MAHARAJA SURAJMAL BRIJ UNIVERSITY
BHARATPUR, RAJASTHAN

MASTERS IN CHEMISTRY
(TWO YEARS)

PROGRAM BROCHURE

SYLLABUS

M.Sc. (Chemistry)

(Semester Scheme)

Proposed to be implemented from

Academic Session: 2025–2026

Syllabus based on CBCS, NEP 2020 Frame Work

Content

1. Eligibility

As per the rules formed/framed by the Commissionerate Higher Education Rajasthan, Jaipur.

2. SCHEME OF EXAMINATION

- Each Semester shall have continuous assessment which shell include internal assessment in theory and practical by Internal examination/seminar/oral examination/viva-voce etc, besides assessment of candidate's regularity and performance in the class
- A candidate has to pass in the continuous assessment as well as EoSE (End of Semester Examination) paper separately.
- Each EoSE of theory paper shall carry 100 marks in which 20% weightage of each paper (Theory/Practical) is of internal assessment. The EoSE will be of 3 hours duration. Candidate has to attempt 05 questions in all.
- Part "A" of the theory paper shall contain 10 Short Answer Questions of total 20 marks, based on knowledge, understanding and applications of the topics/texts covered in the whole syllabus. Each question will carry two (02) marks for correct answer.
- Part "B" of the theory paper will have total four questions of 15 marks each, framed by taking one question from each unit with internal choice. The limit of answer will be live pages.
- Each Laboratory EoSE will be of six hours durations and involve laboratory experiments/exercise record and viva-voce examination with weightage in ratio of 1:1.
- The Practical examination will be conducted by board of examiners consisting of one internal (to be appointed by the Head of Department) and one external examiner (to be appointed by the University)
- The medium of instruction and examination shall be English only.

3. Assessment Method

Assessment of a student will be done on the basis of the internal examination as well as EoSE in Theory and Practical, in which 20% weightage of each paper (Theory/Practical) is of internal assessment. The internal of the practical course consists of performing experiments by the students. Each student will have to give a viva examination to the instructor at the completion of each practical along with the complete lab record of the practical. The instructor will judge the performance of the student and will give marks. The EoSE of the practicals will consist of performing one practical and giving viva to the examiner.

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4. Course Detail

The details of the courses with code, title and credits are as given below –

Abbreviation Used –

Course Category

CCC: Compulsory Core Course
ECC: Elective Core Course
OEC: Open Elective Course
SC: Supportive Course
SSC: Self Study Course
SEM: Seminar
PRJ: Project Work
RP: Research Publication
SEC: Skill Enhancement Course
IEC: Interdisciplinary Elective Course

Contact Hours

L: Lecture
T: Tutorial
P: Practical or Other
S: Self Study

Course Credit Scheme:

Year Wise	Particular Course Discipline	Course Type	Credit Details		Total (I + II)
			Semester (I) Odd	Semester (II) Even	
I Year	Centric Core Paper-I	Major	4	4	8
	Centric Core Paper-II	Major	4	4	8
	Centric Core Elective Paper -III	Major	4	4	8
	Centric Core **Elective** Paper -IV	Major	4	----	4
	Practical Paper	Major	4	4	8
	Introduction to Research Methodology	Major	----	4	4
	Skill Enhancement Course (SEC)	Major/Minor	4	----	4
	Interdisciplinary Elective Course (IEC)	Major/Minor	----	4	4
Total Semester Wise Credit			**24**	**24**	**48**

Year Wise	Particular Course Discipline	Course Type	Credit Details		Total (III + IV)
			Semester (III) Odd	Semester (IV) Even	
II Year	Centric Core Paper -I	Major	4	4	8
	Centric Core Paper -II	Major	4	4	8
	Centric Core **Elective** Paper -III	Major	4	----	4
	Centric Core **Elective** Paper -IV	Major	4	----	4
	Practical Paper	Major	4	4	8
	Skill Enhancement Course (SEC)	Major/Minor	4	----	4
	Interdisciplinary Elective Course (IEC)	Major/Minor	----	4	4
	Dissertation/ Fieldwork / Project / Seminar & Term Paper	Major	----	8	8
Total Semester Wise Credit			**24**	**24**	**48**

Total Credit= (48+48+4*=100); *Internship: It must be **4-6 Weeks (120 Hours)** During Summer Vacation 04 Credit

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5. Semester Structure

First Semester

S. No.	COURSE Code	Course Title	Course Category	Credit	Contact Hours per week			EoSE Duration (Hrs.)		Total Hrs
					L	T	P	Thy	P	
1.	CHE-20101-T	**Inorganic Chemistry- I**	CC	4	4	0	0	4	0	60
2.	CHE-20102-T	**Organic Reaction Mechanism- I**	CC	4	4	0	0	4	0	60
3.	CHE-20103-T	Analytical Techniques	CE	4	4	0	0	4	0	60
	CHE-20104-T	Inorganic Polymers		4	4	0	0	4	0	60
	CHE-20105-T	Organic Synthesis- I		4	4	0	0	4	0	60
	CHE-20106-T	Solid state chemistry		4	4	0	0	4	0	60
4.	CHE-20107-T	Chemical Analysis	CE	4	4	0	0	4	0	60
	CHE-20108-T	Organo-transition Metal Chemistry		4	4	0	0	4	0	60
	CHE-20109-T	Natural Products		4	4	0	0	4	0	60
	CHE-20110-T	Bio Molecules-I		4	4	0	0	4	0	60
5.	SEC	Skill Enhancement Course (Computer for Chemists)	SEC	4	4	0	0	4	0	60
6.	CHE-20112-P	Chemistry Laboratory Work	PR	4	0	0	8	0	8	80
7.		**Total Credits**		24						

In semester first all students have to select one elective paper from the each ECC group. Departments will offer a minimum of three and maximum five theory elective courses for the semester based on options submitted by students and availability of Faculty to teach the course.

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Second Semester

S.No.	COURSE Code	Course Title	Course Category	Credit	Contact Hours per week			EoSE Duration (Hrs.)		Total Hrs
					L	T	P	Thy	P	60
1.	CHE 20201-T	**Physical Chemistry- I**	CC	4	4	0	0	4	0	60
2.	CHE 20202-T	**Spectroscopy- I**	CC	4	4	0	0	4	0	60
3.	CHE 20203-T	Nano science & Nano technology	CE	4	4	0	0	4	0	60
	CHE 20204-T	Photo-Inorganic Chemistry		4	4	0	0	4	0	60
	CHE 20205-T	Heterocyclic Chemistry-I		4	4	0	0	4	0	60
	CHE 20206-T	Bio-Inorganic Chemistry		4	4	0	0	4	0	60
4.	IRM 20207-T	Introduction to Research Methodology	CE	4	4	0	0	4	0	60
5.	IEC 20208-T	Interdisciplinary Elective Course (Green & Sustainable Chemistry)	IEC	4	4	0	0	4	0	60
6.	CHE 20209-P	Chemistry Laboratory Work	PR	4	0	0	8	0	8	80
7.		**Total Credits**		24						

In semester second all students have to select one elective paper from the ECC group. Departments will offer a minimum of three and maximum five theory elective courses for the semester based on options submitted by students and availability of Faculty to teach the course. Elective Core Courses Lab Work will be based on Lab Work of above papers wherever applicable. The medium of instruction and examination shall be English only.

