrobenzene
3. Preparation of *m*-phenylenediamine from nitrobenzene
4. Preparation of methyl orange from aniline
5. Preparation of eosin from phthalic anhydride
6. Preparation of anthranilic acid from phthalic anhydride
7. Preparation of p-aminoazobenzene from aniline

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

Virtual Labs:

1. https://www.slideshare.net/DrSSreenivasa/msc-laboratory-manual-organic-chemistry-binary-mixture-seprations
2. https://www.youtube.com/watch?v=b-0dqL4ZaNg
3. https://www.youtube.com/watch?v=kK0dEhv-9Do
4. https://www.youtube.com/watch?v=YnUnOOgJIp4
5. https://www.science.gov/topicpages/p/practical+two-step+synthesis.html
6. https://www.youtube.com/watch?v=Y9AJtsheGIE

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry by B.S. Furniss, Pearson.
2. Practical Organic Chemistry by J.T. Sharp, Springer.
3. Advanced Practical Organic Chemistry, O.P. Agarwal, Krishna Publications.
4. Advanced Practical Organic Chemistry, N.K. Vishnoi, Vikas Publishing House.

SEMESTER-I
DCC: CHE8005P
Inorganic and Physical Chemistry Lab

Code of the Course: CHE8005P

Title of the Course: Inorganic and Physical Chemistry Lab

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry Practical

Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving.)

Syllabus:

I. **Qualitative Analysis of Inorganic Mixture (Minimum-6)** **30 Marks**

Qualitative analysis of inorganic mixture containing six radicals from the following list: (at least three from Group B)

Group A - Carbonate, Sulphite, Sulphate, Sulphide, Nitrite, Acetate, Oxalate, Nitrate, Chloride, Iodide, Phosphate, Fluoride, Borate, Silver, Lead Mercury, Bismuth, Copper, Cadmium, Tin, Arsenic, Antimony, Aluminium, Chromium, Iron, Nickel, Cobalt, Zinc, Manganese, Calcium, Barium, Strontium, Magnesium, Ammonium.

Group B - Thiosulphate, Cyanate, Thiocyanate, Hypochlorite, Chlorate, Percholrate, Iodate, Persulphate, Silicate, Chromate, Arsenate, Benzoate, Thalium, Tungsten, Molybdenum, Vanadium, Beryllium, Uranium, Thorium, Titanium, Zirconium, Cerium.

II. Kinetics **15 Marks**

1. Determine the specific rate constant for the acid catalyzed hydrolysis of methyl acetate by the initial rate method.
2. Compare the strengths of hydrochloric acid and sulphuric acid by studying rate of hydrolysis of methyl acetate.
3. Determine the specific reaction rate constant of the potassium persulphate-iodide reaction by the initial rate methods.
4. Study the kinetics of the iodination of acetone in the presence of acid by the initial rate method.

III. Conductometry **15 Marks**

1. Determine the equivalent conductance, degree of dissociation, dissociation constant (Ka) for weak electrolytes (CH_3COOH, NH_4OH) and verify Ostwald dilution law.
2. Determine the solubility of sparingly soluble salt and its solubility product.
3. Study the conductometric titration of hydrochloric acid with sodium carbonate and determine the concentration of sodium carbonate in a commercial sample of soda ash.
4. Determine basicity of weak organic acid.
5. Determine the strength of strong and weak acids in a given mixture.

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

Virtual Labs:

1. https://ncert.nic.in/pdf/publication/sciencelaboratorymanuals/classXII/chemistry/lelm107.pdf
2. https://egyankosh.ac.in/bitstream/123456789/79535/1/Unit-1.pdf

3. https://egyankosh.ac.in/bitstream/123456789/79544/1/Unit-10.pdf
4. https://www.slideshare.net/mithilfaldesai/determination-of-equivalence-conductance-degree-of-dissociation-and-dissociation-constant-of-weak-acid-185659712
5. https://www.youtube.com/watch?v=ezXDuUmWJS8

Books Recommended:

1. Vogel's Textbook of Quantitative Analysis, J. Bassett, R.C. Denney, G.H. Jeffery and J. Mendham
2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall.
3. Macro scale and Micro scale Organic Experiments, K.L. Williamson, D.C. Health.
4. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
5. Findley's Practical Physical chemistry, B.P. Levitt, Longman.
6. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
7. Advanced Practical Physical Chemistry; Eighteenth Edition J.B.Yadav; Goel Publishing House, Meerut, 2015.

SEMESTER-II
DCC: CHE8006T
Inorganic Chemistry-II

Code of the Course: CHE8006T
Title of the Course: Inorganic Chemistry-II
Level of the Course: NHEQF Level 6.0
Credit of the Course: 4
Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry
Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites: *Chemistry courses of under graduate or equivalent. The students should have knowledge in basic inorganic chemistry such as chemical bonding, coordination chemistry, chemistry of main group elements etc.*
Course Objectives: *This course is mainly focuses on basic facts and concepts of structure and bonding in metal π-complexes, boranes, silicones, phosphorous-nitrogen compounds, sulphur-nitrogen compounds and metal clusters.*
Learning Outcomes:
After studying this paper, students would learn-

- *preparation, properties, structure and bonding of metal π - complexes particularly learn about chemistry of metal carbonyls, metal nitrosyls, dinitrogen complex, dioxygen complex.*
- *structure and bonding of boranes and higher boranes, lipscomb concept of bonding elements, s,t,y and x nomenclature*
- *preparation, properties, structure and bonding of silicones.*
- *preparation, properties, structure and bonding of sulphur-nitrogen and phosphorus-nitrogen compounds.*
- *structure and bonding of boranes and cluster compounds.*

Syllabus:

UNIT-I

Metal π- Complexes I: Metal carbonyls, carbon monoxide as a ligand, types of metal carbonyls, synthesis, structures and bonding of mono- and poly-nuclear binary carbonyls, use of vibrational spectra of metal carbonyls for bonding and structure elucidation, applications of metal carbonyls in catalysis.

(12 Lecture Hours)

UNIT-II

Metal π- Complexes II: Preparation, bonding, structure, important reactions and applications of transition metal nitrosyls, dinitrogen, dioxygen, carbene and tertiary phosphine complexes of transition metals.

(12 Lecture Hours)

UNIT-III

Boranes: Preparation and important reactions, electron deficient characters of boranes, structure and bonding in boranes, concept of multicentric bonding and M.O. description, Lipscomb concept of bonding elements, semitopological description of s,t,y and x nomenclature.
Silicones- Preparation, properties and structure of silicones, their industrial and technical importance.

(12 Lecture Hours)

UNIT-IV

Metal Clusters: Nomenclature, classification and preparations of higher boranes, carboranes, metalloboranes, metallocarboranes, metal carbonyl and halide clusters, Zintl ions, compounds with metal-metal multiple bonds. Bonding in metal atom cluster including Hoffmann‘s isolobal concept.

(12 Lecture Hours)

UNIT-V

Sulphur-Nitrogen Compounds: Preparation, properties and uses of tetrasulphur tetranitride disulphur, dinitride, polythiozyl and other sulphonitrides, sulphur imides.

Phosphorus-Nitrogen Compounds: Linear and cyclic polymers, their synthesis and reactions, structure and bonding Alcok's skeletal π-bonding concept.

(12 Lecture Hours)

E-resources:

1. https://archive.nptel.ac.in/content/storage2/courses/104106064/lectures.pdf
2. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/11.inorganic_chemistry-iii/12._and_dinitrogen_complexes_and_their_preparation/et/8826_et_et.pdf
3. https://www.youtube.com/watch?v=mLuyVwDdvy0
4. https://chemistnotes.com/inorganic/polythiazyl-preparation-structure-uses/
5. https://www.usb.ac.ir/FileStaff/2896_2019-4-18-0-9-32.pdf

Books Recommended:

1. Advanced Inorganic Chemistry, F. A. Cotton and Wilkinson, John Wiley
2. Inorganic Chemistry, J. E. Huhey, Harpes & Row
3. Chemistry of the Elements, N.N. Greenwood and A. Earnshow, Pergamon
4. Inorganic Electronic Spectroscopy, ABP Lever, Elsevier
5. Magnetochemistry, R.L. Carlin, Springer Verlag

SEMESTER-II
DCC: CHE8007T
Organic Chemistry-II

Code of the Course: CHE8007T
Title of the Course: Organic Chemistry-II
Level of the Course: NHEQF Level 6.0
Credit of the Course: 4
Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry
Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Basics of organic reactions and stereochemistry taught at UG level.*
Course Objectives: *This course provides an introduction to the fundamental and advanced concepts of stereochemistry, rearrangements, reagents and pericyclic chemistry. The course aims to develop student's understanding of the fundamental principles underlying stereochemistry and reaction mechanism.*
Learning Outcomes:
After studying this paper, students would learn-

- *comprehensive knowledge on molecular chirality, optical activity, stereospecific and stereo selective synthesis, methods of resolution and asymmetric synthesis.*
- *mechanistic aspects of various rearrangement reactions including the nature of migration, migratory aptitude and memory effects.*
- *the knowledge about the use of the various reagents in organic synthesis and functional group transformation.*
- *broad knowledge about the molecular orbital symmetry and pericyclic reactions including electrocyclic reactions, cycloaddition reactions and sigmatropic reactions.*

Syllabus:

UNIT-I

Stereochemistry: Elements of symmetry, chirality, molecules with more than one chiral center, DL, RS and EZ nomenclature, methods of resolution, Optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereo specific and stereo selective synthesis, optical activity in the absence of chiral carbon (biphenyl, allenes and spiranes), chirality due to helical shape. Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity.

(12 Lecture Hours)

UNIT-II

Asymmetric Synthesis: Introduction to asymmetric synthesis, Cram's and Prelog's rules. Use of chiral auxiliaries, chiral catalyst (L-Proline based reaction), asymmetric hydrogenation, asymmetric epoxidation (Sharpless epoxidation), and asymmetric dihydroxylation, Enzyme catalyzed asymmetric reactions (Reduction and oxidations).

(12 Lecture Hours)

UNIT-III

Rearrangements: General mechanistic considerations-nature of migration, migratory aptitude, memory effects. Pinacol-Pinacolone rearrangement, Wagner- Meerwin rearrangement, Demjanov rearrangement, Benzil-Benzilic acid rearrangement, Favorskii rearrangement, Wolff rearrangement, Neber rearrangement, Beckmann rearrangement, Hofmann rearrangement, Curtius rearrangement, Schmidt rearrangement, Lossen rearrangement, Bayer-Villiger rearrangement and Steven's rearrangement.

(12 Lecture Hours)

UNIT-IV

Pericyclic reactions: Introduction, classification of pericyclic reactions, molecular orbital symmetry, frontier

orbitals of ethylene, 1,3–butadiene, 1,3,5-hexatriene and allyl system. Woodward Hoffmann Correlation diagram, F.M.O. and PMO approach to cycloaddition and electrocyclic reactions. Electrocyclic reactions- Conrotatory and disrotatory motions, 4n and 4n+2. Cycloadditions- antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3-dipolar cycloaddition and cheleotropic reactions. Sigmatropic rearrangement-suprafacial and antrafacial shifts of H, Sigmatropic shifts involving carbon moieties, Claisen, Cope and aza-Cope rearrangement. Fluxional tautomerism. Ene reaction.

(12 Lecture Hours)

UNIT-V

Reagents in Organic Synthesis: Use of the following reagents in organic synthesis and functional group transformation, Gilman's reagent, lithium dimethyl cuprate LDA, dichlorohexylcarbodiimide, trimethyl silyl iodide, tributyltin hydride, DDQ, Baker yeast, Petersons synthesis, Merrifield resins, 1,3-dithiane, selenium oxide, osmium tetroxide, use of N- heterocyclic carbene in organic synthesis.

(12 Lecture Hours)

E-resources:

1. https://www.uou.ac.in/lecturenotes/science/MSCCH17/CHEMISTRY%20LN%202%20STEREOCHEMISTRY.pdf
2. https://www.degruyter.com/document/doi/10.1351/pac199668122193/pdf
3. https://uscibooks.aip.org/wp-content/uploads/AD06rt.pdf
4. https://www.uwindsor.ca/people/jgreen/sites/uwindsor.ca.people.jgreen/files/asymmetric_synthesis_-_intro_and_diastereoselective_rxns.pdf
5. https://www.slideshare.net/loganathankulandaive/migratory-aptitudes-in-rearrangement-reaction
6. https://edscl.in/pluginfile.php/2878/mod_resource/content/1/teachers%20notes.pdf
7. https://file.helpstudentpoint.com/wp-content/uploads/2022/01/Chemistry2.pdf

Books Recommended:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J. Sundberg, Springer
3. Modern Synthetic Reactions, H.O. House, Benjamin
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
5. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan.
6. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
7. Stereochemistry of Organic Compounds, P.S Kalsi, New age International.
8. The text book of Stereochemistry, Shikha Agarwal & Dinesh K. Jangid, Pragati Prakashan.
9. Organic Reaction and Their Mechanisms, P.S. Kalsi, New Age International.
10. Organic Reaction Mechanism, V.K. Ahluwalia and R.K. Parshar, New Age International.
11. Stereochemistry of Organic Compounds, E.L. Eliel.

SEMESTER-II
DCC: CHE8008T
Physical Chemistry II

Code of the Course: CHE8008T
Title of the Course: Physical Chemistry-II
Level of the Course: NHEQF Level 6.0
Credit of the Course: 4
Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry
Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Chemistry courses of undergraduate level or equivalent.*
Course Objectives: *This course provides an introduction and discussion of thermodynamics of open system, statistical thermodynamics, electrochemistry, surface chemistry, theories of electrified interfaces*.
Learning Outcomes:
After studying this paper, students would-

- *contextualise the connection between quantum mechanics and thermodynamics.*
- *apply the molecular partition functions.*
- *derive the vibrational and translational partition function.*
- *derive and compute thermodynamic functions from partition functions.*
- *describe the different ensemblesand the fundamental aspects of chemistry.*
- *understand the electric double layer (edl) structure.*
- *understand the fundamentals of polarography*

Syllabus:

UNIT-I

Classical Thermodynamics: Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies, partial molar properties, partial molar free energy, partial molar volume and partial molar heat content and their significance, determinations of these quantities.
Non-ideal Systems: Excess function for non-ideal solutions, activity, activity coefficient, Debye-Huckel theory for activity coefficient of electrolyte solutions, determination of activity and activity coefficients, ionic strength.

(12 Lecture Hours)

UNIT-II

Statistical Thermodynamics: Concept of distribution, thermodynamic probability and most probable distribution, ensemble averaging, postulates of ensemble averaging, canonical, grand canonical, and microcanonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers) Partition function, translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions, applications of partition functions. Chemical equilibrium and equilibrium constant in terms of partition functions, Fermi-Dirac statistics, Bose-Einstein statistics, distribution law.

(12 Lecture Hours)

UNIT-III

Surface Chemistry: Surface tension, Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids (Electrokinetic phenomenon), and catalytic activity at surfaces. Surface active agents, classification of surface-active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization, solubilization, micro- emulsion, reverse micelles.

(12 Lecture Hours)

UNIT-IV

Electrochemistry: Debye-Huckel-Onsager treatment and its extension, ion-solvent interactions, Debye-Hückel-Jerum mode, thermodynamics of electrified interface equations, derivation of electro-capillarity, Lippmann

equations (surface excess), methods of determination, structure of electrified interfaces, GuoyChapman, Stern, Bockris, Devanathan models, over potentials, exchange current density, derivation of Butler-Volmer equation, Tafel plot.

(12 Lecture Hours)

UNIT-V

Electrical Double Layer at Metal/Semiconductor-Electrolyte Interface: Thermodynamics of double layer, determination of surface excess charge and other electrical parameters-electrocapillarity, excess charge capacitance, and relative surface excesses, metal/ water interaction-contact adsorption, its influence on capacity of interface, complete capacity-potential curve, constant capacity region hump, semiconductor/electrolyte interface, capacity of space- charge, MottSchottky plot.

Polarography: Theory, Ilkovic equation, half wave potential and its significance.

(12 Lecture Hours)

E-resources:

1. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000665/M019132/ET/1515661483CHE_P10_M10_etext.pdf
2. https://www.uh.edu/engines/StatisticalThermodynamics.pdf
3. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000665/M026473/ET/1515661998CHE_P10_M25_etext.pdf
4. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000661/M026190/ET/1515649970CHE_P6_M30_etext.pdf
5. https://academic.oup.com/book/40724/chapter/348491171

Books Recommended:

1. Modern Electrochemistry Vol. I and Vol.II, J.O.M. Bockris and A.K.N. Reddy, Plenum.
2. Silbey, R. J., Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed. Wiley.
3. McQuarrie, D. A. Statistical Mechanics Viva Books Pvt. Ltd.: New Delhi (2003).
4. Nash, L. K. Elements of Statistical Thermodynamics 2nd Ed., Addison Wesley (1974).
5. Physical Chemistry, P.W Atkins, ELBS.
6. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.
7. Modern Electrochemistry Vol. 1 and Vol II J.O.M. Bockris and A.K.N. Reddy, Planum.

SEMESTER-II
DCC: CHE8009P
Inorganic Chemistry Lab-I

Code of the Course: CHE8009P

Title of the Course: Inorganic Chemistry Lab-I

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry Practical

Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Water Analysis **25 Marks**

1. Determination of hardness of water
2. Determination of BOD in water sample
3. Determination of COD in water sample
4. Determination of DO in water sample
5. Determination of available Chlorine in water sample
6. Determination of fluoride in water

II. Volumetric Estimation and Analysis of Purity of Chemicals **20 Marks**

1. Determination of Al, Ba, Ca, Cu, Fe, Cr, Ni and Co using complexometric titration
2. Determination of Fe^{2+}, nitrite by cerimetry
3. Determination of Iodide, Sn^{2+} by potassium iodate
4. Determination of available oxygen in hydrogen peroxide
5. Determination of phosphoric acid in phosphoric acid
6. Determination of available chlorine in bleaching powder

III. Chromatography **15 Marks**

Separation of a mixture of cations/anions by paper chromatographic technique using aqueous/nonaqueous media and calculations of R_f values of each ion:

1. Pb^{2+} and Ag^{+} (aqueous & non-aqueous media)
2. Co^{2+} and Cu^{2+} (non-aqueous medium)
3. Cl^{-} and I^{-} (aqueous-acetone medium)
4. Br^{-} and I^{-} (aqueous-acetone medium)

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

Virtual Labs:

1. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/environmental_chemistry/10.part_1_analytical_techniques_for_measuring_water_quality_parameters/et/5508_et_et.pdf
2. https://dibru.ac.in/wp-content/uploads/2020/02/Chemistry_Honours__Non-Honours.pdf
3. https://tabraizullah.files.wordpress.com/2018/09/unit-iv-redox-titrations-priciple-and-applications.pdf
4. https://www.youtube.com/watch?v=uRGhzOctlUg
5. https://chem.libretexts.org/Ancillary_Materials/Laboratory_Experiments/Wet_Lab_Experiments/General_Chemistry_Labs/Online_Chemistry_Lab_Manual/Chem_11_Experiments/03%3A_Paper_Chromatogra

phy-_Separation_and_Identification_of_Five_Metal_Cations_(Experiment)

Books Recommended:

1. Advanced Practical Inorganic Chemistry, Gurdeep Raj; Goel Publishing House, Meerut.
2. Vogel's Text book of macro and semi micro qualitative inorganic analysis, Fifth edition, revised by G. Svelha.
3. Water Analysis: A Practical Guide to Physico-Chemical, Chemical and Microbiological Water Examination and Quality Assurance, Franz-Josef Bibo, Hanno Birke, Helmut Böhm Paperback -(2011), Springer.
4. Practical Manual of Analytical Chemistry, Neelam Singla, Navneet Kaur, PharmaMed Press / BSP Books Second Edition (2023).
5. A Teacher's Guide on Complexometric Titration Paperback – Import, 21 April 2020, Shoukat Ali R a, Grin Verlag (2020).
6. Techniques and Practice of Chromatography (Chromatographic Science Series Book 70) 1st Edition, Kindle Edition, Raymond P.W. Scott. CRC Press; 1st edition (2020).

SEMESTER-II
DCC: CHE8010P
Organic and Physical Chemistry Lab

Code of the Course: CHE8010P
Title of the Course: Organic and Physical Chemistry Lab
Level of the Course: NHEQF Level 6.0
Credit of the Course: 4
Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry Practical
Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving)

Syllabus:

I. Quantitative Analysis and Analysis of oils and fats **15 Marks**

1. Determination of equivalent weight of an acid by silver salt method
2. Estimation of phenol/ aniline using Bromate-Bromide solution or by acetylation method
3. Estimation of glucose by titration using Fehling's solution/ Benedict solution
4. Estimation of carbonyl group by using 2, 4-dinitrophenylhydrazine.
5. Determination of saponification value of oil.
6. Determination of iodine value of oil.
7. Determination of acid value of oil.

II. Distribution law **30 Marks**

1. Complex formation between copper sulphate and ammonia.
2. Equilibrium constant of the reaction between iodine and potassium iodide.
3. Study the distribution of benzoic acid in benzene and water to show the benzoic acid dimerize in benzene.

III. Conductometry **15 Marks**

1. Determine the equivalent conductance at infinite dilution for acetic acid by applying Kohlrausch's law of independent migration of ions.
2. Find out the equivalent conductance of strong electrolytes (NaCl, KCl, KNO_3, HCl etc.) at different dilutions and verify Debye-Huckel-Onsager equation.
3. Determination of velocity constant and order of the reaction for saponification of ethyl acetate by sodium hydroxide conductometrically.
4. Study the stepwise neutralization of a polybasic acid e.g. oxalic acid, citric acid, succinic acid by conductometric titration and explain the variation in the plots.
5. Study the estimation of potassium sulphate solution by conductometric titration. Titrate a mixture of copper sulphate, acetic acid and sulphuric acid with sodium hydroxide.

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

Virtual Labs:

1. https://www.youtube.com/watch?v=KqwwS6-TUUA
2. https://egyankosh.ac.in/bitstream/123456789/45362/1/Practical-7.pdf
3. https://ncert.nic.in/pdf/publication/sciencelaboratorymanuals/classXII/chemistry/lelm105.pdf
4. https://www.youtube.com/watch?v=tDaKxskUwA0
5. https://www.youtube.com/watch?v=8hT3HW0Odxk
6. https://www.youtube.com/watch?v=WSaLSRIczLk

Books Recommended:

1. Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold.

2. Handbook of Organic Analysis: Qualitative and Quantitative. H. Clark, Edward Arnold.
3. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
4. Experiments and Techniques in Organic Chemistry, D.P. Pasto, Johnson and Miller, Prentice Hall.
5. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
6. Findley's Practical Physical chemistry, B.P. Levitt, Longman.
7. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
8. Advanced Practical Physical Chemistry; Eighteenth Edition J.B.Yadav; Goel Publishing House.

SEMESTER-II
GEC: CHE8100T
Environmental and Green Chemistry

Code of the Course: CHE8100T
Title of the Course: Environmental and Green Chemistry
Level of the Course: NHEQF Level 6.0
Credit of the Course: 4
Type of the Course: Generic Elective Course (GEC) for PG Chemistry.
Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Chemistry courses of undergraduate level or equivalent.*
Course Objectives: *This course aims to equip students with a thorough understanding of green chemistry principles, waste management, green solvents and reagents, green chemical synthesis, environmental chemistry, and pollution analysis.*
Learning Outcomes:
After studying this paper, students will be able to-

- *understand the principles and importance of green chemistry in promoting sustainability.*
- *analyze the environmental impact of waste production and develop strategies for waste reduction and safe disposal.*
- *identify and utilize environmentally friendly solvents and reagents in chemical processes.*
- *apply green synthesis approaches to minimize waste and enhance reaction efficiency.*
- *understand the interactions between chemical substances and the environment.*
- *perform analytical techniques to measure and assess pollutants in the environment.*

Syllabus:

UNIT-I

Principle and Concepts of Green Chemistry: Introduction, definition, principles, atom economy, atom economic and atom uneconomic reaction, reducing toxicity.
Waste- Production, Problems and Preventions: Introduction, problem caused by waste, source of waste, cost of waste, waste minimization techniques, on-site waste treatment, design for degradation, polymer recycling. Introduction to catalysis, biocatalyst and phase transfer catalysis.

(12 Lecture Hours)

UNIT-II

Green Solvents: Organic solvents, solvent-free systems, controlling of solvent-free reactions, supercritical fluids (H_2O and CO_2), fluorous biphase solvents.
Green Reagents: Introduction, methods of designing safer chemicals, avoidance of toxic functional groups, examples of greener reagents including replacement of phosgene, methylations using dimethyl carbonates and other polymer supported reagents, solid state polymerization, alternative nitrile synthesis.

(12 Lecture Hours)

UNIT-III

Green Synthesis: Design for energy efficiency, classification and applications of green synthesis including Microwave Assisted Synthesis, green synthesis of polycarbonates, paracetamol, ibuprofen, citral, urethane, adipic acid, styrene and α, β-unsaturated nitroalkenes.

(12 Lecture Hours)

UNIT-IV

Environmental Chemistry: Chemical and photochemical reactions in the atmosphere, oxygen and ozone chemistry, greenhouse gases and its effect, hydrosphere-physical chemistry of sea water, eutrophication, sewage treatment, lithosphere and chemistry involved, smoke formation acid rains. A brief idea of toxicological effects of arsenic, lead, cadmium, mercury, ozone PAN, cyanide and pesticides, carcinogens, oxide of nitrogen, sulphur and carbon.

(12 Lecture Hours)

UNIT-V

Analysis of Pollution: Sampling and monitoring of air and water, determination of total dissolved solids, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, phosphate and different forms of nitrogen phenols, pesticides, surfactants, DO, BOD, COD and microorganism, catalysts of aquatic chemical reactions water pollution laws and standards.

(12 Lecture Hours)

E-resources:

1. https://www.acs.org/greenchemistry/principles/12-principles-of-green-chemistry.html
2. https://www.sciencedoze.com/2021/01/green-solvents-definition-examples-types-of-green-solvents.html
3. https://file.helpstudentpoint.com/wp-content/uploads/2022/01/Chemistry2.pdf
4. https://ncert.nic.in/textbook/pdf/kech207.pdf
5. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/environmental_chemistry/10.part_1_analytical_techniques_for_measuring_water_quality_parameters/et/5508_et_et.pdf

Books Recommended:

1. Green Chemistry: An Introductory Text, Mike Lancaster, Royal Society of Chemicals, Cambridge, 2002.
2. Green Chemistry: Frontiers in Benign Chemical Synthesis and Processes, Edited by Paul T. Anastas & Tracy C. Williamson, Oxford University Press.
3. Green Chemical Syntheses and Processes: Edited by Paul T. Anastas, Lauren G. Heine & Tracy C. Williamson, ACS Symposium Series.
4. Green Chemistry: Environment Friendly Alternatives, Edited by Rashmi Sanghi, M. M. Srivastava, Narosa Publishing House, New Delhi.
5. Green Chemistry: Microwave Synthesis, K. R. Desai, Himalaya Publishing House.
6. Green Chemistry: A Teaching Resource, Dorothy Warren, Royal Society of Chemicals, 2001.
7. Green Chemistry: Williams, Charlotte.
8. Environmental Chemistry, S. E. Manahan, Lewis Publishers.
9. Environmental Chemistry, Sharma & Kaur, Krishna Publishers.
10. Environmental Chemistry, A. K. De, Wiley Eastern.
11. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern.
12. Standard Method of Chemical Analysis, F.J. Welcher Vol. Ill, Van Nostrand Reinhold Company, New York, Vol.2 Part B.
13. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
14. Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.
15. Environmental Chemistry, C. Baird, W. H. Freeman.

SEMESTER-II
GEC: CHE8101T
Polymer Processing Management

Code of the Course: CHE8101T

Title of the Course: Polymer Processing Management

Level of the Course: NHEQF Level 6.0
Credit of the Course: 4
Type of the Course: Generic Elective Course (GEC) for PG Chemistry.

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of undergraduate level or equivalent.*

Course Objectives*: This course provides an introduction and classification of polymers, rubber product manufacturing system, process and quality control method, storage and transportation mean of polymers, market research ,management systems.*

Learning Outcomes:

By the end of this course, students would learn-

- *basics of polymer chemistry. their market review, storage and transportation methods.*
- *industrial manufacturing and properties of polymers.*

Syllabus:

UNIT-I

Rubber Product Manufacturing System: The system concept, Prediction, Monitoring and control of process performance, Production organization
Process Control and Quality Control: The interaction of process control and quality control, Specifications, Process capability studies, Process monitoring, Process control, Quality control.

(12 Lecture Hours)

UNIT-II

Plant Layout and Operation Methods: General consideration, transport and storage in manufacture, Handling methods and operations at work stations, Planning and allocating space layout synthesis and evaluation, Installing and commissioning a layout.

(12 Lecture Hours)

UNIT -III

Company Philosophy, Organization and Strategy: Philosophy, Company Organization, Market Research and Company Development.
The Economics of Manufacturing Operations: The flow of cash through a company, Cost identification and analysis methods, Standard costs, Business plans and budgets, Budgetary control.

(12 Lecture Hours)

UNIT -IV

Production Management: Production planning, Purchasing and inventory control, implementing the production plan.

(12 Lecture Hours)

UNIT -V

Quality Management Systems: Quality data, Quality audit, Quality costs, Quality policy, Quality objectives, Quality systems, Inspection, Certification and Accreditation. Basic concepts on ISO 9000, QS 9000, ISO 14000, TS 16949, EFQM model and TQM.

(12 Lecture Hours)

E-resources:

1. https://www.youtube.com/watch?v=18cN8MZvJRA
2. https://www.youtube.com/watch?v=Ey4MqC7Kp7g
3. https://www.yokogawa.com/in/solutions/products-and-services/control/control-and-safety-system/distributed-control-systems-dcs/

Books Recommended:

1. Physical testing of rubbers: R. P. Brown.
2. Rubber Technology and Manufacturing: C.M. Blow.
3. Introduction of Polymer Sc. & Rubber Technology, Vol. I, Ed. By Dr. R. Mukhopadhyay.

SEMESTER III
DCC: CHE9011T
Advanced Spectroscopic Techniques

Code of the Course: CHE9011T
Title of the Course: Advanced Spectroscopic Techniques
Level of the Course: NHEQF Level 6.5
Credit of the Course: 4
Type of the Course: Discipline Centric Compulsory (DCC) course for PG Chemistry
Delivery type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Chemistry courses of under graduate or equivalent with basic spectroscopy, UV-visible spectrum, IR, NMR spectroscopy.*
Course Objectives: *This course introduces the basic spectroscopy, UV-visible spectrum, IR and NMR spectroscopy. This course also aims to develop student's understanding of spectroscopy data analysis.*
Learning Outcomes*:*
After studying this paper, students would learn:

- *detailed overview of spectroscopic methods used in chemistry.*
- *the principle and instrumentation of electronic spectroscopy and analyze the electronic spectra of different species.*
- *the principle and instrumentation of nuclear magnetic and electron spin resonance spectroscopy and apply the knowledge in characterizing the molecules and also their use in medical diagnostics.*
- *the principle, instrumentation, and application of X-Ray spectroscopy to study X-ray structural analysis of crystals.*

Syllabus:

UNIT-I

Ultra-violet and Visible Spectroscopy: Various electronic transitions, Beer-lambert law, effect of solvent on electronic transitions, UV spectra of carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes, Woodward-Feiser rules for conjugated dienes and carbonyl compounds, UV spectra of benzene and its derivatives, applications of UV spectroscopy.
IR Spectroscopy: Brief idea of FT-IR, normal modes of vibration, characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds), factors affecting the band positions.

(12 Lecture Hours)

UNIT-II

Nuclear Magnetic Resonance Spectroscopy: General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), chemical exchange, effect of deuteration, complex spin-spin interaction between two, three, four and five nuclei (second order spectra), virtual coupling. Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with dihedral angle.
Simplification of complex spectra- Nuclear magnetic double resonance, contact shift reagents, solvent effects. Fourier transform technique, Nuclear Overhauser Effect (NOE). Resonance of other nuclei-^{19}F, ^{31}P.

(12 Lecture Hours)

UNIT-III

^{13}C NMR Spectroscopy: General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Two-dimension NMR Spectroscopy - COSY, NOESY, DEPT, INEPT, APT, INADEQUATE, HMBC, HMQC techniques.

Electron Spin Resonance Spectroscopy: Basic principles, instrumentation, zero field splitting and Kramer's degeneracy, isotropic and anisotropic hyperfine coupling, spin-orbit coupling and significance of g-tensors, factors affecting 'g' value, applications to transition metal complexes (having one unpaired electron) including biological systems and inorganic free radicals such as PH_4, F_2 and BH_3.

(12 Lecture Hours)

UNIT-IV

Mass Spectrometry: Introduction, ion production - EI, CI, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement, Retro Diel-Alder reaction, Nitrogen rule, High resolution mass spectrometry. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

(12 Lecture Hours)

UNIT-V

X-ray Diffraction: Bragg condition, Miller indices, Laue method, Bragg method, Debye-Scherer method of X-ray structural analysis of crystals, index reflections identification of unit cells from systematic absences in diffraction pattern. Structure factor and its relation to intensity and electron density, Ramchandran diagram.

Electron Diffraction: Scattering intensity *vs* scattering angle, Wierl equation, measurement technique, elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surfaces.

Neutron Diffraction: Scattering of neutrons by solids and liquids, magnetic scattering, measurement techniques. Elucidation of structure of magnetically ordered unit cell.