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Third Semester

S. No.	Code	Course Title	Course Category	Credit	Contact Hours per week			EoSE Duration (Hrs.)		Total Hrs
					L	T	P	Thy	P	60
1.	CHE 20401-T	**Inorganic Chemistry- II**	CC	4	4	0	0	4	0	60
2.	CHE 20402-T	**Organic Chemistry- II**	CC	4	4	0	0	4	0	60
3.	CHE 20403-T	Medicinal Chemistry	CC	4	4	0	0	4	0	60
	CHE 20404-T	Bioinorganic & Supramolecular Chemistry		4	4	0	0	4	0	60
	CHE 20405-T	Organic Synthesis - II		4	4	0	0	4	0	60
	CHE 20406-T	Advance Electrochemistry		4	4	0	0	4	0	60
4.	CHE 20407-T	Bio- Physical Chemistry	CC	4	4	0	0	4	0	60
	CHE 20408-T	Environmental Chemistry		4	4	0	0	4	0	60
	CHE 20409-T	Heterocyclic Chemistry-II		4	4	0	0	4	0	60
	CHE 20410-T	Natural Product - II		4	4	0	0	4	0	60
5.	SEC 13401-T	Skill Enhancement Course	SEC	4	4	0	0	4	0	60
6.	CHE 20412-P	Chemistry Laboratory Work	PR	4	0	0	8	0	8	80
7.		**Total Credits**		24						

In semester third all students have to select one elective paper from the each ECC group. Departments will offer a minimum of three and maximum five theory elective courses for the semester based on options submitted by students and availability of Faculty to teach the course. Elective Core Courses Lab Work will be based on Lab Work of above papers wherever applicable. The medium of instruction and examination shall be English only.

प्रभारी अकादमिक प्रथम

Fourth Semester

S. No.	Course Code	Course Title	Course Category	Credit	Contact Hours per week			EoSE Duration (Hrs.)		Total Hrs
					L	T	P	Thy	P	60
1.	CHE 20301-T	Physical Chemistry- II	CC	4	4	0	0	4	0	60
2.	CHE 20302-T	Spectroscopy- II	CC	4	4	0	0	4	0	60
3.	CHE 20303-P	Chemistry Laboratory Work	C	4	0	0	8	0	8	80
4.	IEC 20304-T	Interdisciplinary Elective Course	IEC	4	4	0	0	4	0	60
5.		Dissertation/ Fieldwork / Project / Seminar & Term Paper		8	8	0	0	8	0	120
10.		**Total Credits**		24						

Total Credit Summary (as per NEP-2020)

Component	Credit Distribution
Semester I	24
Semester II	24
Semester III	24
Semester IV	24
Internship	4
Grand Total	100 Credits

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SEMESTER - I

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CHE: INORGANIC CHEMISTRY-I

(Theories of Bonding, Spectroscopic methods and Nuclear Chemistry)

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
I	CHE 20101-T	INORGANIC CHEMISTRY-I	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CC	Lectures (4 hrs. a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	This course is an introduction to concepts of inorganic chemistry. It is a compulsory and core paper for M.Sc. Chemistry. This course provides an introduction to the concepts of bonding in main group compounds. It covers topics such 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 as well as detailed knowledge of nuclear and radiochemistry. **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 magnetic properties of the complexes along with the detailed knowledge of Radiochemistry		

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CHE: INORGANIC CHEMISTRY-I

(Theories of Bonding, Spectroscopic methods and Nuclear Chemistry)

4 Credit (4 hrs/week)

UNIT-I **(15 Lectures)**

Stereochemistry and Bonding in Main Group Compounds:

Limitations of VSEPR Theory, dπ-pπ bond, Bent rule and energetics of hybridization, some simple reactions of covalently bonded molecules

Metal Ligand Bonding:

Limitation of crystal field theory, molecular orbital theory, and introduction to ligand field theory σ bonding in octahedral and tetrahedral complexes, π-bonding and molecular orbital theory.

UNIT-II **(15 Lectures)**

Electronic Spectra of Transition Metal Complexes

Spectroscopic ground states, correlation diagrams, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), calculations of Dq, Racah parameters (B) and nephelauxetic ratio (B) parameters, charge transfer spectra.

UNIT-III **(15 Lectures)**

Optical Rotatory Dispersion (ORD), Circular Dichroism (CD) and Magnetic Properties of Transition Metal Complexes:

Spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical conformation, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

UNIT-IV **(15 Lectures)**

Nuclear and Radiochemistry:

Laws of radioactive decay, Detection of radiations; Geiger-Nuttal rule; GM tubes and their characteristics, Ionization chamber, Proportional counters, Scintillation counters, Solid state defectors; Calibration of counting equipments, Determination of absolute disintegration rates.

Activation analysis: Principles; Various methods of activation; Methodology: Advantages, limitations and applications.

SUGGESTED BOOKS AND REFERENCES

1. Inorganic Chemistry, Principles of structure and Reactivity, 4th Edition, Tames E. Huheey: Elleu A Keiter Richard L. Keiter.
2. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson.
3. Theoretical Inorganic Chemistry; Day and Selbin.
4. Concepts and Models in Inorganic Chemistry; Doughlas Me Daniel.
5. Physical Methods in Inorganic Chemistry, R. S. Drago.
6. Chemistry of the Elements, N.N. Greenwood and A. Earnshow, Pergamon, 1984.
7. Inorganic Electronic Spectroscopy; A.B.P. Lever, Elsevier, 1968.
8. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. MeCleverta, Pregamon, 1987; Vol. 2.
9. Nuclear and Radiochemistry; G. Friedlander, J. W. Kennedy, E. S. Macias and J. M. Miller, 3rd Ed Wiley: NY, 1981.
10. Essentials of Nuclear Chemistry, H. J. Amikar, 4" Eds., New Age International N Delhi, India, 2011
11. Nuclear and Radiochemistry: Fundamental and Applications, 2 Vols., Jens Volke Kratz and Karl Heinrich Lieser, 3rd edn., John Wiley & Sons: UK, 2013

CHE: ORGANIC REACTION MECHANISM-I

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
I	CHE 20102-T	ORGANIC REACTION MECHANISM-I	8	4
Level of Course	**Type of Course**	**Delivery of the Course**		
Advance	CC	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Prerequisites	Chemistry courses at the UG level			
Objectives of the Course	The objective of this course is to provide students with a theoretical understanding of the types of organic reactions and their mechanisms, generation and stability of various intermediates, determination of reaction mechanism along with detailed study of concept of aromaticity **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 behaviour's 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. • They have sound knowledge about the types and mechanism of various organic reactions such as substitution reactions, additions reactions and elimination reactions. • Gain 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.		

CHE: ORGANIC REACTION MECHANISM- I

4 Credit (4 hrs/week)

UNIT-I **(15 Lectures)**

Reaction Mechanisms: Structure and Reactivity

A review of types of mechanisms and reactions, methods of determining reaction mechanism, thermodynamic

and kinetic requirements for reaction, kinetic and thermodynamics control, Hammond's postulate, Curtin-Hammett Principle, Isotope effects. Effects of structure on reactivity, resonance and field effects, steric effects. Quantitative treatment of the effect of structure on reactivity. The Hammett equation and linear free energy relationship, substituent and reaction constants, Taft equation

Aromaticity: Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons. Huckel's rule, energy level of π-molecular orbitals, annulenes, anti-aromaticity, homo-aromaticity, PMO approach, energetic and magnetic concept.

UNIT - II **(15 Lectures)**

Aliphatic Nucleophilic Substitution

The S_N^1, S_N^2, mixed S_N^1, S_N^2 and SET mechanisms. The S_N^i mechanism. The neighbouring group mechanism participation by π and σ bonds, anchimeric assistance Classical and nonclassical carbocations, phenonium ions, norbornyl system. Application of NMR spectroscopy in the detection of carbocations. Nucleophilic substitution at the allylic, aliphatic trigonal and a vinylic carbon.

Reactivity effect of substrate structure, attacking nucleophile, leaving group and reaction medium. Ambident nucleophile, regioselectivity.

Aromatic Nucleophilic Substitution

The S_NAr, S_N^1, benzyne and $S_{RN}1$ mechanisms. Reactivity effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser and Smiles rearrangements.