(12 Lecture Hours)

E-resources:

1. https://epgp.inflibnet.ac.in/
2. https://archive.nptel.ac.in/
3. https://swayam.gov.in/
4. http://www.extension.harvard.edu/courses
5. https://spectrabase.com/
6. https://webbook.nist.gov/chemistry/
7. https://nmrshiftdb.nmr.uni-koeln.de/
8. http://www.nou.ac.in/econtent/Msc%20Chemistry%20Paper%20IX/MSc%20Chemistry%20Paper-IX%20Unit-4.pdf
9. http://www.nou.ac.in/econtent/Msc%20Chemistry%20Paper%20IX/MSc%20Chemistry%20Paper-IX%20Unit-5.pdf

Books Recommended:

1. Physical Methods for Chemistry, R.S. Drago, Saunders Company.
2. Structural Methods in Inorganic Chemistry, E. A. V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS
3. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
4. Progress in Inorganic Chemistry vol., 8, ed., F.A. Cotton, vol., 15, ed. S.J. Lippard, Wiley.
5. Transition Metal Chemistry edi R.L. Carlin vol. 3, Dekker
6. Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.
7. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Norwood.
8. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.

9. Spectrometric Identification of Organic Compounds, R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley
10. Introduction to NMR Spectroscopy, R. J. Abraham, J. Fisher and P. Loftus, Wiley.
11. Application of Spectroscopy of Organic Compounds, J. R. Dyer, Prentice Hall.
12. Spectroscopic Methods in Organic Chemistry, D. H. Williams, I. Fleming, Tata McGraw-Hill.
13. Modern Spectroscopy, J.M. Hollas, John Wiley.
14. Applied Electron Spectroscopy for Chemical Analysis Ed. H. Windawi and F.L. Ho, Wiley Interscience.
15. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
16. Physical Methods in Chemistry, R.S. Drago, Saunders College.
17. Chemical Applications of Group Theory, F. A. Cotton.
18. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
19. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
20. Theory and Applications of UV Spectroscopy, H.H. Jaffe and M. Orchin, IBH-Oxford.
21. Introduction to Photoelectron Spectroscopy, P. K. Ghosh, John Wiley.

SEMESTER-III
DCC: CHE9012T
Photochemistry and Supramolecules

Code of the Course: CHE9012T

Title of the Course: Photochemistry and Supramolecules

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses with basic photochemistry, supramolecular chemistry and nanochemistry.*

Course Objectives: *This course introduces the organic photochemistry, covering topics such as photochemical reactions of alkenes, carbonyl compounds and aromatic compounds. This course also aims to develop student's understanding of photochemical reactions, supramolecular chemistry and nano chemistry.*

Learning Outcomes:

After studying this paper, students would learn the:

- *basics of photochemical laws to strengthen the concept used in organic photochemistry.*
- *concepts of photochemical reactions of alkenes, carbonyl and aromatic compounds.*
- *course of an organic photochemical reaction and identify the product with the type of functional group present on the molecule*
- *role of supramolecular chemistry in organic chemistry, chemical biology, materials science and nanotechnology.*
- *nanomaterials synthesis and characterization techniques like SEM, TEM and STM.*

Syllabus:

UNIT-I

Basic of Photochemistry: Photochemical laws, quantum yield, electronic excitation and molecular orbital view of excitation, excited states and fate of excited molecules (modified Jablonski diagram).
Photochemistry of Alkenes: Intramolecular reactions of the olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1, 4-and 1, 5-dienes.

(12 Lecture Hours)

UNIT-II

Photochemistry of Carbonyl Compounds: Intramolecular reactions of carbonyl compounds - saturated, cyclic and acyclic, β, γ- unsaturated and α,β-unsaturated compounds, cyclohexadienones, intermolecular cycloaddition reactions- dimerisations and oxetane formation.
Photochemistry of Aromatic Compounds: Isomerization, additions and substitutions.

(12 Lecture Hours)

UNIT-III

Miscellaneous Photochemical Reactions: Photo-Fries reactions of anilides, Photo Fries rearrangement, Barton reaction, Hoffmann-Loeffler-Freytag reaction, Singlet molecular oxygen reactions, Photochemical formation of smog, Photo degradation of polymers, Photochemistry of vision.

(12 Lecture Hours)

UNIT-IV

Supramolecular Chemistry: Definition and development, nature of supramolecular interactions, Cation binding hosts: Crown ethers, cryptands and spherands - synthesis and properties, binding of anions: biological anion receptors and organometallic receptors, Template and self-assembly-tennis balls and soft balls, catenanes and rotaxanes, supramolecular chemistry of fullerene, fullerene as guests, fullerene as hosts and fullerene as superconducting intercalation compounds, supramolecular photochemistry.

(12 Lecture Hours)

UNIT-V

Nanochemistry: Introduction, Synthesis of nanomaterials, Chemical methods, Dendrimers.
Nanostructured materials: Carbon Nanotubes (CNTs), Single walled carbon nanotubes (SWNTs), Multiwalled carbon nanotubes (MWNTs), Graphenes.
Characterization techniques for nanomaterials: Optical Microscopy: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning tunnel microscopy (STM).

(12 Lecture Hours)

E-resources:

1. https://epgp.inflibnet.ac.in/
2. https://archive.nptel.ac.in/
3. https://swayam.gov.in/
4. https://www2.chemistry.msu.edu/faculty/reusch/virttxtjml/photchem.htm
5. https://www.bbau.ac.in/dept/Chemistry/TM/MCH%20301%20Superamolecular%20Chemistry%20DoC.pdf
6. https://oms.bdu.ac.in/ec/admin/contents/175_P16CHE1B_2020051607305517.pdf

Books Recommended:

1. Photochemistry, J.G. Cavert and J.N. Pitts, Wiley
2. Molecular Photochemistry, N.J. Turro, Benjamin
3. Fundamentals of Photochemistry, K.K. Rohatgi Mukherji, New Age
4. Photochemistry, R.P. Wayne, Butterworth
5. Analytical Chemistry of Macrocyclic and Supramolecular compounds, S.M. Khopkar
6. Supramolecular Chemistry, J.M. Lehn VCH
7. Supramolecular Chemistry, J.W. Stead and J. I. Atwood, John Wiley. G. Timp, Ed. Nanotechnology: Springer-Verlag: N.Y. (1999)
8. Nanochemistry, G.B. Sergeev, Elsevier (2006)
9. Supramolecular and Bioinorganic Chemistry, Rekha Dashora and A. K. Goswami, Pragati Prakashan (2015).

SEMESTER-III
DSE: CHE9102T
Advanced Organometallic Chemistry

Code of the Course: CHE9102T
Title of the Course: Advanced Organometallic Chemistry
Level of the Course: NHEQF Level 6.5
Credit of the Course: 4
Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry
Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Chemistry courses of higher level than under graduate.*
Course Objectives: *This course provides an introduction to the fundamental concepts of organometallic compounds, metal alkyls, metal aryls, and fluxional organometallic compounds. It covers topics such as nature of metal-carbon bond, multicenter bonding in organometallics. It also covers the application of organometallic catalysis in organic synthesis.*
Learning Outcomes:
After studying this paper, students would learn-

- *the use of electron counting in assessing the reactivity and stability of organometallic compounds*
- *bond modes and determine reactivity for normally occurring ligands in organometallic complexes.*
- *typical organometallic reactions, explain their mechanisms and what controls their reactivity*
- *a number of organometallic catalysis reactions for organic synthesis*
- *organometallic applications within organic synthesis, e.g. olefin metathesis, cross-coupling, C-H activation*

Syllabus:

UNIT-I

Classification and Nomenclature and general Characteristics of organometallic Compounds. Nature of bonding of σ bonded organometallics, preparation, properties, structure, bonding and applications of organometallic compounds of non-transition elements like Al, Si, Hg, Li and Mg.

(12 Lecture Hours)

UNIT-II

Concept of hapticity of organic ligands, EAN rule. Preparation, properties, structure, bonding and applications of metal-π-bonded organometallics such as metal-alkene, -alkyne, -allyl (η1 & η3), -cyclopentadienyl and -arene complexes. Structure and bonding in sandwich, half- sandwich and multidecker sandwitch types of complexes.

(12 Lecture Hours)

UNIT-III

Fluxional Organometallic Compounds: Fluxional behavior of organometallic compounds, Rates of rearrangement and techniques of study. Stereochemical non–rigidity in organometallic compounds, ring whizzing in η1-Cp complexes, interchange of η1-and η5-Cp rings, allyl and allene complexes.
Reactions of Organometallic compounds: Substitution, oxidative addition, reductive elimination, insertion and elimination, electrophilic and nucleophilic reactions of coordinated ligands, Metallacycles.

(12 Lecture Hours)

UNIT-IV

Organometallics in organic synthesis: Introduction and bonding. Organometallic reaction mechanism. Synthetic applications of complexes containing metal-carbon σ-bond: Heck, Kumada, Suzuki, Stille, Sonogashira and Negishi coupling reactions and their applications. Carbon monoxide insertion, Carbon hetero-atom bond formation reactions. Pauson-Khand, alkyne cyclotrimerization reaction and C-H activation.

(12 Lecture Hours)

UNIT-V

Biological application and environmental aspect of organometallic compounds: Organometallics in medicine, Organometallics in Industry, Environmental aspects of Organometallic Compounds.

(12 Lecture Hours)

E-resources:

1. https://archive.nptel.ac.in/
2. https://swayam.gov.in/
3. https://kshaughnessy.people.ua.edu/uploads/8/8/6/4/88645274/shaughnessy-omets-notes.pdf
4. https://www.youtube.com/watch?v=4ew9LqftVXg
5. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/chemistry/organic_chemistry_iii/34.fluxional_tautomerism/et/4828_et_et.pdf
6. https://kshaughnessy.people.ua.edu/uploads/8/8/6/4/88645274/shaughnessy-omets-notes.pdf

Books Recommended:

1. Principle and Applications of Organotransition Metal Chemsitry, J.P. Coliman, L.S Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
2. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.
3. Metallo-Organic Chemistry, A.J. Pearson, Wiley
4. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books
5. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lipparad and J.S Valentine, University, Science Books
6. Inorganic Biochemistry Volume I and II. Ed G.L. Eichhorn, Elsevier
7. Progress in Inorganic Chemistry, Volume 18 and 38 Ed. J.J. Lipparad, Wiley.

SEMESTER-III
DSE: CHE9103T
Chemistry of Heterocyclic Compounds

Code of the Course: CHE9103T
Title of the Course: Chemistry of Heterocyclic Compounds
Level of the Course: NHEQF Level 6.5
Credit of the Course: 4
Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry
Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Basics of heterocyclic chemistry taught at UG and higher level*
Course Objectives: *This course provides new insights about heterocycles, their nomenclature, synthesis and reactions of three, four, five, six, seven membered heterocyles. The course aims to develop student's understanding of the fundamental principles of synthesis of different heterocycles with their nomenclature.*
Learning Outcomes:
After studying this paper, students would learn-

- *comprehend nomenclature of different heterocyclic compounds.*
- *A fundamental theoretical understanding of heterocyclic chemistry, including alternative general methods for ring synthesis and application of such methods for the preparation of specific groups of heterocyclic systems.*
- *synthesis and reactivity of fused, six membered and smaller heterocyclic compounds, mostly used in industry as such or its derivatives.*
- *alternative general methods for ring synthesis and application of such methods for the preparation of specific groups of heterocyclic systems.*

Syllabus:

UNIT-I

Nomenclature of Heterocycles: Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles.
Aromatic Heterocycles: General chemical behavior of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in ^{1}H-NMR spectra). Empirical resonance energy, delocalization energy, Dewar resonance energy and diamagnetic susceptibility exaltations.

(12 Lecture Hours)

UNIT-II

Small Ring Heterocycles: Three membered heterocycles with one and two heteroatoms synthetic methods, physical, spectroscopic and chemical properties of aziridines, oxiranes, Thiiranes, diaziridines, diazirines, oxaziridines. Four membered heterocyclic compounds synthetic methods, physical, spectroscopic and chemical properties of azetines, azetidines, oxetanes, thietanes and their carbonyl derivatives.

(12 Lecture Hours)

UNIT-III

Five Membered Heterocycles: Synthetic methods, physical and chemical properties of pyrroles, furanes, thiophenes, pyrazoles, imidazoles, oxazoles, thiazoles.
Benzo-fused Five Membered Heterocycles: Synthetic methods, physical and chemical properties of benzopyrroles, benzofuranes and benzothiophenes.

(12 Lecture Hours)

UNIT-IV

Six Membered Heterocycles: Synthetic methods, physical and chemical properties of pyrilium salts, pyrones, quinolizinium salts, pyridazines, pyrimidines, pyrazines, acridines and phenanthridines, diazines and triazines.

Seven and Large Membered Heterocycles: Synthetic methods, physical and chemical properties of azepines, oxepines, thiepines and diazepins.

(12 Lecture Hours)

UNIT-V

Meso-ionic Heterocycles: Synthetic methods, properties of 1,3-oxazolium-4-olates, 1,3- oxathiolium-4-olates, 1,3-diazolium-4-olates, 1,2,3,-oxadiazolium-5-olates and 1,2- dithiolium-4-olates.

(12 Lecture Hours)

E-resources:

1. https://nptel.ac.in/courses/111/106/111106066/
2. https://ocw.mit.edu/index.htm
3. https://epgp.inflibnet.ac.in/
4. https://swayam.gov.in/
5. https://old.amu.ac.in/emp/studym/99998885.pdf
6. https://boyer-research.com/teaching/2021-10-06_Heterocycles2021.pdf

Books Recommended:

1. Heterocyclic Chemistry, R.R Gupta, M. Kumar and V. Gupta, Springer Verlag.
2. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic Chemistry, R. K. Bansal, New Age International Publishers.
4. Heterocyclic Chemistry, J.A Joule, K. Mills and G.F. Smith. Wiley
5. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scientific & Technical
6. An Introduction to the Heterocyclic Compounds, R. M. Acheson, John Wiley.
7. Comprehensive Heterocyclic Chemistry, A.R Katritzky and C.W Rees, Pergamon Press.

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SEMESTER-III
DSE: CHE9104T
Chemical Kinetics

Code of the Course: CHE9104T
Title of the Course: Chemical Kinetics
Level of the Course: NHEQF Level 6.5
Credit of the Course: 4
Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry
Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Chemistry courses of undergraduate level or equivalent.*
Course Objectives: *This course provides an introduction and discussion of brief of chemical kinetics, structure effect on rate, solvation and solvent effect on rate, electron transfer processes in solution, kinetic isotope effect, reaction on surfaces and gas phase reactions.*
Learning Outcomes*:*
By the end of this course, students will be able to:

- *solve numerical problems related with kinetics*
- *understand effect of structure on reaction rate*
- *explain electron transfer process in solutions*
- *explain kinetic isotope effect and solvent effect*
- *understand the concept of surface and gas phase reactions.*
- *apply reaction kinetics to determine the rate of chemical reactions; understand the factors that influence rates of reaction.*

Syllabus:

UNIT-I

Brief Resume of Chemical Kinetics with emphasis on methods for determining rate of reaction, reaction mechanism with some problems.
Principles of Reactivity: Significance of entropy, enthalpy and Gibb's free energy, Arrhenius equation, uses of activation parameters, nature of activation barrier in chemical reaction.

(12 Lecture Hours)

UNIT-II

Structure Effect on Rate: Linear free energy relationship, Hammett equation, substitution constants, theories of substituent effect, interpretation of σ values and reaction constant ρ, deviation from Hammett equation, the Taft model, σ_I and σ_R scales, steric acceleration, molecular measurements of steric effect on rates.

(12 Lecture Hours)

UNIT-III

Solvation and Solvent Effect on Rate: Factors affecting reaction rate in solution, effect of solvation on reaction rate, solvent effect on ion - ion, ion-dipole and dipole- dipole reactions, and preliminary idea about diffusion - controlled reactions.

(12 Lecture Hours)

UNIT-IV

Electron Transfer Processes in Solution: Inner-sphere, outer sphere, bridged transition states, Marcus theory and its modifications, one equivalents and two equivalent exchange reactions, reactions of solvated electron with metal ions.

Kinetic Isotope Effect: Theory of isotope effects, primary and secondary kinetic effect, heavy atom isotope effect, tunneling effect, solvent isotope effect.

(12 Lecture Hours)

UNIT-V

Reaction on Surfaces: Adsorption isotherm, structure of solid surface and adsorbed layers, mechanism of surface reactions, unimolecular and bimolecular surface reactions, transition state theory of surface reactions, surface chemistry in industrial processes.

Gas Phase Reaction: Hydrogen-oxygen reaction, combustion of hydrocarbons decomposition of N_2O_5 and acetaldehyde, Gold, Finger- Lettort –Niclause rule and inhibition mechanism.

(12 Lecture Hours)

E-resources:

1. https://nptel.ac.in/
2. https://ocw.mit.edu/index.htm
3. https://epgp.inflibnet.ac.in/
4. https://web.stanford.edu/~kaleeg/chem32/kinT/
5. https://www.intechopen.com/chapters/62052

Books Recommended:

1. Surface activity and Detergency, K. Durham, Ed. Mc Millan.
2. Emulsion and Foams, S. Berkman and G. Egloff, Reinhold.
3. Surface Chemistry, J. B. Bikeman, Academic
4. Chemical Kinetics, K. J. Laidler
5. Chemical Kinetics and Mechanism, A. A Frost and R.G. Pearson.

SEMESTER-III
DSE: CHE9105T
Modern Analytical Methods

Code of the Course: CHE9105T

Title of the Course: Modern Analytical Methods

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of post graduate or equivalent with electrochemical, atomic and ionization, oxidation of Chemistry.*

Course Objectives: *This course introduces the electrochemical methods and refractory chemical and processing, it covers topics such as atomic florescence, phosphoresce, flame photometer analysis. This course also aims to develop student's understanding of working and principal of AAS and flow injection methods.*

Learning Outcomes:

By the end of this course, students will be able to:

- *explain the theoretical principles and important applications of classical analytical methods.*
- *understand the theoretical principles of selected instrumental methods within electroanalytical and spectrometric/spectrophotometric methods, and main components in such analytical instruments.*
- *explain the theoretical principles of various separation techniques in chromatography, and typical applications of chromatographic techniques.*
- *learn ion exchange and gel electrophoresis technique specially used in industry.*

Syllabus:

UNIT-I

Electrochemical Methods of Analysis: Electrochemical reduction and oxidation, electrode materials, cathode materials, Polarizable and non-polarizable electrodes. Theory of electrochemical oxidations and reductions possible path for electroreduction reactions, Conductometry and high frequency titrations.

(12 Lecture Hours)

UNIT- II

Refractometric and Interferometric: Principle of refractometric, parameters influencing refraction, significance of critical angle during measurement, refractometer, Qualitative and quantitative analysis
Interferometer: Principle and application.

(12 Lecture Hours)

UNIT- III

Chemiluminescence, Atomic fluorescence and ionization spectroscopy- luminescence, Chemiluminescence,

measurement of Chemiluminescence quantitative analysis thermoluminescence titrations, chemiluminescence of liquids, electro Chemiluminescence, Atomic fluorescence principle and applications instruments for atomic fluorescence, ionization spectroscopy, laser enhanced ionization spectroscopy.

(12 Lecture Hours)

UNIT-IV

Flame Photometry: Basic Principles, experimental techniques, schematic diagram and its applications in analytic work with special reference to alkali and alkaline earth metals Atomic Absorption Spectroscopy: Basic principles and applications.

(12 Lecture Hours)

UNIT – V

Flow Injection Analysis: Characteristics of physical parameters of a flow injection analysis system, Single line FIA spectrometric determination of chloride, three-line FIA spectrometric determination of phosphate.

(12 Lecture Hours)

E-resources:

1. https://nptel.ac.in/courses/111/106/111106066/
2. https://ocw.mit.edu/index.htm
3. https://epgp.inflibnet.ac.in/
4. https://nptel.ac.in/
5. https://archive.nptel.ac.in/
6. https://swayam.gov.in/
7. https://egyankosh.ac.in/bitstream/123456789/43285/1/Unit-7.pdf
   https://www.ipen.br/biblioteca/slr/cel/0151

Books Recommended:

1. Vogel's textbook of quantitative analysis, sixth edition, Pearson education.
2. Analytical chemistry, 7th edition by Skoog, West and Holler, Harcourt college publishers
3. Quantitative chemical Analysis, Eighth edition by Daniel C. Harris, Publish by Clany Marshall

SEMESTER III
DSE: CHE9106T
Advanced Bio-inorganic Chemistry

Code of the Course: CHE9106T

Title of the Course: Advanced Bio-inorganic Chemistry

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Students have studied Botany and Zoology subject as core paper in undergraduate course.*

Course Objectives: *This course provides an introduction to bioinorganic chemistry. It covers topics such as role of alkali/alkaline earth metals in bio-systems, transition metal ions in biosystem, metals in the regulation of biochemical events and metals in medicine. It also provides method of biological and abiological dinitrogen fixation, enzymes, nucleic acids, DNA and RNA.*

Learning Outcomes:

On completion of the course, students shall be able to-

- *understand the fundamental of bioinorganic chemistry and role of metal in biology.*
- *describe the role of metal ions in oxygen carriers and synthetic oxygen carriers.*
- *explain the environmental bioinorganic chemistry.*
- *describe the role of metal ions in replication and transcription process of nucleic acids.*
- *learn the role of metals in the regulation of biochemical events.*

Syllabus:

UNIT-I

Metal ions in Biological Systems: Classification of elements in human systems. Geo-chemical effects on life systems, concept of essentiality and evolution of essential elements. Distribution and biological role of essential trace and ultra-trace elements. Role of alkali/alkaline earth metals in bio-systems. Role of 3d block elements and non-metals in bio-systems. Effects of deficiency of essential trace elements in biological systems and its treatment.

(12 Lecture Hours)

UNIT –II

Role of metal ions in oxygen carriers and synthetic oxygen carriers. Designing of chelating agents and metal chelates as medicines. Fixation of dinitrogen biologically and abiologically, biotransformation of nonmetallic inorganic compounds.

(12 Lecture Hours)

UNIT-III

Environmental Bioinorganic Chemistry: Metal ions as probes for locating active sites. Anti- oxidants. Metal ions as antioxidants, metal ion enhancing catalytic activity of enzymes (Biocatalysts). Inhibitions as competitive and non-competitive metals and metalloproteins. Metal complexes of polynucleotides, nucleosides and nucleic acids (DNA & RNA) Template temperature, stability of DNA.

(12 Lecture Hours)

UNIT-IV

Role of metal ions in replication and transcription process of nucleic acids, Biochemistry of dioxygen, bioinorganic chips and biosensors. Biochemistry of calcium as hormonal messenger, muscle contraction blood clotting neurotransmitter, calcification reclaiming of barren land.

(12 Lecture Hours)

UNIT-V

Metals in the regulation of biochemical events, transport and storage of metal ions in vivo, Metal complexes as probes of structure and reactivity with metal substitution. Fundamentals of toxicity and detoxification, nuclear medicines.

(12 Lecture Hours)

E-resources:

1. https://nptel.ac.in/
2. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000670/M013990/ET/1455878156CHE_P15_M2_e-Text.pdf
3. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000670/M013991/ET/1455878224CHE_P15_M5_e-Text.pdf
4. https://library.ncifrederick.cancer.gov/discovery/fulldisplay?vid=01FREDERICK_INST%3A01FREDERICK&search_scope=MyInst_and_CI&tab=Everything&docid=alma991000020419706426&lang=en&context=L&adaptor=Local%20Search%20Engine&query=sub%2Cexact%2C%20Nucleosides
   https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000670/M014544/ET/1515748856CHE_P15_M6_e-Text.pdf
5. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000005CH/P000670/M014420/ET/1456913196CHE_P15_M1_e-Text.pdf

Books Recommended:

1. Supramolecular and Bioinorganic chemistry, Rekha Dashora and A. K. Goswami, Pragati Prakashan.
2. S. J. Lippard and J. M. Berg, Principle of Bioinorganic Chemistry, University Science Books (1994).
3. Kaim, W. and Schwederski (1994): Bioinorganic Chemistry: Inorganic perspective in the chemistry of Life, An Introduction and Guide, Wiley, Chichester.

SEMESTER-III
DSE: CHE9107T
Modern Interfaces of Organic Chemistry

Code of the Course: CHE9107T
Title of the Course: Modern Interfaces of Organic Chemistry
Level of the Course: NHEQF Level 6.5
Credit of the Course: 4
Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry
Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Basics of organic chemistry, reaction mechanism, common reactions of various functional groups.*
Course Objectives: *This course is designed to provide advanced knowledge and practical skills in the field of organic chemistry, focusing on name reactions, the disconnection approach, protecting groups, oxidation, reduction, reagents containing phosphorus, silicon, boron, phase transfer catalysts, polymer supported reagents, and the application of microwave and ultrasound in organic reactions. Students will explore the fundamental principles, mechanisms, and applications of these topics. The course will include theoretical lectures, laboratory experiments, and problem-solving exercises to enhance the understanding and application of the concepts covered.*
Learning Outcomes:
On the completion of this course students will be able to learn-

- *deep understanding of name reactions, disconnection approach, oxidation, reduction, and microwave/ultrasound-assisted reactions in organic chemistry.*
- *the use of transition metal based and other catalysts for different organic reactions.*
- *the use of reagents for different reaction transformations specially used in industrial applications.*
- *complex synthetic routes using the disconnection approach and appropriate reactions/strategies.*
- *application of phase transfer catalysts, polymer supported reagents, biocatalysts, microwave and ultrasound induced reactions.*
- *the outcome of oxidation and reduction reactions in organic chemistry.*
- *the advantages, limitations, and mechanisms of microwave-assisted and ultrasound-assisted organic reactions.*

Syllabus:

UNIT-I

Selective Organic Name Reactions: Hoffmann-Loffer-Fretag reaction, Chichibabin reaction, Sharpless asymmetric epoxidation, Barton reaction, Ene reaction, Stork enamine reaction, Aldol, Perkin, Stobbe and Dieckmann condensation, Michael addition, Mannich reaction, Sonagashira coupling, Heck reaction, Suzuki-Miyaura coupling, Stille coupling, Negishi reaction, Kumada coupling, Hiyama coupling, Ring closure metathesis.

(12 Lecture Hours)

UNIT-II

Disconnection Approach: Elementary idea of disconnection, an introduction to synthons, synthetic equivalents, functional group one and two group C-X and C-C disconnection. Interconversions, Chemoselectivity, Diels-alder reaction, 1,3- and 1,5-difunctionalised compounds, α, β-unsaturated carbonyl compounds, Michael reaction, Robinson annelation.
Protecting Groups: Principle of protection of hydroxy, amine and carbonyl groups.

(12 Lecture Hours)

UNIT-III

Oxidation: Introduction, different oxidative processes, hydrocarbons (alkenes, aromatic rings, activated and inactivated saturated C-H groups), alcohols, diols aldehydes, ketones, ketals and carboxylic acids, singlet oxygen, ruthenium tetroxide and Tl (III) nitrate as oxidizing agent, Provost reaction, Wacker's process, Barbier-Wieland degradation.

(12 Lecture Hours)

UNIT-IV

Reduction: Introduction, different reductive processes, hydrocarbons (cycloalkanes, alkenes, conjugated system, alkynes and aromatic rings), carbonyl compounds, nitro, azo and oxime compounds, hydrogenolysis, reductions using Wilkinson's catalyst, Meerwein-Pondrof-Verley reduction.

(12 Lecture Hours)

UNIT-V

Applications of phase transfer catalysts, polymer supported reagents, biocatalysts, microwave and ultrasound induced reactions in organic synthesis.

Reagents containing phosphorous, Silicon and Boron in organic synthesis: Preparation, properties, applications and mechanistic details.

(12 Lecture Hours)

E-resources:

1. https://www.youtube.com/watch?v=ZvT8XArTfn0
2. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004101314199439sangeeta_sriv_chem_Disconnection_Approach.pdf
3. https://snyder-group.uchicago.edu/downloads/Lectures2020/Protecting%20Groups.pdf
4. https://ethz.ch/content/dam/ethz/special-interest/chab/organic-chemistry/wennemers-dam/documents/Teaching_Peptide/Peptides%202.pdf
   https://chemistry.ucr.edu/sites/default/files/2019-10/Chapter17.pdf
5. https://personal.utdallas.edu/~scortes/ochem/OChem1_Lecture/Class_Materials/17_redox_states_carbon.pdf

Books Recommended:

1. Modern Synthetic Reactions, H.O. House, W.A Benjamin.
2. Some Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Principles of Organic Synthesis, R.O.C Norman and J.M. Coxon, Blackie Academic and Professional.
4. Advanced Organic Chemistry, F.A Carey and R.J. Sundberg.
5. The Disconnection Approach- An art of organic synthesis, Suresh Ameta and P. B. Punjabi, Sadguru Publications, Udaipur.
6. Organic Synthesis-Concept, Methods and Starting Materials, J. Fuhmop and G. Penzillin.
7. Guide Book to Organic Synthesis, R.K. Mackie and D.M. Smith, ELBS.
8. Organic Synthesis, V.K. Ahuwalia and Renu Agarwal, Narosa.
9. Synthesis Approaches in Organic Chemistry, R.K. Bansal, Narosa.
10. Advanced Organic Chemistry -Reactions, Mechanism and Structure, Jerry March, John Wiley.

SEMESTER-III
DSE: CHE9108T
Industrial Aspects of Chemistry

Code of the Course: CHE9108T
Title of the Course: Industrial Aspects of Chemistry
Level of the Course: NHEQF Level 6.5
Credit of the Course: 4
Type of the Course: Discipline Specific Elective (DSE) Course for Chemistry Discipline
Delivery type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).
Prerequisites*: Chemistry courses of organic and inorganic chemistry with basic formulation of fertilizer, cement and other industrial product.*
Course Objectives: *This course introduces the fertilizer chemistry, it covers topics such as fertilizer and its formulation with glass manufacturing, raw material of refractory and ceramics. This course also aims to develop student's understanding of industrial production of polymers, and cement industry.*
Learning Outcomes*:*
On the completion of this course students will be able to:

- *describe synthesis and knowledge about fertilizers, glass, ceramics, and cement. It helps to develop interpretation skills.*
- *describe synthesis of silicates and mineral resources and explosive.*
- *produce qualified trainees who can operate in the design, fabrication, and testing of chemicals*.

Syllabus:

UNIT-I

Fertilizers: Introduction, types and synthesis of nitrogenous/ ammonia-based fertilizers, phosphoric acid and phosphatic fertilizers.

(12 Lecture Hours)

UNIT-II

Glass, Ceramics and Refractory: Glass manufacture and different types of glasses, manufacture of fused, silica, safety and poetical glass, glass fibers, manufacture of ceramics and refractories, super refractories, insulating and pure oxide refractories, modern ceramics.

(12 Lecture Hours)

UNIT-III

Cement Industry: Types of cement manufacture of Portland cement, composition, setting and hardening of cement, mortars and concrete, gypsum, plaster of paris, proximate and ultimate analysis of cements.

(12 Lecture Hours)

UNIT-IV

Contemporary Polymers: Feldspar, Asbestos, Mica talc, pyrophylite and steatite, Zeolites, ultramarines.

(12 Lecture Hours)

UNIT-V

Polymer-Bonded Explosives: Classification, Characterization, preparation of nitrocellulose-TNT, Picric acids, Dynamite-cordrate and Gunpowder, dynamites, HMX, PETN, Cyclonite, plastic explosives, gelatin, RDX, Cordite and sesmic explosives, properpellants-manufacturing of liquid and solid properpellants-hydrazine, incendiaries and smoke screens and their industrial application.

(12 Lecture Hours)

E-resources:

1. https://epgp.inflibnet.ac.in/
2. https://nptel.ac.in/
3. https://extension.tennessee.edu/publications/documents/pb1637.pdf
4. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SCH1604.pdf

5. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000831ME/P001860/M030557/ET/15264736006_6_1_Glass_Text.pdf
6. https://egyankosh.ac.in/bitstream/123456789/31849/1/Unit-3.pdf

Book Recommended:

1. Clays, H. ReiCoal Conversion, E.J. Hoggman, The Energon Co., Lavamic Wyomnig,
2. Introduction of Petroleum Chemicals, H. Steiner, Pergamen
3. From Agrocarbon to Petrochemicals, L.F. Hatch & S. Matarm, Gulf Publishing Co., Houston.
4. Colten Cellutose: Its Chemistry & Technology, Hall
5. Modified Starches: Properties & Uses, Wurzburg,
6. Principles of Extractive Metallurgy, K.S. Ray and HK Gosh.
7. Clays, H. Reis, John Wileys & Unit Processes of Extractive Metallurgy, Pehike, Elsevier Industrial Chemistry, Reigel, Reinhold

SEMESTER-III
DSE: CHE9109T
Fundamentals of Analytical Chemistry

Code of the Course: CHE9109T

Title of the Course: Fundamental of Analytical Chemistry

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course*:* Discipline Specific Elective (DSE) Course for PG Chemistry

Delivery type of the Course*:* 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses with basic techniques of analytical chemistry.*

Course Objectives: *This course introduces the basic study of laboratory tools and their management, analytical data handling, calibration of instrument. It also covers topics such as environmental protection and monitoring sample of soil, water etc. This course also aims to develop student's understanding of sampling technique, handling of samples, labeling of sample.*

Learning Outcomes*:*

After completion of this course student will be able to-

- *explain the basics of laboratory tools, management and analytical data handling.*
- *perform the calibration of instrument.*
- *explain the topics of environmental protection and monitoring sample of soil, water etc.*
- *learn sampling techniques, preparation of analytical samples and labeling of sample.*

Syllabus:

UNIT-I

Basic Tools and Operations of Analytical Chemistry: Role of analytical chemistry, types of analysis, analysis methods, classical and instrumental, selecting an analytical method, laboratory operations and practices, Analytical balance, volumetric glass wares, calibration of glassware, sample dissolution and decomposition, selecting and handling of reagents, preparation of solution of analytic. Laboratory safety measurements.

(12 Lecture Hours)

UNIT-II

Data Handling in Analytical Chemistry: Accuracy and precision, central value and its measurement, errors, determinant and indeterminant errors. Standard derivation. Reporting analytical data, Statistical evaluation of data significant figure and it's rounding off. Test of significance, rejecting of a result Q-test.

(12 Lecture Hours)

UNIT-III

Use of Spreadsheets in Analytical Chemistry: Spreadsheets and their use, control charts, Statistics for small data sets, linear least square method, plotting right standard straight line, correction coefficient and coefficient of determination. Use of spreadsheet for plotting calibration, slops and intercepts and coefficient of determination LINSET for additional statics.