UNIT-III **(15 Lectures)**

Aliphatic Electrophilic Substitution

Bimolecular mechanisms-SE^2 and SE^i The SE^1 mechanism electrophilic substitution accompanied by double bond shifts, Effect of substrates, leaving group and solvent polarity on reactivity

Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction.

Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity of aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity. Allylic halogenations (NBS). Oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

UNIT-IV **(15 Lectures)**

Addition to Carbon-Carbon Multiple Bonds

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophile and free radicals, regio and chemo selectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, Hydrogenation of aromatic: rings. Hydroboration, Michael reaction. Sharpless asymmetric epoxidation.

Addition to Carbon-Heteroatom Multiple Bonds

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagent, organozinc and organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction. Introduction to condensation reactions involving enolates-Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions

Elimination Reactions

The E^2, E^1 and E^1cB mechanisms. Steric orientation of the double bond. Reactivity, effect of substrate structure, the attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic eliminations.

SUGGESTED BOOKS AND REFERENCES

1 Advanced Organic Chemistry: Reactions Mechanisms and Structure by Jerry March, McGraw Hill

2. Mechanism and Structure in Organic Chemistry-ES Gould (Holt, R nehart and Winston).

3. Advanced Organic Chemistry Part-A. FA Carey and RJ Sundberg, Fifth Ed. Springer (2007)

4. Physical Organic Chemistry-J. Hine.

5. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes. Long nan

6 Organic Chemistry J. Clayden, N. Greeves, S. Warren and P. Wother, Oxford University Press (2001)

7. Structure and Mechanism in Organic Chemistry. C.K. Ingold Cornell University Press.

8. Organic Chemistry. RT Morrison and R N. Boyd. Prentice-Hall.

9. Modern Organic Reactions. HO House, Benjamin.

10 Principles of Organic Synthesis. ROC Norman and J.M. Coxon, Blackie Academic & Professional.

11. Reaction Mechanism in Organic Chemistry, S.M. Mukherji and S.P. Singh, Macmillan

CHE: ANALYTICAL TECHNIQUES

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
I	CHE 20103-T	ANALYTICAL TECHNIQUES	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	DCE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The objective of this course is to equip students with some of the concepts that are widely used in Analytical Techniques. The course aims to develop a deep understanding of principle and different applications of AAS, Coulometry, Conductometry Potentiometry and Solvent extraction method used in chemistry.			

CHE: ANALYTICAL TECHNIQUES

4 Credit (4 hrs/week)

UNIT- I

(15 Lectures)

Statistics-Introduction to Chemometrics

Limitations of analytical methods, Errors and classification, Determinant, constant and indeterminants accuracy precision minimization of errors, significant figures and computation rules, mean and standard deviation, distribution of random errors, variance and confidence interval, paired r-test, least square method, correlation and regression, linear regression.

UNIT- II

(15 Lectures)

Sampling in analysis

Definition, theory, basis and techniques of sampling, sampling statistics sampling and physical state, crushing and grinding, hazards in sampling, techniques of sampling of gases, fluid, solids, and particulates, minimization of variables, transmission and storage of samples, high pressure ashing techniques (HPAT) particulate matter, its separation in gas stream, filtering and gravity separation, analysis of particulate matter like asbestos, mica, dust and aerosols etc.

Solvent extraction method in analysis Principle, classification, theory, instrumentation and applications.

UNIT- III

(15 Lectures)

Conductometry:

Important laws, definitions, relations, effect of dilution on conductivity, measurement of conductivity, types of

conductometric titrations, its applications and limitations.

Potentiometry:

Principle, instrumentation, types of potentiometric titrations and its applications, pH measurements, determination of pH ion, selective electrodes, instrumentation and applications.

UNIT - IV (15 Lectures)

Coulometry:

Introduction, principle, experimental details of coulometry at constant current and constant potential, titrational applications.

Atomic Absorption Spectroscopy:

Introduction, principle, Grotrian diagram, instrumentation, applications, detection limit, sensitivity and disadvantages

SUGGESTED BOOKS AND REFERENCES

1. Mendham J, Denney R.C., Barnes J. D., Thomas M.J.K., Vogels' text book of quantitative chemical analysis, 6 edition, Prentice Hall, 2000.
2. Skoog Douglas A., Holler F. James, Nieman Timothy A, Principles of instrumental analysis, College Pub, 1998
3. Day R. A and A. L. Underwood, Quantitative analysis, Prentice Hall, 1999.
4. Drago B. S. Physical methods in Chemistry, Saunders, 1999.
5. Peters D.G, J. M. Hayes and G. M. Hefige, A brief introduction to Modern chemical analysis Philadelphia: Saunders, 1976.
6. Ebsworth E.A.V, DWA Rankin and C. Craddock, Structural methods in inorganic chemistry, ELBS
7. Eliel EL, Stereochemistry of carbon compounds, Tata-Mc-GrawHill
8. Elan JAD Butter Worth, Photoelectron spectroscopy

CHE: INORGANIC POLYMERS

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
I	CHE 20104-T	INORGANIC POLYMERS	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	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. • different electrical and electrometric properties of polymers & fire resistant polymers, • Synthesis and Characterization of different polymers • various types of inorganic polymer and their uses • Industrial manufacturing and properties of polymers.			

CHE: INORGANIC POLYMERS

4 Credit (4 hrs/week)

UNIT-I **(15 Lectures)**

Basic Concepts

Classification by connectivity and classification by dimensionality, metal/backbone classification of metal-containing polymers, linear inorganic polymer.

Unit-II **(15 Lectures)**

Synthesis and Characterization

Step-growth synthesis, chain polymerization, ring-opening polymerization, reductive coupling and other redox polymerization reactions, Inorganic polymer characterization: average molecular masses, and characterizing methods

using Gel permeation chromatography and viscosity, degree of polymerization

Unit-III **(15 Lectures)**

Applications

Polysiloxane and polyphosphazene elastomers, inorganic medical polymers: polysiloxanes and polyphosphazene as bio polymers, Inorganic polymer conductivity: main group inorganic polymers, metal-containing polymers, Luminescent inorganic polymers: Ruthenium polymers for solar energy conversion.

Unit-IV **(15 Lectures)**

Polymetallocenes

Introduction, Polymetallocenes with short spacers obtained by condensation routes, ring-opening polymerization (ROP) of strained Metallocenophanes, thermal ROP of silicon-bridged [1] Ferrocenophanes, thermal ROP of other strained metallocenophane, transition metal catalyzed ROP of strained metallocenophanes.

SUGGESTED BOOKS AND REFERENCES

1 Ronald D. Archer, Inorganic and Organometallic Polymers, Wiley-VCH

2. J.E. Huheey, Inorganic Chemistry, Harper Row.

3. M.F. Lappert and G.J. Leigh, Developments in Inorganic Polymer Chemistry, ACS Publications, 1963.

4. N.H. Ray, Inorganic Polymers, Academic Press, NY, 1979.

5. FW Billimeyer Jr, Textbook of Polymer Science, Wiley, NY, 1977.

6. HR. Alcock and F.W. Lambe, Contemporary Polymer Chemistry, Prentice Hall

7. I. Manners, Synthetic Metal-Containing Polymers, Wiley-VCH, Weinheim, 2004.

8. A.S. bd El-Aziz, I. Mancers Eds, Frontiers in Transition Metal-Containing Polymers, Wiley-Inter-science, 2007

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CHE: ORGANIC SYNTHESIS-I

Semester	Code of the Course	Title of the Course / Paper	NHEQF Level	Credits
I	CHE 20105-T	ORGANIC SYNTHESIS-I	8	4
Level of Course	**Type of Course**	**Delivery of the Course**		
Advance	CE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Prerequisites	Chemistry courses at the UG level			
Objectives of the Course	This course provides an introduction and different characteristic properties of different organometallic compounds as well as metallocenes and nonbenzenoid aromatic compounds along with the detailed knowledge of oxidation, reduction process of different compounds with different reagents and their mechanism. This course provides detailed study of different type of rearrangement and their mechanism also. **Learning Outcomes**: By the end of this course, students would learn- • different characteristic properties of different organometallic compounds • different characteristic properties of metallocenes and nonbenzenoid aromatic compounds • Able to learn detailed study of different type of rearrangement their mechanism along with their applications also			

CHE: ORGANIC SYNTHESIS-I

4 Credit (4 hrs/week)

UNIT-I **(15 Lectures)**

Organometallic Reagents

Principle, preparations, properties and applications of the following in organic synthesis with mechanistic details

Group I and II metal organic compounds. Li, Mg, Hg, Zn and Cd compounds.