(12 Lecture Hours)

UNIT-IV

Environmental Sampling and Qualitative Analysis: Getting a meaningful sample, air sample collection and qualitative analysis, water sample collection and qualitative analysis, soil sample sediment sample. Sample preparation for trace organic contaminated land sites, EPA (Environmental protection agencies)-methods and performance-based analysis.

(12 Lecture Hours)

UNIT-V

Thermal Methods of Analysis- Thermometric titration, thermogravimetric analysis, Activation analysis.

(12 Lecture Hours)

E-resources:

1. https://epgp.inflibnet.ac.in/
2. https://nptel.ac.in/
3. https://resources.saylor.org/wwwresources/archived/site/wp-content/uploads/2012/07/Chapter211.pdf
4. https://www2.chemistry.msu.edu/courses/cem434/Granger%20Ch%2022.pdf
5. https://www.iitk.ac.in/che/pdf/resources/TGA-DSC-reading-material.pdf
6. https://egyankosh.ac.in/bitstream/123456789/82040/3/Unit-8.pdf

Books Recommended:

1. Analytical Chemistry by Gurdeep R. Chatwal, Himalaya Publishing House
2. Analytical chemistry, 6th edition by Gary D. Christian, Wiley student Edition.
3. Analytical Chemistry by S.M. Khopkar, New Age International
4. Instrumental Methods of analysis, 7th edition, CBS Publishers and distributors
5. Instrumental Methods of chemical analysis, 3rd edition by Galen W. Ewing, International student edition.
6. Principles and practice of Analytical chemistry by F.W. Fifield and D. kealey, Blackwell Publishing

SEMESTER-III
DSE: CHE9110P
Inorganic Chemistry Lab-II

Code of the Course: CHE9110P

Title of the Course: Inorganic Chemistry Lab-II

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry practical.

Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Quantitative analysis I (Minimum-5) **30 Marks**

a. Volumetric determination of two components (binary) mixture containing any two of the following;
   1. Copper and Zinc
   2. Tin and Lead
   3. Lead and Cadmium
   4. Tin and Cadmium
   5. Chromium and Iron
   6. Calcium and Magnesium, etc.

II. Volumetric determination of ores and alloys such as dolomite, pyrolusite, marble solder, brass, Zinc Sludge etc. **20 Marks**

III. Spectrophotometry II (minimum-4) **10 Marks**

1. Study of complex formation by Jobs, Mole ratio and slope ratio method
2. Stability constant by Bjerrum's method.
3. Stability constant by Turner-Anderson method

Separation of Nickel, Manganese, Cobalt, Cadmium, Zinc, Magnesium etc. using TLC and paper chromatography.

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

E-resources:

1. http://www.pca.ac.in/uploaded_files/M.Sc%20CH-I-1%20Practical%20Manual.pdf
2. https://egyankosh.ac.in/bitstream/123456789/15904/1/Experiment-16.pdf
3. https://www.youtube.com/watch?v=668HBVYP-8k
4. http://www.lscollege.ac.in/sites/default/files/e-content/msc%20I%20sem%2003.pdf
5. https://www.youtube.com/watch?v=RFHHqMbMyUY

Books Recommended:

1. Standard Methods of Chemical Analysis, F. J. Welcher.
2. A Text Book of Quantitative Inorganic Analysis (3rd Edition) – A. I. Vogel.

3. Handbook of Industrial Chemistry – Davis Burner • Association of Official Analytical Chemistry (AOAC) – 13th Edition 1980
4. Principle & practice of Analytical chemistry by F.U. Fifield and D. Keuley 3rd, Blackie and sons Ltd.

SEMESTER-III
DSE: CHE9111P
Organic Chemistry Lab-II

Code of the Course: CHE9111P

Title of the Course: Organic Chemistry Lab-II

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry Practical

Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Separation of Ternary Mixture (Minimum-6) **30 Marks**

Separation, Purification and identification of compounds in a ternary mixture of three organic compounds (three solids or two solids-one liquid), Separation by H_2O, ether, $NaHCO_3$, dil. NaOH, Preparation of their suitable derivatives.

II. Organic Synthesis (Minimum-3) **15 Marks**

1. The exercise should illustrate the use of organic reagents and may involve purification of the products by chromatographic technique.

2. Photochemical Reaction: Benzophenone- Benzpinacol- Benzpinacolone
3. Beckmann Rearrangement
   a) Benzopheone- Benzophenone oxime- Benzanilide- Benzoic Acid
   b) Acetophenone-Acetophenone oxime-Acetanilide- (p-Nitroacetanilide or p-Bromoacetanilide)

4.Hoffmann and Sandmeyer Reaction
   a) Phthalic anhydride- Phthalimide- Anthranilic acid- o-Chlorobenzoic acid
   b) Benzillic Acid Rearrangement Benzoin- Benzil- Benzilic Acid

III. Spectrophotometric Estimation **15 Marks**

1. Amino Acids
2. Proteins
3. Carbohydrates

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

Virtual Labs:

1. https://fac.ksu.edu.sa/sites/default/files/vogel-practicalorganicchemistry_longmans-3rdedrevised-1957_.pdf
2. https://www.cs.gordon.edu/courses/organic/salem/photochem.html
3. http://assets.vmou.ac.in/MSCCH10.pdf
4. https://www.youtube.com/watch?v=d4JeKxZhYQs
5. https://www.slideserve.com/said/spectrophotometric-methods-for-determination-of-proteins-concentration
6. https://slideplayer.com/slide/3286796/

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry by B.S. Furniss, Pearson.

2. Practical Organic Chemistry by J.T. Sharp, Springer.
3. Advanced Practical Organic Chemistry, O.P. Agarwal, Krishna Publications.
4. Advanced Practical Organic Chemistry, N.K. Vishnoi, Vikas Publishing House.

SEMESTER III
DSE: CHE 9112P
Industrial Chemistry Lab

Code of the Course: CHE9112P

Title of the Course: Industrial Chemistry Lab

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry Practical

Delivery type of the Course*:* 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Quantitative Analysis: **30 Marks**

1. Ultimate and proximate analyses of cement.
2. Spectrophotometric estimation of Chromium in synthetic sample.
3. Spectrophotometric estimation of Iron in synthetic sample.
4. Calculate the percentage of 'Mg' in a sample of Talcum Powder by complexometrically titration with EDTA

II. Petrochemical Analysis: **15 Marks**

1. Determination of viscosity of mineral oil / Lubricating oil.
2. Analysis of flash point and Aniline point of mineral oil / Lubricating oil.

III. Synthesis of Industrial Products: **15 Marks**

1. Preparation of potash alum and find out the percentage of aluminum in the alum.
2. Synthesis of Bakelite resin
3. Synthesis of urea-formaldehyde resin

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

Virtual Labs:

1. https://www.vssut.ac.in/images/chemical-lab/laboratory-pdf/Fuel-Technology-2-Lab-manual.pdfirtual
2. https://www.youtube.com/watch?v=bhoMvPJKc24
3. https://www.youtube.com/watch?v=IZZQ35cWHNw
4. https://www.youtube.com/watch?v=UC79jXxzq8s

Books Recommended:

1. Industrial Chemistry by Dr. G. S. Gugale, Dr. A. V. Nagawade, Dr. R. A. Dr. R. A. Pawar, Dr. K. M. Gadave from Nirali Prakashan.
2. A Text Book of Industrial Chemistry by Melaku Masresha Woldeamanuel
3. A text book of Industrial Chemistry by Loutfy H. Madkour, Helen Njenga

SEMESTER-III
DSE: CHE 9113P
Analytical Chemistry Lab - I

Code of the Course: CHE9113P

Title of the Course: Analytical Chemistry Lab - I

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry Practical.

Delivery type of the Course*:* 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Instrumental Analysis: 30 Marks

1. Estimation of Ca, Na and K by Flame photometry
2. Separation of amino acids by ion exchange and chromatographic method
3. Polarimetric estimation of sugar
4. Analysis of German silver (copper, zinc and nickel)

II. Volumetric Analysis: 15 Marks

1. Analysis of oils and fats and determine saponification value and iodine values
2. Analysis of HCl extract of fusion with Na_2CO_3 for Al, Fe, Ca, Mg, P and K
3. Analysis of fertilizers

III. Gravimetric Analysis: 15 Marks

1. Determination of fats, protein and solid in milk
2. Estimation of lead and tin in solder or bismuth, cadmium and lead in low melting alloys such as woods metal using EDTA

IV. Viva-voce 10 Marks

V. Evaluation of record book of experiments performed in semester 10 Marks

Virtual Labs:

1. https://www.liverpool.ac.uk/~agmclen/Medpracs/practical_2/practical_2.pdf
2. https://jru.edu.in/studentcorner/lab-manual/bpharm/7th-sem/INSTRUMENTAL%20METHODS%20OF%20ANALYSIS.pdf
3. https://labmonk.com/determination-of-saponification-value-of-the-given-oil-fat
4. https://egyankosh.ac.in/bitstream/123456789/15901/1/Experiment-14.pdf
5. https://egyankosh.ac.in/bitstream/123456789/9654/1/Experiment-4.pdf

Books Recommended:

1. Experiments in chemistry by D.V. Jahagirdar, Himalaya Publishing House
2. Instrumental Methods of Chemical Analysis B. K. Sharma
3. Analytical chemistry, 6th edition by Gary D. Christian, Wiley student Edition.
4. Analytical Chemistry by S.M. Khopkar, New Age International

SEMESTER-III
GEC: CHE9114P
Inorganic Chemistry and Spectral Problems

Code of the Course: CHE9114P

Title of the Course: Inorganic Chemistry and Spectral Problems

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Generic Elective Course (GEC) for PG Chemistry Practical.

Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Inorganic preparation (Minimum -8) **20 Marks**

1. $Na[Cr(NH_3)_2(SCN)_4]$
2. $Mn(acac)_3$
3. $K_3[Fe(C_2O_4)_3]$
4. Prussian Blue, Turnbull's Blue.
5. $Co[(NH_3)_6][NO_2]_6$
6. $Cis\text{-}[Co(trien)(NO_2)_2]Cl.H_2O$
7. $Hg[Co(SCN)_4]$
8. $[Co(Py)_2Cl_2]$
9. $[Ni(NH_3)_6]Cl_2$
10. $Ni\ (DMG)_2$
11. $[Cu(NH_3)_4]SO_4.H_2O$
12. $VO(acac)_2\ TiO(C_9H_8NO)_2.2H_2O$
13. $Cis\text{-}K[Cr(C_2O_4)2(H_2O)_2]$

II. Spectral problems (Minimum-10) **20 Marks**

Identification of organic and inorganic compounds by the analysis of their spectral data (UV, NMR, IR and Mass spectral analysis.

III. Titrimetric estimation of drugs (Minimum-3) **20 Marks**

Paracetamol, Ascorbic acid, Aspirin, Sulpha drugs, Benzocaine etc.

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

Virtual Labs:

2. https://www.youtube.com/watch?v=myrqhi0zXLk
3. https://www.youtube.com/watch?v=L53Kqm1nDFc
4. https://www.youtube.com/watch?v=iYc07c33S6Y
5. https://www.lehigh.edu/~kjs0/carey-13.PDF

Books Recommended:

1. A Practical Book of Pharmaceutical Inorganic Chemistry, Ketan B. Patil, Narendra B. Patil, Paresh A. Patil, IP, innovative publication Pvt. Ltd
2. Practical Inorganic Chemistry: Preparations, reactions and instrumental methods, G. Pass, H. Sutcliffe, Springer; 2nd edition.
3. Structure Determination of Organic Compounds, Erno Pretsch, Philippe Buhlmann, Martin

Badertscher, Fourth, Revised and Enlarged Fourth Edition, Springer (2009)

4. A Practical Book on Pharmaceutical Analysis, Dr. Suresh M. Jain, Dr. Vandana B. Patel, Nirali prakashan (2018).

SEMESTER-III
GEC: CHE9115P
Mechanical Properties and Testing of Rubbers

Code of the Course: CHE9115P

Title of the Course: Mechanical Properties and Testing of Rubbers

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Generic Elective Course (GEC) for PG Chemistry Practical.

Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/class activity and problem solving).

Syllabus: (any two) **30 * 2 Marks**

1. Mechanical testing and Processing of Polymers
2. Tensile impact strength of polymers
3. MFI of thermoplastics
4. Abrasion loss, Abrasion index of rubber Vulcanisate
5. Swell index and volume fraction of cured rubber stock
6. Stress –strain properties of organic Tyre cord
7. Textile to rubber adhesion by H- adhesion technique
8. Testing and characterization of polymer : volatile matter, ash content, mooney viscosity

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

Virtual Labs:

1. https://worldwidescience.org/topicpages/s/styrene-butadiene+rubber+sbr.html
2. https://www.youtube.com/watch?v=YL91SZEU-y4
3. http://www.issp.ac.ru/ebooks/books/open/Abrasion_Resistance_of_Materials.pdf

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry by B.S. Furniss, Pearson.
2. Practical Organic Chemistry by J.T. Sharp, Springer.
3. Advanced Practical Organic Chemistry, O.P. Agarwal, Krishna Publications.
4. Advanced Practical Organic Chemistry, N.K. Vishnoi, Vikas Publishing House

SEMESTER-IV
DCC: CHE9013T
Special Methods of Analysis

Code of the Course: CHE9013T

Title of the Course: Special Methods of Analysis

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for PG Chemistry

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of basic analytical techniques, chromatography and radioactivity.*

Course Objectives: *This course introduces the various analytical techniques, like TGA, DSC, DTA, polarography, voltammetry and amperometry. This course also aims to develop student's understanding of methods of chromatographic separations, radioactive and light scattering techniques.*

Learning Outcomes:

On the completion of this course students will able to learn-

- *theoretical principles and important applications of classical analytical methods.*
- *theoretical principles of selected instrumental methods within electroanalytical and spectrometric/spectrophotometric methods, and main components in such analytical instruments.*
- *theoretical principles of various separation techniques in chromatography, and typical applications of chromatographic techniques.*
- *ion exchange and gel electrophoresis technique specially used in industry.*
- *radioactive technique and light scattering techniques.*

Syllabus:

UNIT-I

Thermogravimetric Analysis (TGA): Thermogravimetry introduction, principle, instrumentation and application, factors affecting TG curves.
Differential Thermal Analysis (DTA): Principle, instrumentation and application, factors affecting DTA curves
Differential Scanning Calorimeter (DSC): Principle, instrumentation and application, factors affecting DC curves, comparison with DTA.

(12 Lecture Hours)

UNIT-II

DC Polarography: Basic principle, types of currents, experimental technique, Illovic equation (no derivation) and application of polarography. Principle, technique and application of voltammetry, cyclic voltammetry, amperometry, and anodic stripping voltammetry.

(12 Lecture Hours)

UNIT-III

High Performance Liquid Chromatography (HPLC): Introductory knowledge of adsorption basic principle, instrumentation and applications of HPLC, comparison with gas liquid chromatography.
Gas Liquid Chromatography: Principle, instrumentation and applications.
Gel Permeation or Size Exclusion Chromatography: Introduction, theory and applications.

(12 Lecture Hours)

UNIT-IV

Ion Exchange: Introduction, types-cationic, anionic, chelating and liquid ion exchangers, preparation, action and properties of exchangers and applications of ion exchangers.
Gel Electrophoresis: Introduction, factors affecting ionic migration, detection of separated components and applications of gel electrophoresis, solvent extraction, ion association complexes.

(12 Lecture Hours)

UNIT-V

Radioactive Technique: Tracer technique, neutron activation analysis, counting technique such Geiger-Muller, ionization and proportional counters.
Light Scattering Techniques: Principle, instrumentation and applications of nephelometry and Raman spectroscopy.

(12 Lecture Hours)

E-resources:

1. https://www.google.co.in/books/edition/Introduction_to_Thermal_Analysis/DpfeBwAAQBAJ?hl=en&gbpv=1&dq=Thermogravimetric+Analysis+(TGA):+free&printsec=frontcover&bshm=rimc/1
2. https://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000014ER/P000272/M027510/ET/1519203786paper2_Module27_etext.pdf
3. https://faculty.ksu.edu.sa/sites/default/files/introduction_to_modern_liquid_chromatography.pdf
4. https://rnlkwc.ac.in/pdf/study-material/physiology/ion%20exchange,molecular%20sieve,affinity.pdf
5. https://microbenotes.com/gel-electrophoresis-system-apparatus-parts-types-examples/#applications-of-electrophoresis
6. https://thebiotechnotes.com/2019/03/19/detection-and-measurement-of-radioactivity-geiger-muller-counter-and-more/
7. https://youtu.be/Z-d4NecOTX8?si=SuhYTf9GUNMalHGd
8. https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Physical_Methods_in_Chemistry_and_Nano_Science_(Barron)/04%3A_Chemical_Speciation/4.03%3A_Raman_Spectroscopy

Books Recommended:

1. Ion exchange separations in analytical chemistry. O. Samuelson, John Wiley.
2. Exchangers and solvent extractions, J.A. Marinsky and Y. Parcus, Marcel Dekker.
3. Polagraphic techniques, I. Metes, Interscience.
4. Gel chromatography, Tibor Kremmer and Laszol Boross, Wiley.