Transition metals Cu, Pd, Ni, Fe, Co, Rh, Cr, and Ti compounds.

Metallocenes, Nonbenzenoid Aromatics and Polycyclic Aromatic Compounds

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General considerations, synthesis and reactions of some representative compounds, (tropone, tropolone, Azulene, ferrocene and phenanthrene).

Unit-II **(15 Lectures)**

Oxidation

Introduction. Different oxidative processes. Hydrocarbons alkenes, aromatic rings, saturated C groups (activated and unactivated).

Alcohols, diols, aldehydes, ketones, ketals and carboxylic acids Amines, hydrazines, and sulphides. Oxidations with ruthenium tetraoxide, iodobenzenadiacetate and thallium (III) nitrate.

Unit-III **(15 Lectures)**

Reduction

Introduction. Different reductive processes.

Alkanes, alkenes, alkynes and aromatic rings. Carbonyl compounds aldehydes, ketones, acids and their derivatives. Epoxides. Nitro, nitroso, azo and oxime groups. Hydrogenolysis.

Unit-IV **(15 Lectures)**

Rearrangements

General mechanistic considerations nature of migration, migratory aptitude, memory effects. A detail study of the following rearrangements: Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil Benzillic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofmann, Curtius, Schmidt, Baeyer Villiger, Shapiro and Schimdt reaction.

Books Suggested:

1. Modern Synthetic Reactions H.O. House. W.A. Benjamin.
2. Some modern Methods of Organic Synthesis. W Carruthers. Cambridge Univ. Press
3. Advance Organic Chemistry, Reaction Mechanisms and Structure J. March. Jobs Wiley.
4. Principles of Organic synthtais. KDC Norman and JM. Coxon. Blackie Academic & Professional.
5. Advance Organic Chemistry Part B. FA Carey and RJ. Sundberg. Plenus Preas
6. Rodd's chemistry of Carbon Compounds. Ed. S Coffey, Elsevier.

CHE: SOLID STATE CHEMISTRY

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
I	CHE 20106-T	SOLID STATE CHEMISTRY	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	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, different diffraction methods and nanomaterials. **Learning Outcomes**: By the end of this course, students would learn- • To describe, with confidence, the features of the common crystalline structures. • crystalline structure with the bonding to predict materials properties. • To learn about different defect structures in the solid state and its effects on the materials properties. • To learn band theory to describe the operation of modern semiconductor devices • thermodynamics to explain the presence of point defects in crystalline solids. • Uses of semiconductors, superconductors & scope of nanomaterials in chemistry. • To increase the knowledge of X ray diffraction, electron diffraction & techniques SEM, TEM etc. • To know the principle, instrumentation, and application of X-Ray spectroscopy and its role in structural analysis of crystals.		

CHE: SOLID STATE CHEMISTRY

Credit (4 hrs/week)

UNIT-I

(15 Lectures)

Solid State Chemistry

Introduction to the solid state, defects of solids, classification of imperfections, Electronic defects, atomic defects, Lattice imperfections, thermodynamics of Schottky defect and Frenkel defect. Electrical, optical, magnetic and thermal properties of inorganic materials.

Solid State Reactions: general principles, types, sintering, nucleaion; Factors influencing the reactivity of solids; co-precipitation as a precursor to solid state reactions, kinetics of solid state reactions.

UNIT-II

(15 Lectures)

Superconductors

Superconductors, with special emphasis on the synthesis and structure of high temperature superconductors; solid state LASERS (Ruby, YAG and tunable lasers): Inorganic phosphor materials, synthesis and advantages of optical fibers over conducting fibres, diffusion in solids, catalysis and zone refining of metals.

UNIT-III

(15 Lectures)

Diffraction Methods

A. **X-ray Diffraction**

Bragg condition, Miller indices, Laue Method, Bragg method, Debye Scherrer method of X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern, Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity and electron density, phase problem; description of the procedure for an X-ray structure analysis, absolute configuration of molecules.

UNIT-IV

(15 Lectures)

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, measurements techniques, Elucidation of structure of magnetically ordered unit cell.

SUGGESTED BOOKS AND REFERENCES

1. H.V. Keer, Principles of the Solid State; Wiley Eastern Ltd. Now Delhi, 1993.
2. A.L. West, Solid State Chemistry and its Applications, 2nd Edn, John Wiley and Sons, 2014.
3. X. B. Hannay, Treatise on Solid State Chemistry, Plenum, 1976

Mishra

4. A. K. Cheutsam and P. Day, Eds. Solid State Chemistry Techniques, Clayndon Prasa, Oxford, 1917
5. John Wulff, The structure and properties of materials, John Wiley & Sons Trans edition, 1966.
6. L.V. Azaroff, J. J. Brophy, Electronic processes in materials, Mc Craw 1till, 1967.
7. D. K.Chakrabarty, Solid State Chemistry, New Wiley Rastern, 2009.
8. M. Day, J. belbin, Theoretical Inorganic Chemistry, Reinhold Publishing, New York, 1962.
9. A.W. Adamson and A.P. Gast, Physical Chemistry of Surfaces, Wiley-Inter-science 6 edn. 1997.
10. O. Timp. Edn. Nanotechnology; Springer-Varleg: N. Y., 1999
11.B. D. Fahiman, Materials Chemistry, Springer, 2007.

CHE: CHEMICAL ANALYSIS

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
I	CHE 20107-T	CHEMICAL ANALYSIS	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The objective of this course is to equip students with some of the concepts that are widely used in chemical analysis used in chemistry. The course aims to develop a deep understanding of concept of water, soil, fuel, food analysis in detail along with drug analysis and their applications in chemistry. This course also introduces the food analysis techniques and pesticides content in food. **Learning Outcomes**: On the completion of this course, student would learn • Detailed knowledge about food analysis technique, pesticide content analysis in food. • Learn about the measurement of DO, BOD and COD of water sample • Learn about Principle of radio immunoassay (RIA) and its applications. • Learn about the sources of water pollution. • Understand the composition of blood & collection and preservation of samples. • Learn about the Narcotics and dangerous drugs & classification of drugs also.			

CHE: CHEMICAL ANALYSIS

Mrinal

4 Credit (4 hrs/week)

UNIT-I

(15 Lectures)

Water Analysis

Sources of water pollution domestic, industrial, agricultural soil and radioactive wastes as sources of pollution. Objectives of analysis-parameter for analysis color, turbidity, total solids, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen. Heavy metal pollution-public health significance of cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems (Measurement of DO, BOD and COD). Pesticides as water pollutants and analysis. Water pollution laws and standards.

UNIT-II

(15 Lectures)

Food Analysis

Moisture, ash, crude protein, fat, crude fiber, carbohydrates, calcium, potassium, sodium and phosphate. Food adulteration-common adulterants in food, contamination of food stuffs. Microscopic examination of foods for adulterants. Pesticide analysis in food products. Extraction and purification of sample HPLC, Gas chromatography for organophosphates. Th in-layer chromatography for identification of chlorinated pesticides in food products.

UNIT-III

(15 Lectures)

Soil and Fuel: Analysis

(a) Analysis of soil, moisture, pH, total nitrogen, phosphorus, silica lime, magnesia, manganese, sulphur and alkali salts.