SEMESTER-IV
DSE: CHE9116T
Bioinorganic, Bioorganic and Biophysical Chemistry

Code of the Course: CHE9116T

Title of the Course: Bioinorganic, Bioorganic and Biophysical Chemistry

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry.

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Basic knowledge of chemistry, biology, and biochemistry is required to understand the concepts covered in this course, including photosynthesis, enzymology and cellular processes.*

Course Objectives*: This course aims to provide students with a comprehensive understanding of various topics in biochemistry, including the role of metal ions in biological systems, the functions of photosynthetic pigments, the transport and storage of dioxygen, enzyme mechanisms and actions, coenzyme chemistry, bioenergetics, and the transport of ions across cell membranes.*

Learning Outcomes:

On the completion of this course, students would learn-

- *the role of metal ions in biological systems and their impact on protein structure and function.*
- *the functions of photosynthetic pigments and their role in capturing and converting light energy during photosynthesis.*
- *the mechanisms of dioxygen transport and storage in biological systems, as well as its regulation and impact on physiological processes.*
- *enzyme mechanisms and the factors that influence enzyme activity, including the role of coenzymes.*
- *the principles of bioenergetics to understand energy transformation and utilization in biological systems.*
- *the structure and function of cell membranes and the mechanisms of ion transport across membranes.*

Syllabus:

UNIT-I

Metal Ions in Biological Systems: Essential and trace metals, Na/K^+ pump, role of metals ions in biological processes.
Electron Transfer in Biological Systems: Structure and functions of electron transfer proteins: cytochromes and iron Sulphur proteins.
Photosynthetic Pigments: Photosynthesis, chlorophyll molecule, photosystem-I and photosystem-II.

(12 Lecture Hours)

UNIT-II

Transport and Storage of Dioxygen: Heme proteins and oxygen uptake, structure and function of hemoglobin and myoglobin.
Nonheme Dioxygen Carrier: Structure and function of hemocyanin and hemerythrin, model synthetic complexes of iron, cobalt and copper.

(12 Lecture Hours)

UNIT-III

Enzyme and Mechanism of Enzyme Action: Introduction of enzymes, enzyme action, transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion, examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase-A.

(12 Lecture Hours)

UNIT-IV

Co-enzyme Chemistry: Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes, structure and biological functions of coenzyme-A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+, $NADP^+$, FMN, FAD, lipoic acid, vitamin B-12, mechanisms of reactions catalyzed by the above cofactors.

(12 Lecture Hours)

UNIT-V

Bioenergetics: Standard free energy change in biochemical reactions, exergonic, endergonic, hydrolysis of ATP, synthesis of ATP from ADP, muscular contraction and energy generation in mechanochemical system.
Cell Membrane and Transport of Ions: Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport, nerve conduction.

(12 Lecture Hours)

E-resources:

1. https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Book3A_Bioinorganic_Chemistry_(Bertini_et_al.)
2. https://youtu.be/nJTkPyIhC-k?si=TueArF97j9XiI6om
3. https://ds.amu.edu.et/xmlui/bitstream/handle/123456789/14159/Introduction%20To%20Enzyme%20And%20Coenzyme%20Chemistry%20-%20303%20pages.pdf?sequence=1&isAllowed=y
4. https://www.chem.uwec.edu/chem406_f06/pages/lecture_notes/lect05/lehninger-ch13_small.pdf
5. https://youtu.be/CkXt5kdjaK4?si=gh1guS-frooM2yJv

Books Recommended:

1. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
2. Understanding Enzymes, Trevor Palmer, Prentice Hall.
3. Enzyme Chemistry: Impact and Applications, Ed. Collin J Suckling, Chapman and Hall.
4. Enzyme Mechanisms Ed, M. I. Page and A. Williams, Royal Society of Chemistry.
5. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
6. Immobilized Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan,Wiley.
7. Enzymatic Reaction Mechanisms, C. Walsh, W. H. Freeman.
8. Enzyme Structure and Mechanism, A. Fersht, W.H. Freeman.
9. Biochemistry: The Chemical Reactions of Living Cells, D. E. Metzler, Academic Press.
10. Principles of Biochemistry, A. L. Lehninger, Worth Publishers.
11. Biochemistry, L. Stryer, W.H. Freeman.
12. Biochemistry, J. David Rawn, Neil Patterson.
13. Biochemistry, Voet and Voet, John Wiley.
14. Supramolecular and Bioinorganic Chemistry, Rekha Dashora and A. K. Goswami, Pragati Prakashan.
15. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
16. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.

SEMESTER-IV
DSE: CHE9117T
Specialty Polymers

Code of the Course: CHE9117T

Title of the Course: Specialty Polymers

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Chemistry Discipline

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of undergraduate level or equivalent.*

Course Objectives: *This course provides an introduction and classification of polymers, fire resistant polymers, electrical and electrometric properties of polymers, ionic polymers, biopolymers and their application, structure and characteristics of natural polymer and industrial manufacturing.*

Learning Outcomes:

By the end of this course, students would learn-

- *basics of polymer chemistry.*
- *fire resistant polymer, electrical and electrometric properties of polymers.*
- *ionic polymers, biopolymers, natural polymers, and their properties.*
- *various types of inorganic polymer.*
- *industrial manufacturing and properties of polymers.*

Syllabus:

UNIT-I

Introduction and Classification of Polymers: Introduction, natural polymers-carbohydrate, proteins, semi-synthetic polymers, hydrogel, polyacrylamides, hydrophilic polymers, polyvinyl alcohol, polyvinyl pyrrolidone.

Analysis of Polymer: chemical, mechanical, rheological, morphological, and thermal characterization techniques.

(12 Lecture Hours)

UNIT-II

Fire Resistant Polymer: Introduction, polymers for high temperature resistance, fluropolymer, aromatic polymers, hydrocarbon polymers, polyethers, polyphenyl sulphide, polysulphones, polyesters, polyamides, polyketones, heterocyclic polymers.

(12 Lecture Hours)

Electrical and Electrometric Properties of Polymers: Introduction, conducting polymers [definition, inherently conducting polymer: polyacetylene, polydiacetylene, polyaniline, poly (p-phenylene sulphide), photo-conducting polymers], photo-conducting polymer, polymers with piezoelectric and ferroelectrics properties, and photo-resistance properties of semiconductor fabrication.

(12 Lecture Hours)

UNIT-III

Ionic Polymers: Introduction, classification, synthesis, physical properties and application, ionomers based on polyethylene, polystyrene, ionomers with polyaromatic backbones, polyelectrolyte, polyelectrolyte complexes.

Biopolymers and Their Application: Introduction, definition, classification, advantages and disadvantages, applications of biopolymers in: 1) Drug delivery system, 2) Disposable in Health Care, 3) Packaging, 4) Medication.

Structure and Characteristics of Natural Polymer: Polypeptides, proteins, nucleic acid-based polymers, poly lactic acid, PHBV, carbohydrates.

(12 Lecture Hours)

UNIT-IV

Inorganic Polymer: Introduction, inorganic reaction mechanism, condensation organ metallic, polymers, addition polymers, coordination polymers, sol-gel, portland cement, silicates, silicon dioxide, asbestos, diamond, graphical polymers, polysulphur.

(12 Lecture Hours)

UNIT-V

Industrial Manufacturing and Properties of Polymers: Polyethylene, polyimides, polypropylene, polyacrylanitriles, polystyrene, polyvinyl alcohol, polymethyl methacrylate, polyvinyl acetate, polyvinyl chloride, epoxy resins, phenol formaldehyde resin, polyurethanes, urea formaldehyde resin, polyesters, melamine formaldehyde, polycarbonates, melamine, formaldehyde resin, and polyamides.

(12 Lecture Hours)

E-resources:

1. https://aits-tpt.edu.in/wp-content/uploads/2018/08/UNIT-II-Polymers.pdf
2. https://www.unpa.edu.mx/~aramirez/caracterizacion%20de%20polimeros.pdf
3. https://gptcadoor.org/assets/downloads/moxc3wy305pqi6s.pdf
4. https://www.intechopen.com/chapters/53915
5. https://www.vssut.ac.in/lecture_notes/lecture1541230922.pdf
6. http://www.vpscience.org/materials/Unit-IV%20Inorganic%20Polymers%20(Sem-V).pdf
7. https://www.britannica.com/science/industrial-polymer

Books Recommended:

1. Polymer science: V. R. Goowarikar, N. V. Viswanathan, Jayadev Sridhar.
2. Text book of polymer science: Fred W. Billmeyer.
3. Polymer science & Technology: Joel R. Fried.
4. Polymer Science and Technology: Premamoy Ghosh.
5. Specialty polymers: R.W. Dyson.

SEMESTER-IV
DSE: CHE9118T
Modern Aspects of Inorganic Chemistry

Code of the Course: CHE9118T

Title of the Course: Modern Aspects of Inorganic Chemistry

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of under graduate or equivalent with basic inorganic chemistry, solid state and photochemistry.*

Course Objectives: *This course provides an introduction to the isomerism in coordination compounds. It covers topics such as magnetochemistry, photochemical reactions of metal complexes. This course also aims to develop student's understanding of the solid-state chemistry and chemistry of smart materials such as ceramics, alloys, gels and polymers.*

Learning Outcomes:

After studying this paper, students would learn-

- *stereochemistry and isomerism of coordination compounds.*
- *types of magnetic materials and magnetic properties of coordination compounds.*
- *photochemical reactions in coordination compounds of chromium (III), cobalt (III), iron(III) and Ir(III) complexes.*
- *solid state chemistry, defects in solids and their properties.*
- *chemistry of smart materials like; ceramics, alloys, gels, polymers.*

Syllabus:

UNIT-I

Isomerism of Coordination Compounds: Isomerism's and stereochemistry, classification of isomers. Study of constitutional and configurational isomerism. optical activity of coordination compounds, symmetry requirements for optical activity, study of ORD, circular dichroism, cotton effect with special reference to complexes of Cr, Co, Ni and Pt.

(12 Lecture Hours)

UNIT-II

Magnetochemistry: Magnetic substances, origin, classification, magnetic susceptibility and basic derivation of diamagnetic susceptibility, pascal constant and its utility, temperature dependence of magnetic susceptibility, Curie's Law and Curie-Weiss Law, anti-ferromagnetism and ferromagnetism. Types of anti-ferromagnetism, anti-ferro magnetic exchange pathway: direct-metal-metal interaction and indirect-atom exchange *i.e*. super exchange mechanism.

(12 Lecture Hours)

UNIT-III

Inorganic Photochemistry: Absorption, excitation, photochemical laws, quantum yield, Frank-Condon principle. Absorption of light and formation of excited states, ligand field excited state, charge transfer excited state, ligand to metal, metal to ligand, charge transfer to solvent, tetra ligand state, metal to metal state, THEXI state and DOSENCO state. Photo-substitution reactions, photo-redox reactions, photo-rearrangement reaction, prompt and delayed photochemical reactions transition metal complexes, photolysis rules and ligand field theory. Photochemical reactions of chromium (III), Cobalt (III), Iron (III) and Ir (III) complexes.

(12 Lecture Hours)

UNIT-IV

Solid-state Chemistry: Molecular orbital theory of solids, electrical properties, insulators and semiconductors, super conductors, Schottky and Frenkel defects, intermetallic, interstitial and non-stoichiometric compounds, defects and non-stoichiometry, electrical conductivity, spinel structure, perovskite and related phases chervrel phases, atom and ion diffusion, mechanism of diffusion.

(12 Lecture Hours)

UNIT-V

Smart Materials: General definition of smart materials and smart systems, ceramics, alloys, gels and polymers. Photochromic, piezochromic, electrochromic, piezoelectric, pyroelectric, thermo-/photo-actuating materials, shape memory material, polymorphic solids, self-healing materials, pH responsive materials, superhydrophobic materials and smart gels.

(12 Lecture Hours)

E-resources:

1. https://www.youtube.com/watch?v=s1Q9Pn5OCT8
2. https://is.muni.cz/el/1431/jaro2017/C4010/um/C4010_6_magnetochem.pdf
3. https://www.usb.ac.ir/FileStaff/5269_2018-9-18-10-21-39.pdf
4. https://www.uobabylon.edu.iq/eprints/publication_10_10256_250.pdf
5. https://www.tce.edu/sites/default/files/PDF/RV4-Smart-Materials.pdf

Books Recommended:

1. Principle and Applications of Organotransition Metal Chemsitry, J.P. Coliman, L.S Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
2. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.
3. Metallo-Organic Chemistry, A.J. Pearson, Wiley.
4. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
5. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lipparad and J.S Valentine, University, Science Books.
6. Inorganic Biochemistry Volume I and II. Ed G.L. Eichhorn, Elsevier.
7. Progress in Inorganic Chemistry, Volume 18 and 38 Ed. J.J. Lipparad, Wiley.

SEMESTER-IV
DSE: CHE9119T
Chemistry of Natural Products

Code of the Course: CHE9119T

Title of the Course: Chemistry of Natural Products

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Basics of organic chemistry, medicinal chemistry, biochemistry, and pharmacology learnt at undergraduate level.*

Course Objectives: *The main aim is to provide students with a basic understanding and knowledge of the chemistry of natural products of medicinal importance. It also aims to understand the different methods that are used in natural products chemistry, including extraction, isolation, and structural elucidation.*

Learning Outcomes:

After studying this paper, students would learn to-

- *identify and characterize various classes of natural products by their structure and biosynthesis of the various classes of natural products.*
- *draw structural and molecular formula of natural products.*
- *recognize the structure of terpenes, steroids, alkaloids, flavonoids.*
- *analyze and discuss the Information and data related to the various classes of natural products.*
- *use of natural products in the biological process.*

Syllabus:

UNIT-I

Terpenoids and Carotenoids: Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule, structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules-citral, geraniol, α-terpineol, menthol, farnesol, zingiberene, santonin, phytol, abietic acid and β-carotene.

(12 Lecture Hours)

UNIT-II

Alkaloids: Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants, structure, stereochemistry, synthesis and biosynthesis of following-ephedrine, (+)-coniine, nicotine, atropine, quinine and morphine.

(12 Lecture Hours)

UNIT-III

Plant Pigments: Occurrence, nomenclature and general methods of structure determination, isolation and synthesis of apigenin, luteolin, quercetin, myrcetin, quercetin-3-glucoside, vitexin, diadzein, butein,

aureusin, cyanidin-7, arabinoside, cyanidin and hirsutidin.
Biosynthesis of Flavonoids: acetate pathway and shikimic acid pathways.
Porphyrins: Structure and synthesis of hemoglobin and chlorophyll.

(12 Lecture Hours)

UNIT-IV

Steroids: Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry, isolation, structure determination and synthesis of cholesterol, bile acids, androsterone, testosterone, estrone, progestrone, aldosterone, biosynthesis of steroids.

(12 Lecture Hours)

UNIT-V

Prostaglandins: Occurrence, nomenclature, classification, biogenesis and physiological effects, synthesis of PGE_2 and $PGF_{2\alpha}$.
Pyrethroids and Rotenones: Synthesis and reactions of pyrethroids and rotenones.

(12 Lecture Hours)

E-resources:

1. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/unit-1.pdf
2. https://www.intechopen.com/chapters/66742
3. https://talcottlab.tamu.edu/wp-content/uploads/sites/108/2019/01/Natural-Colors.pdf
4. https://www.life.illinois.edu/govindjee/photosynBook/Chapter9.pdf
5. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/downloads/Steroids.pdf
6. https://www.epa.gov/sites/default/files/documents/rmpp_6thed_ch4_pyrethrinspyrethroids.pdf

Books Recommended:

1. New Trends in Natural Products Chemistry, Atta-ur-Rahman and M.I. Choudhary.
2. Chemistry of Natural Products, S.N. Bhat.
3. Organic Chemistry Vol.-II, I.L. Finar.

SEMESTER-IV
DSE: CHE9120T
Agro-Based Chemicals

Code of the Course: CHE9120T

Title of the Course: Agro-Based Chemicals

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of under graduate or equivalent with basic knowledge of paper, soap, fermentation, pesticides and food and dairy products.*

Course Objectives: *This course enriches the student to work in paper, pesticide, food and dairy industries. It's also equipped the student with knowledge of fermentation and various perfumes.*

Learning Outcomes:

On the completion of this course, students would learn-

- *synthesis and knowledge of paper and pulp industries, fermentation industry and surfactants.*
- *synthesis of pesticides, food and diary chemistry, oil/fats/wax/soaps. It helps to develop interpretation skills.*
- *various surfactants and role of detergents in washing process.*
- *the use of pesticides pesticide formulations in proper way and can guide the farmers in the field*
- *to operate the design, fabrication, and testing of chemicals in food, paper, pesticide industries.*

Syllabus:

UNIT-I

Paper and Pulp Industries: Manufacture of pulp, mechanical and chemical pulping, manufacturing of paper.

Oil/fats/Wax/Soaps: Fatty acids and triglycerides, saturated and unsaturated fats, hydrogenation, polymerization, rancidity of oils, fat analysis, butter, margarine and mayonnaise, waxes: their types and applications, soap and soap manufacture, hard and soft soaps, disadvantages of soaps over synthetic detergents.

(12 Lecture Hours)

UNIT-II

Fermentation Industry: Anaerobic and aerobic fermentation production of antibiotics acids (lysine, glutamic acid), alcohol, acetone, butanol, lactic acid, citric acid, vitamins and enzymes, brewing industry.

Perfumes: Introduction of perfumes and perfumery chemicals, theory of olfaction and mechanism, classification of perfumes, essential oils and their isolation, some important terpenes and esters, flavors, synthesis of civetone and muskone, relation between perfumes and pheromones.

(12 Lecture Hours)

UNIT-III

Surfactants: Classification with example, adsorption micelle formation, manufacture of anionic, cationic, zwitterionic and nonionic detergents, applications in industries. Application as foaming agent, wetting

agents, dispersant, solublizers, emulsifiers and rheology modifiers, detergents formulations, detergents, biodegradation, biosurfactants**.**

(12 Lecture Hours)

UNIT-IV

Pesticides: Introduction, classification, synthesis of few common pesticides of chlorinated (DDT, BHC, chlordane, aldrin), organophosphorus and carbamate (parathion, malathion, carbaryl) compounds family, Plant Pesticides, pesticide formulations.

(12 Lecture Hours)

UNIT-V

Food and Dairy Chemistry: Composition and chemistry of cream, butter, ghee, ice-cream, cheese, condensed and dried milk, infant food, spoilage of ghee and use of antioxidant, chemistry of milk fermentation, chemistry of rennin coagulation of milk and changes occurring during ripening of cheese, physicochemical changes in manufacture and storage of milk powder lactose, crystallization and its significance, physicochemical changes during the manufacture of indigenous milk product, quality standard of dairy product.

(12 Lecture Hours)

E-resources:

1. https://www.kngac.ac.in/elearningportal/ec/admin/contents/2_18KP2CHELCH2_2021012801374329.pdf
2. https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Organic_Chemistry_(Morsch_et_al.)/27%3A_Biomolecules__Lipids/27.01%3A_Waxes_Fats_and_Oils#:~:text=The%20hydrolysis%20of%20fats%20and,)%20and%20200%C2%B0C%5D.
3. http://www.scientificspectator.com/documents/book%20service/Guttenberg%20Books/Perfumes%20And%20Their%20Preparation.pdf
4. https://colloidmueg.weebly.com/uploads/2/5/7/3/25736627/puu0_3110_surfactants_types_and_uses.pdf
5. https://kvk.icar.gov.in/API/Content/Uploads/3907c7d6-4610-42f8-894bacc69468027d/3907c7d6-4610-42f8-894b-acc69468027dbrochure.pdf
6. http://ecoursesonline.iasri.res.in/course/view.php?id=89

Books Recommended:

1. Pulp and Paper Industry: Chemicals, Pratima Bajpai, Elsevier Science Publishing Co Inc; Illustrated edition (2015).
2. The Complete Technology Book on Pulp & Paper Industries, NIIR Board of Consultants and Engineers, Asia pacific business press inc., (2004).
3. Animal and Vegetable Fixed Oils, Fats, Butters, and Waxes: Their Preparation and Properties, and the Manufacture Therefrom of Candles, Soaps, and Othe, Charles Romley Alder Wright (Author), Publisher: Nabu Press (2013).
4. Principles of Fermentation Technology, A. Whitaker, Publisher: Butterworth-Heinemann; 2nd edition (1998).
5. Hand Book of Perfumes with Formulations, 2nd Edition, Publisher: Engineers India Research Institute (2008).
6. Surfactants in Chemical/Process Engineering (Surfactant Science Book 28) 1st Edition, Kindle Edition, Darsh T. Wasan, Martin E. Ginn, Dinesh O. Shah, Publisher: Routledge; 1st edition (2017).
7. The Complete Technology Book on Pesticides, Insecticides, Fungicides and Herbicides with Formulae & Processes, H. Panda, Publisher: National institute of industrial Research (2003).
8. Food Chemistry Hardcover - Illustrated, H.-D. Belitz, Werner Grosch, Peter Schieberle, Publisher: Springer; 4th revised and extended ed. (2009).

SEMESTER-IV
DSE: CHE9121T
Analytical Techniques

Code of the Course: CHE9121T

Title of the Course: Analytical Techniques

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course*:* Discipline Specific Elective (DSE) course for PG Chemistry

Delivery type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of post graduate or equivalent with basic chemistry of food analysis, cement, analysis of polymer, and other analysis.*

Course Objectives: *This course introduces the food analysis techniques and pesticides content in food, cement production and its quality control measures, it covers topics as polymer analysis. This course also deals with voltametric analysis, amperometric analysis, electro-gravimetric analysis.*

Learning Outcomes:

On the completion of this course, student would learn-

- *food analysis technique, pesticide content analysis in food.*
- *cement production techniques and its quality control measures.*
- *methods of polymer analysis.*
- *identify and analyze about the metal content like cobalt and copper analysis in different compound and mineral sample*

Syllabus:

UNIT- I

Food Analysis: Reason for analysis of food, analysis of moisture in food materials, analysis of ash, crude fibers, fats, proteins and carbohydrates in food. Analysis of calcium and sodium, adulterants and contaminants in food, microscopic examination of food, extraction, purification and estimation of pesticides samples in food by HPLC, TLC for chlorinated pesticides in food products, gel chromatic analysis of food products for organophosphorus.

(12 Lecture Hours)

UNIT-II

Cement: Introduction raw material for cement, portland cement, weathering of cement and concrete, other types of cement, chemical admixture of concrete, analysis of constituents of cement by various methodology.

(12 Lecture Hours)

UNIT-III

Analysis of Polymers: Introduction, types of polymers and their uses, chemical analysis of polymers spectroscopic methods for polymer analysis X-ray diffraction analysis, microscopy, thermal analysis of

polymers, physical testing of polymers.

(12 Lecture Hours)

UNIT-IV

Electrogravimetric Analysis: Principles involving electrogravimetric analysis, instrumentations electrolysis at constant current principle and instrumentation, estimation of copper and cobalt by constant current electrolysis, electrolysis at constant potential, principle instruments and application determination copper lead and tin in brass sample by control potential method, electrolysis using mercury electrode principle and application.

(12 Lecture Hours)

UNIT-V

Voltammetry: Principle and application of voltametric analysis and amperometric analysis.

(12 Lecture Hours)

E-resources:

1. https://student.cc.uoc.gr/uploadFiles/184-%CE%A7%CE%97%CE%9C-068/Compositional%20Analysis%20of%20foods%20-%20Food%20Analysis%20-%20S.S.%20Nielsen.pdf
2. https://ccsuniversity.ac.in/bridge-library/pdf/Engg-AG-Engg-Chem-2nd-sem-subodh-Lecture-2.pdf
3. https://www.unpa.edu.mx/~aramirez/caracterizacion%20de%20polimeros.pdf
4. https://faculty.uml.edu//david_ryan/84.314/Instrumental%20Lecture%2025%20Electrochem.pdf
5. https://youtu.be/6_WD1Whd2As?si=A5VjQo40zKeNO03Y

Books Recommended:

1. Analytical Chemistry by Gurdeep R. Chatwal, Himalaya Publishing House.
2. Analytical chemistry, 6th edition by Gary D. Christian, Wiley student Edition.
3. Analytical Chemistry by S.M. Khopkar, New Age International.

SEMESTER-IV
DSE: CHE9122P
Polymer Synthesis and Extraction of Natural Products Lab

Code of the Course: CHE9122P

Title of the Course: Polymer Synthesis and Extraction of Natural Products Lab

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry Practical

Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Extraction of Organic Compounds from Natural Sources (Minimum-4) 25 Marks

1. Extraction of tea leaves and identification of caffeine.
2. Identification of casein in milk (the students are required to try some typical colour reactions of proteins).
3. Identification of lactose in milk (purity of sugar should be checked by TLC and Rf value reported).
4. Extraction of tobacco leaves and identification, isolation of nicotine and synthesize its dipicrate.
5. Extraction of black pepper and identification of piperine.
6. Extraction of tomato and identification of lycopene.

II. **Polymer Synthesis (Minimum-5) 15 marks**

1. Preparation of urea formaldehyde resin
2. Preparation of phenol formaldehyde resin
3. Preparation of thiol rubber
4. Preparation of condensation polymer
5. Preparation of epoxy resin
6. Preparation of polymerization of acrylonitrile
7. Preparation of solution polymerization of vinyl acetate
8. Preparation of free radical polymer

III. Coal Analysis 20 Marks

1. Moisture contents/Volatile matter
2. Ash contents
3. Fixed carbon

IV. Viva-voce 10 Marks

V. Evaluation of record book of experiments performed in semester 10 Marks

Virtual labs:

1. https://www.youtube.com/watch?v=sPhJWBL17OQ
2. https://mitrask.com/extraction-and-isolation-of-piperine-from-black-pepper/
3. https://www.youtube.com/watch?v=K9XehILQT5E
4. https://youtu.be/AR0vQ2EW4ZI?si=I0P4x1A0Uti2ofUn

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry by B.S. Furniss, Pearson.
2. Practical Organic Chemistry by J.T. Sharp, Springer.
3. Advanced Practical Organic Chemistry, O.P. Agarwal, Krishna Publications.
4. Advanced Practical Organic Chemistry, N.K. Vishnoi, Vikas Publishing House

SEMESTER-IV
DSE: CHE9123P
Inorganic Chemistry Lab-III

Code of the Course: CHE9123P

Title of the Course: Inorganic Chemistry Lab-III

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry

Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Quantitative Analysis by Spectrophotometry (Minimum-4) 15 Marks

1. Iron/Manganese/Chromium/Vanadium in steel sample by spectrophotometric method
2. Nickel/Molybdenum/Tungsten/Vanadium/Uranium by extractive spectrophotometric method.
3. Fluoride/Nitrite/Phosphate
4. Barium/Sulphate by turbidimetric method

II. Quantitative analysis (Minimum-2) 30 Marks

1. Volumetric determination of three components (ternary) mixture from synthetic mixture, Ores and minerals, Alloys like German silver, Cement.
2. Simultaneous estimation of Cr(III) and Fe(III) by EDTA titration, Ca^{+2} and Zn^{+2} , Pb^{+2} and Mg^{+2}

III. Solvent Extraction (Minimum-2) 15 Marks

1. Uranyl nitrate from thorium nitrates with the help of tributyl phosphate
2. Separation of metal from a mixture
3. Study of the solvent extraction of Hg and Al with 8-hydroxyquinoline
4. **Atomic absorption Spectroscopy**: Determination of components of soil, cement, and industrial wastes.

IV. Viva-voce 10 Marks

V. Evaluation of record book of experiments performed in semester 10 Marks

Virtual Labs:

1. https://www.youtube.com/watch?v=5b2LNdsfQdQ
2. https://www.youtube.com/watch?v=x8A4lAeTLwQ
3. https://pediaa.com/difference-between-tga-dta-and-dsc/

Books Recommended:

1. Advanced Practical Inorganic Chemistry, Gurdeep Raj; Goel Publishing House, Meerut.
2. Vogel's Text book of macro and semi micro qualitative inorganic analysis, Fifth edition, revised by G. Svelha.
3. Water Analysis: A Practical Guide to Physico-Chemical, Chemical and Microbiological Water Examination and Quality Assurance, Franz-Josef Bibo, Hanno Birke, Helmut Böhm Paperback -(2011), Springer.
4. Practical Manual of Analytical Chemistry, Neelam Singla, Navneet Kaur, PharmaMed Press / BSP Books Second Edition (2023).
5. A Teacher's Guide on Complexometric Titration Paperback – Import, 21 April 2020, Shoukat Ali

R a, Grin Verlag (2020).
6. Techniques and Practice of Chromatography (Chromatographic Science Series Book 70) 1st Edition, Kindle Edition, Raymond P.W. Scott. CRC Press; 1st edition (2020).

SEMESTER-IV
DSE: CHE9124T
Solid State Chemistry

Code of the Course: CHE9124T

Title of the Course: Solid State Chemistry

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry.

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of undergraduate level or equivalent.*

Course Objectives: *This course provides an introduction and discussion of solid-state reactions, crystal defects, electronic structure of metals, insulators and semiconductors, magnetic properties and superconductors.*

Learning Outcomes:

By the end of this course, students would learn-

- *to describe, with confidence, the features of the most common crystalline structures.*
- *crystalline structure with the bonding to predict materials properties.*
- *different defect structures in the solid state and its effects on the materials properties.*
- *band theory to describe the operation of modern semiconductor devices*
- *thermodynamics to explain the presence of point defects in crystalline solids.*
- *similarities and differences among important classes of materials including glasses, metals, polymers, biomaterials, and semiconductors.*
- *superconductors in generators, particle accelerators, transportation, electric motors, computing, medical, power transmission.*

Syllabus:

UNIT- I

Solid: Crystalline solid, solid-state reactions-general principles and experimental procedures reference to MgO and Al_2O_3, Enhancement of reactivity of solids, Co-precursor to solid state reaction, kinetics of solid-state reaction. Difference between reactions in solution, gaseous and solid-state phases.

(12 Lecture Hours)

UNIT-II

Crystal Defects: perfect and imperfect crystals, intrinsic and extrinsic defect, point defects, line defect- Dislocation (edge and screw) and plane defects- lineage boundary, Grain boundary, stacking fault, Thermodynamics of Schottky and Frenkel defect, color centers.

(12 Lecture Hours)

UNIT-III

Electronic Structure of Solids: Free electron theory of metals, formation of energy bands, valence and conduction bands, Kronig-Penny Model, band theory of solids (qualitative treatments), Brillouin zone, motion of electron in a band, velocity and effective mass of an electron, f_k factor, structure of metals, insulators and semiconductors, charge transfer complexes.

(12 Lecture Hours)

UNIT-IV

Semiconductor: Intrinsic and extrinsic semiconductor, p- type and n-type semiconductor, dependence of conductivity of p- type and n-type semiconductor on temperature, p-n junction, photoconduction and photoelectric effect, magnetic properties (para-, dia-, ferro- and antiferromagnetic substances).

(12 Lecture Hours)

UNIT-V

Superconductors: Superconductivity, factor affecting superconductivity, isotope effect, Meissner effect, magnetic effect, magnetic hysteresis, persistent current and BCS theory of superconductors, cooper pair, occurrence of superconductivity-conventional, organic and high temperature superconductor, new superconductors.

(12 Lecture Hours)

E-resources:

1. https://www.uobabylon.edu.iq/eprints/publication_10_10256_250.pdf
2. https://gacbe.ac.in/pdf/ematerial/18MPH22C-U2.pdf
3. https://byjus.com/physics/band-theory-of-solids/
4. https://www.pearsonhighered.com/assets/samplechapter/0/1/3/4/0134414446.pdf
5. https://www.youtube.com/watch?embeds_referring_euri=https%3A%2F%2Fwww.globalspec.com%2Flearnmore%2Fmaterials_chemicals_adhesives%2Felectrical_optical_specialty_materials%2Fsuperconductors_superc&source_ve_path=MTY0OTksMjg2NjQsMTY0NTAz&feature=emb_share&v=fuloQcljFOs

Books Recommended:

1. Solid State Chemistry and its Applications, A. R. West, Plenum.
2. Principles of the Solid State, H. V. Keer, Wiley Eastern.
3. Solid State Chemistry, N. B. Hannay.
4. Solid State Chemistry, D. K. Chakrabarty, New Age International

SEMESTER-IV

DSE: CHE9125T
Inorganic Polymers

Code of the Course: CHE9125T

Title of the Course: Inorganic Polymers

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of under graduate or equivalent with basic knowledge inorganic polymers and metal chelates.*

Course Objectives: *This course enhancements the student with knowledge of various inorganic polymers, its applications, metal chelates and about biomedical materials.*

Learning Outcomes:

On the completion of this course, students would learn:

- *inorganic polymers in detail (classification, preparation, and general characteristics).*
- *silicon polymers and its applications.*
- *chemistry of phosphorus nitrogen and sulphur nitrogen-based polymers and their importance.*
- *the structure and chemical reactions of ferrocenes, chromocene and fluxionality.*
- *chemistry of phosphorous, nitrogen, silicon and metal based inorganic polymers and its applications.*

Syllabus:

UNIT-I

Inorganic Polymers: Introduction, history of macromolecular science, general characteristics of inorganic polymers, classification of inorganic polymers, importance of monomers and polymers. Nomenclature of polymers, intermolecular forces and chemical bonding in polymers, types of polymerizations: addition polymerization, condensation polymerization and mechanism.

(12 Lecture Hours)

UNIT-II

Comparison of organic polymers with inorganic polymers, inorganic chains, ring sand cages, fluorocarbons, carbides, borazines, isopoly and heteropoly acids and their salts, zeolites, phosphonate polymers.

Silicates: Structure of silicates-applications of Pauling's rule of electrovalence-isomorphous replacements in silicates-ortho, meta and pyro silicates-one dimensional, two dimensional and three-dimensional silicates.

(12 Lecture Hours)

UNIT-III

Silicon Polymers: General preparation, properties and application of silazanes, polysilazanes, organo-siloxy and poly-carbosilanes.