(b) Fuel analysis: liquid and gas. Ultimate and proximate analysis, heating values-grading of col. Liquid fuels flash point, aniline point, octane number and carbon residue. Gaseous fuels-producer gas and water gas-calorific value.

UNIT-IV

(15 Lectures)

Body Fluids and Drug Analysis:

Composition of blood collection and preservation of samples. Serum electrolytes, blood glucose, blood urea nitrogen, uric acid albumin, globulins acid and alkaline phosphatases, Immunoassay: Principle of radio immunoassay (RIA) and applications. The blood gas analysis trace elements in the body.

Narcotics and dangerous drugs classification of drugs. Screening by gas and thin layer chromatography and spectrophotometric measurements.

SUGGESTED BOOKS AND REFERENCES

1. G.D. Christian, P.K. Dasgupta, K.A. Schug, Analytical Chemistry, Wiry, 7th edn., 2013.
2. DA. Skoog, D.M. West and F.J. Hooler, S.R. Crouch, Fundamentals of Analytical Chemistry, 2014
3. J.H. Kennedy, Analytical Chemistry-Principles, Saunders College Publishing, New York, edn, 1990.
4. L.G. Hargis, Analytical Chemistry-Principles and Techniques, Prentice Hall, 1988.

5. R.A. Day, Jr. and A.L. Underwood, Quantitative Analysis, 6 edn, Prentice Hall, 1991.

6. S.M. Khopkar, Environmental Solution, Wiley Eastern.

7.S.M. Khopkar, Basic Concepts of analysis Chemistry, New Age International, 1998.

8. Alla Gupta, Analytical Chemistry, Pragati Publication, 2014.

9. D.C Das, Analytical Chemistry, Prentice Hall India Learning Private Limited, 2010

CHE: ORGANOTRANSITION METAL CHEMISTRY

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
I	CHE 20108-T	ORGANOTRANSITION METAL CHEMISTRY	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The objective of this course is to equip students with some of the concepts that are widely used in organo-transition metal chemistry. The course aims to develop a deep understanding of concept Synthesis, Properties, Structure and Bonding of carbene and carbyne, alkene and alkyne complexes, allyl complexes, dienyl complexes, dienyl complexes Metal nitrosyls, cyanides and isocyanides Hydrogenation of alkenes, Hydrosilylation of alkenes, Metathesis of alkenes & Catalysis and their applications in chemistry. **Learning Outcomes**: On the completion of this course, student would learn • Able to understand the deep knowledge of Synthesis, Properties, Structure and Bonding of carbene and carbyne, alkene and alkyne complexes, allyl complexes, dienyl complexes, dienyl complexes. • Able to understand the deep knowledge of Synthesis, Properties, Structure and Bonding of Metal nitrosyls, cyanides and isocyanides complexes. • Able to understand the deep knowledge of Hydrogenation of alkenes, Hydro-silylation of alkenes, Metathesis of alkenes with mechanism. • Able to understand the deep knowledge of Hydroformylation of alkenes & Oxidation of alkenes through various examples.		

	• Able to understand the deep concept of catalysis and its types with various examples.

CHE : ORGANOTRANSITION METAL CHEMISTRY

(Synthetic aspects of organo-transition metal & Metal nitrosyls, cyanides and isocyanides, and Catalysis)

4 Credit (4 hrs/week)

UNIT-I

(15 Lectures)

Synthesis, Properties, Structure and Bonding of:

(Giving some specific examples)

(i) η1- bonded alkyl complexes

(ii) η1- carbene and carbyne complexes

(iii) η2 - alkene and alkyne complexes

(iv) η3- allyl complexes

(v) η4 - dienyl complexes

(vi) η5- dienyl complexes

UNIT-II

(15 Lectures)

Metal nitrosyls, cyanides and isocyanides:

Synthesis, reactions, structure and bonding in metal nitrosyls: nitrosyl complexes, metal cyanides and isocyanides: cyanogens, cyanates and its analogue. Sulfur, selenium and tellurium ion. Diisocyanides, reactions of isocyanide complexes and their uses.

UNIT-III

(15 Lectures)

Synthetic and Catalytic Aspects of Organo -transition Metal Chemistry:

(i) Transition metal organometallics in organic synthesis

(ii) Homogenous catalysis by transition metal organometallics

(a) Hydrogenation of alkenes

(b) Hydrosilylation of alkenes

(c) Metathesis of alkenes

(d) Oligomerization and polymerization of alkenes and alkynes

(e) Hydroformylation of alkenes

(f) Acetic acid synthesis and other carbonylation reactions

(g) Oxidation of alkenes

UNIT-IV

(15 Lectures)

Catalysis

(a) Heterogenous catalysis by organo-transition metal compounds

(b) Fisher-Tropsch synthesis: Methanation reactions, Synthesis of methanol, gasoline production, function of ZSM-5 Zeolite in stabilization of carbine molecule, application of reaction to industry.

(c) Water gas shift reaction: Role of ZnO/Cr2O3 in the reaction, Acetic acid synthesis from water gas shift, Role of Co catalyst.

(d) Fluxional organometallic compounds: Rate of rearrangement, Simple examples of non-rigid molecules in different coordination geometries, classification, future developments.

SUGGESTED BOOKS AND REFERENCES:

1. Principles and Applications of Organo-transition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G.Finke, University Science Books, 1987.
2. The Organometallic Chemistry of Transition Metals, R.H. Crabtree, John Willey, 1989.
3. Metalloorganic Chemistry, A.J. Pearson, Wiley, 1985.
4. Organometallic Chemistry, R. C. Mehrotra and A. Singh, New Age International, 1991.
5. Reaction of Transition Metal Complexes, J.P. Candlin K. Aayler and D.T Thomson, Elsevier
6. Organometallic Compounds, M.L.H. Green, Vol. II, Methuen, 1968.

CHE: NATURAL PRODUCTS-I

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
I	CHE 20109-T	NATURAL PRODUCTS-I	8	4
	Type of course	**Delivery type of the course**		
Advance	CE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The objective of this course is to provide student with a basic understanding and knowledge of the chemistry of natural product of medicinal importance. It also aims to understand the difference method 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, plant hormones and Natural pigments. • analyze and discuss the Information and data related to the various classes of natural products. • Different uses of natural products to the biological process.			

CHE: NATURAL PRODUCTS-I

4 Credit (4 hrs/week)

UNIT-I **(15 Lectures)**

Terpenoids and Carotenoids

Introduction, occurrence, nomenclature, general methods of structure determination, isoprene rule, stereochemistry and synthesis of following representative molecules: Citral, Geraniol, α-Terpineol, Menthol, Farnesol, Zingiberene. Phytol, and Abietic acid. Biosynthesis of Terpenoids. General methods of structure determination of β-Carotene and Lycopene

UNIT-II **(15 Lectures)**

Alkaloids

Introduction, occurrence, nomenclature, classification based on structure, Isolation, general methods of structure elucidation of alkaloids, stereochemistry and synthesis of the following: Narcotine, Quinine, Reserpine and Morphine.

UNIT-III **(15 Lectures)**

Steroids

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrogen and Progesterone Biosynthesis of cholesterol.

Plant Hormones

Introduction, occurrence, isolation and physiological effects of Auxins, Gibberellins (Synthesis of GA_3), Cytokinins and Abscisic acid.

Nutraceuticals and Natural Products

Occurrence, isolation, biological function and structure elucidation by spectroscopic methods) of Curcumin, Silymarin, 5-hydroxytryptophan, Chlorogenic acid and Vinpocetine.

UNIT-IV **(15 Lectures)**

Natural Pigments

Occurrence, nomenclature and general methods of structure determination. Isolation, structure determination and synthesis of Luteolin, Quercetin, Luteolin, Dindzein, Genistein, and Cyanidin chloride

Porphyrins: Structure, reactions and synthesis of haemoglobin, chlorophyll, chlorins, bacteriochlorins and purpurin anhydride. Photosensitizers in Photodynamic Therapy.