Phosphorus nitrogen polymers: Synthesis and important properties of organometallic polyphosphazenes, liquid crystalline high refractive index polyphosphazenes, poly carbophosphazenes, polynitrophosphazenes. cyclophosphazenes and cyclophosphazanes and applications of polyphosphazenes in drug delivery.

(12 Lecture Hours)

UNIT-IV

S-N Compounds - S_4N_4, $(SN)_x$, isopoly and heteropoly acids, structure, and bonding of 6- and 12-isopoly and heteropoly anions.

Metal Chelates Polymers: Mechanism of extraction, extraction equilibria of metal chelates, stability of chelates. thermodynamic explanation, macrocyclic effects, linking of ligands with metal ions, factors favoring solvent extraction of metal chelates.

(12 Lecture Hours)

UNIT-V

Ferrocenes: History, structure and bonding, synthesis of ferrocenes and ferrocenes containing polyamides and polyurea polymers, applications of ferrocene and its analogs.

Chromocene: Synthesis, structure and bonding and its reactions.

Applications of phosphorous, nitrogen, silicon and ferrocene as well as other metal chelate polymers in industry such as advanced elastomers and biomedical materials.

(12 Lecture Hours)

E-resources:

1. http://www.vpscience.org/materials/Unit-IV%20Inorganic%20Polymers%20(Sem-V).pdf
2. http://www.adichemistry.com/inorganic/p-block/group-14/silicates/silicates-1.html
3. http://www.lscollege.ac.in/sites/default/files/econtent/TDC%20PART%20III%20SILICONES_0.pdf
4. https://www.google.co.in/books/edition/Phosphorus_Based_Polymers/ur2SAwAAQBAJ?hl=en&gbpv=1&dq=Phosphorus+nitrogen+polymers+free&printsec=frontcover&bshm=rimc/1
5. https://www.youtube.com/watch?v=tX8gdpDJTHU
6. https://www.google.co.in/books/edition/Chemistry_of_Polymeric_Metal_Chelates/TxBMDwAAQBAJ?hl=en&gbpv=1&dq=Metal+chelate+polymer+PDF&printsec=frontcover&bshm=rimc/1
7. https://chemistnotes.com/inorganic/ferrocene-properties-structure-uses/
8. https://en.wikipedia.org/wiki/Chromocene

Books Recommended:

1. Advanced Inorganic chemistry, J. E. Huheey.
2. Advanced Inorganic chemistry, F. A. Cotton and G. Wilkinson.
3. Text Books of Polymer Science-Bill Meyer (Wiley Inter Science Publishers).
4. Polymer Science, V. R. Gowarikar.
5. Introduction to Polymer Chemistry, Charles E. Carroher Jr., C.RC Press, Taylor & Francis, Boca Raton (2010).
6. Contemporary Polymer Chemistry- H. R. Allcock and F. W. Lampe, Prentice-Hall Inc. (2003).
7. Inorganic Polymers, J. E. Mark, H. R. Alcock and R.West, Prentice Hall Publishers, (2005).
8. Contemporary Polymer Chemistry, J. E. Mark, H.R. Alcock and F. W. Lampe, Prentice Hall Publishers, 3rdEdition (2005).
9. D. E. Douglas, D.H. McDaniel and J. J. Alexander, Concepts and Models in Inorganic Chemistry, 3rd Ed, 1994.
10. D.F. Shriver, P.W. Atkins, Inorganic Chemistry, 3rd Ed, 1999.
11. A.G. Sharpe, Inorganic Chemistry, Pearson Education, 2008.
12. G. H. Morrison and H. Freiser, Solvent Extraction in Analytical Chemistry, John Wiley & Sons, New York, 1966.

SEMESTER-IV
DSE: CHE9126T
Medicinal Chemistry

Code of the Course: CHE9126T

Title of the Course: Medicinal Chemistry

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry.

Delivery Type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites: *Basic knowledge of pharmacology, biochemistry, and medicinal chemistry, along with familiarity with drug development processes and relevant disease biology, is required for comprehending the concepts and principles discussed in this study.*

Course Objectives: *Objective of this study is to investigate various aspects of drug design, pharmacokinetics, and pharmacodynamics, with a specific focus on antineoplastic agents, cardiovascular drugs, local anti-infective drugs, and psychoactive drugs. The study aims to explore different strategies and methodologies involved in designing novel drugs, including target identification and lead optimization. It also seeks to examine the absorption, distribution, metabolism, and elimination of drugs within the human body, as well as factors influencing drug bioavailability and pharmacokinetic parameters. Additionally, the study will analyze the mechanisms of drug action, drug-receptor interactions, and dose-response relationships, providing insights into the pharmacological effects and therapeutic optimization of drugs.*

Learning Outcomes:

After completing this course, students would learn-

- *drug design, development, and personalized treatment approaches.*
- *drugs absorption, distribution, metabolism, and elimination.*
- *desired effects of the drugs.*
- *drug effectiveness, safety, and side effects for various conditions.*
- *drug-related concepts effectively and consider ethics and regulations.*

Syllabus:

UNIT-I

Drug Design: Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAR), factors affecting bioactivity: resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity- occupancy theory, rate theory, induced fit theory, concept of quantitative structure activity relationship, drug receptors, drug receptor interactions. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constants, steric, Free-Wilson analysis, Hansch analysis, LD-50, ED-50 (Mathematical derivations of equations excluded).

(12 Lecture Hours)

UNIT-II

Pharmacokinetics: Introduction to drug absorption, disposition, elimination using pharmacokinetics, important pharmacokinetic parameters in defining drug disposition and in therapeutics. Mention of uses of pharmacokinetics in drug development process.

Pharmacodynamics: Introduction, elementary treatment of enzyme stimulation, enzyme inhibition, sulphonamides, membrane active drugs, drug metabolism, xenobiotics, biotransformation, significance of drug metabolism in medicinal chemistry.

(12 Lecture Hours)

UNIT-III

Antineoplastic Agents: Introduction, cancer chemotherapy, special problems, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitotic inhibitors. Synthesis of mechlorethamine, cyclophosphamide, melphalan, uracil, mustards, and 6-mercaptopurine, hormone and natural products.

Cardiovascular Drugs: Introduction, cardiovascular diseases, drug inhibitors of peripheral sympathetic function, central intervention of cardiovascular output, direct acting arteriolar dilators, synthesis of amyl nitrate, sorbitrate, diltiazem, quinidine, verapamil, methyldopa, atenolol, oxyprenolol.

(12 Lecture Hours)

UNIT-IV

Local Anti-infective Drugs: Introduction and general mode of action, synthesis of sulphonamides, furazolidone, nalidixic acid, ciprofloxacin, norfloxacin, dapsone, amino salicylic acid, isoniazid, ethionamide, ethambutal, flucanazole, econozole, griseofulvin, chloroquin and primaquin. Antibiotics, Cell wall biosynthesis, inhibitors, (3-lactam rings, antibiotics inhibiting protein synthesis. Synthesis of penicillin-G, penicillin-V, ampicillin, amoxycillin, chloramphenicol, cephalosporin, tetracyclin and streptomycin.

(12 Lecture Hours)

UNIT-V

Psychoactive Drugs: Introduction (chemotherapy of mind), neurotransmitters, CNS depressants, general anaesthetics, mode of action of hypnotics, sedatives, anti-anxiety drugs, benzodiazipines, buspirone, neurochemistry of mental diseases. Antipsychotic drugs-the neuroleptics, antidepressants, butyrophenones. Synthesis of diazepam, oxazepam, chlorazepam, alprazolam, phenytoin, ethosuximde, trimethadione, barbiturates, thiopental sodium, glutethimide.

(12 Lecture Hours)

E-resources:

1. https://www.philadelphia.edu.jo/academics/s_telfah/uploads/Chapter-2-Introduction%20to%20Drug_Design%20and%20Discovery_25_02_2020.pdf
2. https://www.slideshare.net/pooranachithraflowry/introduction-to-pharmacokinetics-and-pharmacodynamics-principles
3. https://www.ramauniversity.ac.in/online-study-material/pharmacy/bpharma/vsemester/medicinalchemistry-ii/lecture-1.pdf
4. https://www.people.vcu.edu/~urdesai/Lectures/CardiovascularDrugs.pdf
5. https://www.youtube.com/watch?v=yVl4OxgyXss
6. http://www.drugs.ie/resourcesfiles/guides/Psychoactive_substances_low_res.pdf

Books Recommended:

1. Introduction to Medicinal Chemistry, A Gringuage, Wiley-VCH.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F. Dorge.
3. An Introduction to Drug Design, S. S. Pandeya and J. R. Dimmock, New Age International.
4. Burger's Medicinal Chemistry and Drug Discovery, Vol-1 (Chapter-9 and Ch-14), Ed. M. E. Wolff, John Wiley.
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
6. The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, Academic Press.
7. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley.

SEMESTER-IV
DSE: CHE9127T
Applied Analytical Methods

Code of the Course: CHE9127T

Title of the Course: Applied Analytical Methods

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) course for PG Chemistry

Delivery type of the Course: 60 hours (40 hours for lectures and 20 hours for diagnostic and formative assessment).

Prerequisites*: Chemistry courses of post graduate or equivalent with basic environmental chemistry and its related analysis. environmental monitoring of soil, water, air.*

Course Objectives: *This course introduces the soli chemistry and water pollutant analysis and, it covers topics about chemical content in water. This course also aims to develop student's understanding of petrochemical analysis fuel and its chemical analysis clinical analysis of different sample of urine blood serum albumin and different drug and their chromatographic study.*

Learning Outcomes:

After completing this course, students would learn:

- *about the details of soil chemistry and water pollutant analysis.*
- *details of water analysis, DO, COD, BOD and TDS.*
- *petrochemical analysis.*
- *biochemical analysis of blood samples and serum samples.*
- *understand the instrumental analysis of different drugs and their chromatographic studies.*

Syllabus:

UNIT- I

Soil Analysis: Introduction, type of soils, analysis of moisture, determination of pH, total nitrogen, phosphorous, silica, magnesium, manganese, lime, sulphur and salts in soil and their quantitative estimation.

(12 Lecture Hours)

UNIT-II

Analysis of Water Pollutants: Water pollution, water pollutants, origin and source of water pollutions effect of water pollutants, analysis of water, colour turbidity, TDS, total solids, conductivity, acidity/alkalinity and hardness, chloride, sulphate and fluoride in water, analysis of silica phosphate and heavy metals pollutants in water. Determination of DO, BOD and COD, separation and estimation of herbicides as water pollutants, water quality standards and drinking water standards.

(12 Lecture Hours)

UNIT-III

Fuel Analysis: Fuels types and classifications, solid, liquid and gaseous fuels, producer gas, natural gas, calorific value of fuel, analysis of coal, proximate analysis, ultimate analysis, grading of coal, aniline point,

flash point and free point, octane number and its significance.

(12 Lecture Hours)

UNIT-IV

Clinical Analysis: Composition of blood, collection and preservation of samples immunoassay principal of radioimmunoassay (RIA) and its applications serum electrolytes, test for carbohydrates, blood glucose blood urea uric acid blood urea nitrogen total serum proteins, serum albumin, non- protein nitrogen (serum creatinine), serum phosphate, alkaline phosphatase, bilirubin, serum cholesterol, trace elements in body.

(12 Lecture Hours)

UNIT-V

Drug Analysis: Introduction, sources of drugs, dangerous drug, narcotics, classification of drugs, assay of drugs, drug screening by gas chromatography, thin layer chromatography of drugs, analysis of drugs by spectrophotometric methods.

(12 Lecture Hours)

E-resources:

1. https://www.uaeu.ac.ae/en/cavm/doc/aridland/methods_of_analysis.pdf
2. https://www.sathyabama.ac.in/sites/default/files/course-material/2020-10/UNIT-III_15.pdf
3. https://www.google.com/search?sca_esv=562363535&sxsrf=AB5stBhSAov1cugOoMEvX4VCNe_r8FNV5A:1693760106377&q=fuel+analysis&tbm=vid&source=lnms&sa=X&sqi=2&ved=2ahUKEwizmeaL9I6BAxWvbmwGHR26DlsQ0pQJegQIDhAB&biw=1440&bih=680&dpr=1#fpstate=ive&vld=cid:8815d55f,vid:wkNak_znQ48
4. https://pharmainfonepal.com/wp-content/uploads/2020/12/Vogels-Textbook-of-Quantitative-Chemical-Analysis-G.H.-Jeffery-et-al.-5th-Edition.pdf

Books Recommended:

1. Analytical Chemistry by Gurdeep R. Chatwal, Himalaya Publishing House.
2. Analytical chemistry, 6th edition by Gary D. Christian, Wiley student Edition.
3. Analytical Chemistry by S.M. Khopkar, New Age International.
4. Instrumental Methods of analysis, 7th edition, CBS Publishers and distributors.
5. Instrumental Methods of chemical analysis, 3rd edition by Galen W. Ewing, International student edition.
6. Principles and practice of Analytical chemistry by F.W. Fifield and D. kealey, Blackwell Publishing.

SEMESTER-IV
DSE: CHE9128P
Organic Chemistry Lab-III

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Code of the Course: CHE9128P

Title of the Course: Organic Chemistry Lab-III

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry Practical

Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Quantitative Analysis **30 Marks**

1. To estimate the percentage of Nitrogen in the given organic sample by Kjeldahl's method.
2. To estimate Halogen in the given sample by Alkaline Reduction method. (Modified Stepanow's method)
3. To estimate the percentage of Sulfur in the given organic sample by Messenger's method.

II. Synthesis of Organic Compounds (Minimum-4) **15 Marks**

1. Fisher-Indole Synthesis-Preparation of 2-phenylindole or 2-methylindole or 1, 2, 3, 4- tetrahydro carbazole.
2. Enzymatic Reduction-Reduction of ethyl acetoacetate using Baker's yeast to yield
3. Synthesis using Microwaves-Benzoic acid, chalcones, coumarin, synthesis of simple heterocyclic compound
4. Synthesis using phase transfer catalyst-Alkylation of diethyl malonate or ethyl acetoacetate with alkyl halides.
5. Diels Alder reaction
6. Ultrasound assisted reaction-Esterification, saponification

III. Miscellaneous experiments **15 Marks**

1. Estimation of glycine (Sorenson's method)
2. Estimation of formaldehyde
3. Estimation of cane sugar

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

Virtual Labs:

1. https://www.itwreagents.com/uploads/20180114/A173_EN.pdf
2. https://www.brainkart.com/article/Estimation-of-sulphur_36464/
3. https://www.youtube.com/watch?v=sdeoC41478k
4. https://www.youtube.com/watch?v=WLv8r_zBdVA#:~:text=the%20glycine%20solution%20

Books Recommended:

1. Vogel's Textbook of Practical Organic Chemistry by B.S. Furniss, Pearson.
2. Practical Organic Chemistry by J.T. Sharp, Springer.

3. Advanced Practical Organic Chemistry, O.P. Agarwal, Krishna Publications
4. Advanced Practical Organic Chemistry, N.K. Vishnoi, Vikas Publishing House.

SEMESTER-IV
DSE: CHE9129P
Analytical Chemistry Lab-II

Code of the Course: CHE9129P

Title of the Course: Analytical Chemistry Lab-II

Level of the Course: NHEQF Level 9

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for PG Chemistry Practical.

Delivery Type of the Course: 120 hours (80 hours for the hands on experiments, observations and record of the data , 20 hours for the experiment, instruments demonstration, lab practices and the 20 hours for the diagnostic assessment, formative assessment, subject/ class activity and problem solving).

Syllabus:

I. Mineral Analysis: **30 Marks**

1. Determination of Ca, Mo, Zn, Cu, phosphate and silica contents of soil samples
2. Analysis of cement
3. Estimation of soluble salts in soils by conductometric method

II. Instrumental Analysis: **15 Marks**

1. Analysis of sludge obtained from Zinc Smelter
2. Colorimetric estimation of fluoride, Fe in drinking waters
3. Separation and identification of most common acidic and basic drugs by TLC.

III. Raw Material Analysis: **15 Marks**

1. Determination of water in mixture by Karl-Fisher method
2. Analysis of aspirin, sulpha drugs and vitamin C
3. Potentiometric estimation of Ni, Zn, etc.
4. Analysis of Lime, Brass and gun metal

IV. Viva-voce **10 Marks**

V. Evaluation of record book of experiments performed in semester **10 Marks**

Virtual Labs:

1. https://www.youtube.com/watch?v=DMY2Y3YZrz0
2. https://www.youtube.com/watch?v=XuLT8i4g4Yw
3. https://youtu.be/TGMh_IlYZ4I?si=tXV8LWQBDPrTOQHH
4. https://youtu.be/diL9dxATZ70?si=TiqODXb0ctdlaRp7
5. https://youtu.be/xb7dOHSeyIU?si=1wPe7m_oYJs_PrAt

Books Recommended:

1. Instrumental methods of analysis, 7th edition, CBS Publishers and distributors
2. Instrumental methods of chemical analysis, 3rd edition by Galen W. Ewing, International student edition.
3. Principles and practice of analytical chemistry by F.W. Fifield and D. Kealey, Blackwell Publishing