SUGGESTED BOOKS AND REFERENCES

1. J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harbome Natural Products, Chemistry and Biological Significance, Prentice Hall, 1994.
2. I. L. Finar, Organic Chemistry: Vol. 2, ELBS, Longman, 1996.
3. M. Norgradi, Stereoselective Synthesis; A Practical Approach, Wiley-VCH, 1994.
4. Bhat, BLA. Nagasampagi and M. Sivakumar, Chemistry of Natural I products, Narosa Publishing House 2015.

5. Ed. Kurt Hostertunann, M.P. Gupta and A. Marston, Chemistry, Biological of Medicinal Plants from the Americas, Harwood Academie Publishers, 1999,
6. B.A. Bohm, Introduction to Flavonoids, Harwood Academic Publishers, 1998
7. Atur-Rahman and M.L. Choudhary, New Trends in Natural Product Chemistry, Harwood Academic Publishes, 1998.

CHE: BIOMOLECULES - I

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
I	CHE-20110-T	BIOMOLECULES- I	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	ECCE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The objective of this course is to equip students with some concepts of the biomolecules used in chemistry. The course aims to develop a deep understanding of concept Carbohydrates, Lipids, Protein & Transmission of genetic information and their applications in chemistry. **Learning Outcomes**: On the completion of this course, student would learn • Able to understand the deep knowledge of Structure and biological functions of Carbohydrates. • Able to understand the deep knowledge of nomenclature, classification, and physical properties of fatty acids. • Able to understand the deep knowledge of nomenclature, classification, different properties of Amino-acids, Peptides and Protein and their structures. • Able to understand the deep knowledge of Nucleic acid structure and function.			

CHE: BIOMOLECULES- I

(Carbohydrates, Lipids, Protein& Transmission of genetic information)

4 Credit (4 hrs/week)

UNIT-I

(15 Lectures)

Carbohydrates

Structure and biological functions of derivatives of monosaccharides like, Amino sugars - Glucosamine and N-Acetylglucosamine; Carboxylic acid sugars- Glucuronic acid and Gluconic acid; Sugar phosphates- Adenosine triphosphate (ATP); Sugar alcohols- Maltitol and Lactitol. Structure, nomenclature, properties and reactions of oligosaccharides. Structure and biological functions of derivatives of polysaccharides - chondroitin sulphate, heparin and hyaluronan.

Unit-II

(15 Lectures)

Lipids

Introduction, nomenclature, classification, and physical properties of fatty acids. Chemical properties of fatty acids - methylation of carboxyl groups, halogen addition reactions, transformation of isolene-type fatty acids to conjugated fatty acids and hydrogenation. Nomenclature, classification, structure, and function of triacylglycerols, Phospho- and Glycolipids, Definition and classification of lipoproteins. Involvement of lipids in the formation of biological membranes, Introduction of diol lipids, higher alcohols (Waxes and alkoxy lipids) and Cutin.

UNIT -III

(15 Lectures)

Amino-acids, Peptides and Protein

Peptide bond, Chemical and enzymatic hydrolysis of proteins to peptides. Synthetic Amino Acids Utilized for Increasing the Biological Value of Food (Food Fortification) - Glutamic Acid, Aspartic Acid, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan. General Remarks, Nomenclature, physical properties and sensory properties of Peptides. Structure and use of peptides of interest to food chemists - Glutathione, Carnosine, Anserine and Balenine, Nisin and Lysine Peptides. Secondary structure of proteins-α-helix, β-sheet, forces responsible for holding the secondary structures of proteins.

UNIT-IV

(15 Lectures)

Transmission of Genetic Information from the Gene to the Protein

Nucleic acid structure and function - DNA, double helix, DNA replication, Mutation and DNA repair, RNA types of RNA, transcription, RNA modification, Genetic code, Translation, Transfer RNA, Steps o translation-initiation, elongation and termination, Chromosome organization, Repetitive DNA sequences. Prokaryotic regulation of gene expression, Eukaryotic control of gene expression, transcriptiona regulations.

SUGGESTED BOOKS AND REFERENCES

1. Principles of Biochemistry, A. L. Lehninger, Worth Publishers.
2. Biochemistry, L. Stryer, W.H.Freeman.
3. Biochemistry, J. David Rawn, Neil Patterson.
4. Biochemistry, Voet and Voet, John Wiley.
5. Outlines of Biochemistry, E.E. Conn and P.K. Stumpf, John Wiley.
6. Food Chemistry, H.D. Belitz et.al., Springer

CHE: CHEMISTRY CORE LAB-1

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
I	CHE 20111 -P	CHEMISTRY CORE LAB-1	8	4/4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	PR	Practical (08 hrs in a week), including diagnostic and formative assessment during practical hours.		
Pre-requisites	Chemistry courses of the Undergraduate level or equivalent.			
Objectives of the course	This course aims - i. To enable students to Qualitative analysis of mixture of inorganic compounds ii. To provide hands-on experience in synthesis of different organic compounds through multiple step. iii. To develop the concept of surface tension, viscosity and phase rule phenomenon in laboratory through different experiments.			

CHE: CHEMISTRY CORE LAB-1

4 Credit (08 hrs/week)

A. Qualitative analysis of mixture consisting of six cationic/ anionic radicals including

a. Interfering anionic radical

b. Insoluble oxides, sulphates and halides

c. Less common metal ions Tl, W, Mo, Se, Te, V, Th, Ti, Zr, Ce, Li

B. Two Step Organic Synthesis

1. Aniline To 2,4,6-Tribromoaniline To 1,3,5-Tribromobenzene
2. Aniline To Diazoaminobenzene To p-Aminoazobenzene
3. Phthalic anhydride To Fluorescein To Eosin
4. Phthalic anhydride To Phthalimide To Anthranilic acid
5. Acetanilide To p-Nitroacetanilide To p-Nitroaniline
6. More two step organic preparations involving general organic reactions may be carried out. The products to be characterized by m.pt/spectral techniques.

C.Experiments based on

Surface tension

i. To study surface tension concentration relationship for solution (Gibbs equation).

ii. To determine the critical micelle concentration (CMC) of SDS and CTAB by surface tension techniques.

Phase rule

Determination of critical solution temperature of water- phenol system.

Viscosity, Solubility and Molecular weight determination

i. Experiment based determination of viscosity of given liquid using Ostwald's viscometer

ii. Study the variation of viscosity of pure liquid with temperature and determination of temperature coefficient of viscosity of the liquid.

iii. Determination of Solubility of various salts like NaCl, KCI, KNO_3 and $NaNO_3$, at different temperature and draw the solubility Curve.

iv. Determination of molecular weight of given polymer (Polyvinyl alcohol, polystyrene, methyl acrylate, etc.) using viscometer

v. Determination of molecular weight of non-volatile and non-electrolyte/electrolyte by cryoscopic method and to determine the activity coefficient of an electrolyte

Reference Books:

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett. R.C. Denney, G.H. Jeffrey and Menibam, ELBS.

प्रभारी अकादमिक प्रथम

2. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly. Prentice Hall
3. Experiments and Techniques in Organic Chemistry, D.P. Pasto. C. Johnson and M. Miller, Prentice Hall.
4. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Health.
5. Systematic Qualitative Organic Analysis, H. Middieson. Adward Amold.
6. Handbook of Organic Analysis-Qualitative and Quantitative. H. Clar. Adward Arnold.
7. Vogel's Textbook of Practical Organic Chemistry A.R. Tatchell. John Wiley.
8. Practical Physical Chemistry. A.M. James and F.E. Porichard, Longman.
9. Findley's Practical Physical Chemistry, B.P. Levitt, Loogman.
10. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata-McGraw Hill.

SEMESTER - II

प्रभारी अकादमिक प्रथम

CHE: THERMODYNAMICS AND CHEMICAL KINETICS

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
II	CHE 20201-T	THERMODYNAMICS AND CHEMICAL KINETICS	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CC	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The objective of this course is to provide students with a theoretical understanding of the concepts that are widely used in Physical chemistry. The course aims to develop a deep understanding of classical and statistical Thermodynamics as well as Chemical Kinetics and their applications in chemistry. **Learning Outcomes**: After studying this paper, students would learn- • Understand the laws of thermodynamics and basic knowledge of chemical potential and partial molar properties, • Learn about the concept of activity, activity coefficient and fugacity and its determination • Learn about the concept of Ensemble averaging, Partition functions and its types and different statistics distribution Law • Understand the deep knowledge of Methods used for determining rate			

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प्रभारी अकादमिक प्रधान

	laws, different theories of reaction rates as well dynamics of different chemical reaction • Learn about the concept of fast reactions and different methods used for the study of these reactions.

CHE: THERMODYNAMICS AND CHEMICAL KINETICS

4 Credit (4 hrs/week)

UNIT-I (15 Lectures)

Classical Thermodynamics

Brief resume of concept 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 significances. Determinations of these quantities. Concept and determination of fugacity non-ideal systems. Excess functions for non-ideal solutions. Activity, activity coefficient and its determination. Debye-Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients; ionic strength.

Application of phase rule to two component systems; second order phase transitions.

UNIT-II (15 Lectures)

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 functions-translational, rotational, vibrational and electronic partition functions. Calculation of thermodynamic properties in terms of partition functions. Application of partition functions. Maxwell-Boltzmann distribution Law & statistics, Bose-Einstein statistics and Fermi-Dirac statistics.

UNIT-III (15 Lectures)

Chemical Kinetics-I

Rate of chemical reactions and its representation, order and molecularity of reactions, kinetics and reaction mechanism, complex reactions, steady state and steady state concept, opposing reactions, consecutive reactions and parallel reactions, chain reactions, kinetics of different reactions such as photochemical and thermal combination of hydrogen and bromine reaction, decomposition of ethane, decomposition of acetaldehyde, combination of hydrogen and chlorine.

Catalyst and catalysis, classification of catalysis, theories of homogeneous and heterogeneous catalysis. Enzyme catalysis. Kinetics of homogeneous catalysis.

UNIT-IV **(15 Lectures)**

Chemical Kinetics-II-

Effect of temperature on rate of reactions, Temperature coefficient, activation energy, Arrhenius theory of reactions, collision theory, modified collision theory, absolute reaction rate theory (Activated complex theory). Dynamics of unimolecular reactions (Lindemann theory, Hinshelwood treatment, Rice -Ramsperger Kassel Marcus Theory RRKM)

Kinetics of liquids in solutions, Kinetic salt effect, kinetics and thermodynamical control of reactions, general feature of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis, and nuclear magnetic resonance method.

SUGESTED BOOKS AND REFERENCES

1 P. W. Atkins, Physical Chemistry, ELBS.

2 K.J. Laidler, Chemical Kinetics, McGraw Hill.

3 J. Refaraman and J. Kuriacose, Kinetics and Mechanism of Chemical Transformation, Plenum.

4 Samuel Glasstone, Thermodynamics for Chemist, East West Press

5 R. P. Rastogi and R. R. Mishra, Introduction to Chemical Thermodynamics, Vikash Publication House.

6 Puri, Sharma and Pathaniya, Principles of Physical Chemistry, Vishal Publication.

CHE: SPECTROSCOPY-I

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
II	CHE 20202-T	SPECTROSCOPY-I	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CC	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The course aims to develop an advanced and strong understanding of atomic and molecular spectroscopy, Microwave, photoelectronic, Mossbauer and NMR spectroscopy in terms of governing principles, laws, theoretical knowledge, experimental techniques along with their applications in structural determination and the impact of different external parameters on the energy levels of atomic and molecular spectra. The identification of atoms, molecules, determination of atomic and molecular structures, bond energy, bond length, moment of inertia, isotope determination, etc. **Learning Outcomes**. After studying this paper, students would learn- • The knowledge about the principle of spectroscopy & concept of mechanism of absorption and emission of radiation • The knowledge about the basic principles of electromagnetic radiations and its Interaction with matter Students will also gain the knowledge		

	about the rotational spectroscopy, IR & Raman spectroscopy. • The knowledge about the basic principles, instrumentation and applications of various spectroscopic techniques including Infrared spectroscopy, NMR & ESR spectroscopy, electronic spectroscopy, Photoelectron and Mossbauer Spectroscopy

CHE: SPECTROSCOPY-I

4 Credit (4 hrs/week)

UNIT-I (15 Lectures)

Introduction: Interaction of light with mattes, mechanism of absorption and emission of radiation

Microwave Spectroscopy: Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor: stark effect, nuclear and electros spin interaction and effect of external field applications.

Vibrational Spectroscopy: Vibrational energies of diatomic molecules, zero-point energy, force constant and bond strengths: anharmonicity, Morse potential energy diagram, vibration-rotation spectroscopy. PQR branches, breakdown of Oppenheimer approximation; vibrations of polyatomic molecules, selection rules, normal modes of vibration, group frequencies overtones, hot bands, factors affecting the band positions and intensities, far IR region, metal ligand vibrations.

Raman Spectroscopy: Origin, rotational and vibrational Raman Spectra of diatomic molecules

UNIT-II (15 Lectures)

Electronic Spectroscopy

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

Molecular Spectroscopy: Energy levels, molecular orbitals, vibronic transitions, vibrational progressions and geometry of the excited states, 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: Photo-electric effect, ionization process, Koopman's theorem, photoelectron spectra of simple molecules, ESCA, chemical information from ESCA; Auger electron spectroscopy-basic idea

UNIT-III (15 Lectures)

Magnetic Resonance Spectroscopy

Nuclear Magnetic Resonance: Basic Principle, Spin quantum number, interaction between Spin and a Magnetic

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Field, Larmor Precession, Relaxation Times, Continuous Wave NMR Spectroscopy, Fourier Transform NMR Spectroscopy, Introduction to Chemical Shift, Spin- spin coupling, Coupling constant. Nuclei other than hydrogen: Nuclei with spin 1/2 (^{13}C, ^{19}F, ^{31}P, ^{117}Sn, ^{119}Sn etc.), Nuclei with spin greater than ½ (^{14}N,^{11}B). Quadrupole effects, factors affecting chemical shift in inorganic compounds geometry, electronegativity, charge, oxidation state, coordination number. Coupling tween two or more than two types of NMR active nucleus in a compound (e.g. $CHFCl_2$, $HPFCl_2$, $OP(O)FH$, $HP(O)F_2$, BH_4.

Electron Spin Resonance: Basic principles, zero field splitting and Kramer's degeneracy, Isotropic and anisotropic Hyperfine coupling, spin-orbit coupling and significance of g- tensors, factors affecting value, its applications to the study of free radicals & fast reactions and application transition metal complexes; spin Hamiltonian, spin densities and McConnell relationship applications - spin polarization for atoms and transition metal ions.

UNIT-IV **(15 Lectures)**

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

Electron Microscopy: Basic principles of Electron Microscopy SEM, TEM, APM and their Applications in structural analysis.

SUGGESTED BOOKS AND REFERENCES

1 Fundamentals of Molecular Spectroscopy, Banewell and McCash.

2 Modern Spectroscopy, J. M. Hollas, Joho Wiley.

3 Applied Electron Spectroscopy for Chemical Analysis D. H. Windavi and F.L. Ho, Wiley Interscience

4. Physical Methods in Chemistry, R.S. Drago, Saunders College.

5. Chemical Applications of Group Theory, F.A. Cotton

6. Introduction to Molecular Spectroscopy, G.M. Burrow, Mc Graw Hill

7. Electronic Absorption Spectroscopy and related Techniques, D.N. Senyanarayana

8. Basic Principles of Spectroscopy. R. Chang, Mc Graw Hill

9. Theory and Application of UV Spectroscopy, H.H Jaffe and M. Orel in, IBH-Oxford

10. Introduction to Photoelectron Spectroscopy, P.K. Ghosh, Joha Wiley

11. Introduction to Magnetic Resonance A Carrington and A.D. Maclachalan, Harper & Row.

12. NMR Spectroscopy in Inorganic Chemistry, J.A. Iggo, Oxford University Press. Oxford, 1999, pp 1-21. 31-35

13. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry. R.V. Parish, Ellis Harwood.

CHE: ADVANCED NANOSCIENCE AND NANOTECHNOLOGY

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
II	CHE 20203-T	ADVANCED NANOSCIENCE AND NANOTECHNOLOGY	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The course aims to develop an advanced and deep understanding of nanoscience and nanotechnology in terms of theoretical knowledge, synthesis by micro-organisms experimental techniques along with their different applications **Learning Outcomes**. After studying this paper, students would learn- • Able to gain the knowledge about the basic concepts of Nano science and technology. • Able to gain the knowledge about different synthesis methods • Able to gain the knowledge about Characterization TEM, SEM and SPM technique • Able to gain the knowledge about the nanoscale carbon • Able to gain the knowledge different applications in Nanomedicine, Nanofoods, Nano-cosmetics and Nanobiotechnology.		

CHE: ADVANCED NANOSCIENCE AND NANOTECHNOLOGY

(Nano materials synthesis, properties, Nanoscale Carbon and Applications)

4 Credit (4 hrs/week)

UNIT-I **(15 Lectures)**

Nanoscience and Nanotechnology

Basic concepts of Nano science and technology, Quantum wire, Quantum well, Quantum dot, Properties and technological advantages of Nano materials, Material processing by Sol, Gel method, Chemical Vapour deposition and Physical Vapour deposition methods

UNIT II **(15 Lectures)**

Synthesis

Top-down (Nanolithography, CVD), Bottom-up (Sol-get processing, chemical synthesis). Wet Deposition techniques, Self-assembly (Supramolecular approach), Characterization TEM, SEM and SPM technique, Fluorescence Microscopy and Imaging.

Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Viruses as components for the formation of nanostructured materials; Synthesis process and application, Role of plants in nanoparticle synthesis.

UNIT III **(15 Lectures)**

Nanoscale Carbon

Introduction –Carbon molecules-nature of the carbon bond-new carbon structures-discovery of C60- structure of C60 and its crystal- From a Graphene Sheet to a Nanotube, Single wall and Multi walled Nanotubes, Zigzag and Armchair Nanotubes, Euler's Theorem in Cylindrical and Defective Nanotubes. History Molecular and Super molecular Structure-Intrinsic properties of individual carbon nano tubes- Synthesis -Arcing in the present and absent of catalyze-laser method-Chemical Vapour Deposition -ball milling.

UNIT IV **(15 Lectures)**

Applications

Solar energy conversion and catalysis, Polymers with a special architecture, Liquid crystalline systems, Applications in displays and other devices, Advanced organic materials for data storage, Photonics, Plasmonics, Chemical, electrochemical and biosensors, Nanomedicine, Nanofoods, Nano-cosmetics and Nanobiotechnology.

SUGGESTED BOOKS AND REFERENCES

1. B. Vishwanathan, Nano materials, Narosa Publication, 2009.
2. Foster Lynn E, Nanotechnology, Pearson education, 2005.
3. T. Varghese and K M Balakrishna, Nanotechnology, Thomas Atlantic Publication, 2005.
4. J.J. Ramsden, Nanotechnology: An Introduction, Elesevier Publication, 2004.

5. B.K. Parathasarathy, An Introduction to Nanotechnology, Isha publication, 2007.
6. K.K. Chattopadhyay, Introduction to Nanoscience and Nanotechnology, PHI Publication, 2009.
7. Frank Owens, Introduction to Nanotechnology, Wiley, 2007.

CHE: PHOTOINORGANIC CHEMISTRY

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
II	CHE 20204-T	PHOTOINORGANIC CHEMISTRY	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The objective of this course is to equip students with some of the concepts that are widely used in Photo-inorganic chemistry. The course aims to develop a deep understanding of concept of Photochemical, Photophysical processes and their kinetics and excited electron transfer in Redox Reactions & Metal Complex Sensitizers and their applications in photo-inorganic chemistry			

CHE: PHOTOINORGANIC CHEMISTRY

4 Credit (4 hrs/week)

UNIT-I **(15 Lectures)**

Basic Concept

Introduction, Photochemical laws and photochemical kinetics. Physical properties of the electronically excited molecules, Photophysical processes in electronically excited molecules

UNIT-II **(15 Lectures)**

Photophysical Properties

Photophysical kinetics of Biomolecular processes; kinetics of collisional quenching: Stern-Volmer Equation, Concentration dependence of quenching and excimer formation, charge transfer mechanism and energy transfer mechanism.

UNIT-III **(15 Lectures)**

Photochemical Reactions

Photo-electochemistry of excited state redox reactions. Photosensitization. Types of Photochemical reactions; substitution, decomposition and fragmentation, rearrangement, and redox reactions, photochemistry of metallocenes

UNIT-IV **(15 Lectures)**

Redox Reactions by Excited Metal Complexes

Redox reactions of metal complexes in excited states, excited electron transfer, examples using $[Ru(bpy)_3]^{+2}$, complex and $[Fe(bpy)_3]^{+3}$ complex. Role of spin-orbit coupling, life-times of excited states in these complexes.

Metal Complex Sensitizers: Electron relay, semiconductor supported metal oxide systems, water-photolysis, nitrogen fixation and carbon dioxide reduction.

SUGGESTED BOOKS AND REFERENCES:

1. K.K. Roharagi-Mukherjee, Fundamentals of Photochemistry, Wiley Eastern, 1986
2. A.W. Adanson and P.D. Fleischauer, Concepts of Inorganic Photo-chemistry, Wiley, NY, 1975.
3. G.L. Gooffrey and M.S. Wrighton, Organometallic Photochemistry, Academic Press, 1979.
4. Inorganic Photochemistry, J. Chem. Educ. vol. 60 No. 10, 1983.
5. Coordination Chem Revs, vol. 39, 121, 1231, 1981; 14, 321,1975; 97,313 1990.
6. V. Balzari and V. Carassiti, Photochemistry of Coordination Compounds, Academic Press, 1970,
7. G.J., Ferraudi, Elements in Inorganic Photochemistry, Wiley, NY, 1983.
8. S.J. Lippard, ed. Progress in Inorganic Chemistry, Vol. 30. Wliey, 2009.

CHE: HETEROCYCLIC CHEMISTRY– I

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
II	CHE 20205-T	HETEROCYCLIC CHEMISTRY– I	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The objective of this course is to equip students with some of the concepts that are widely used in Heterocyclic chemistry. The course aims to develop a deep understanding of concept of Nomenclature of Heterocycles along with General chemical behaviour of aromatic heterocycles, empirical resonance energy, delocalization energy and Dewar resonance energy. Stereo-electronic effects torsional strains and their consequences in small ring heterocycles Synthesis and reactions Three-membered and Four-membered Heterocycles: **Learning Outcomes**: On the completion of this course, student would learn • Able to understand the deep knowledge of Nomenclature of Heterocycles for monocyclic, fused, spiro and bridged heterocycles • Able to understand the deep knowledge of General chemical behaviour of aromatic heterocycles			

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	• Able to understand the deep knowledge of empirical resonance energy, delocalization energy and Dewar resonance energy for aromatic heterocycles • Able to understand the deep knowledge of Concept of pyramidal inversion and 1,3-diaxial interactions. • Able to understand the deep knowledge of Synthesis and reactions Three-membered and Four-membered Heterocycles.

CHE: HETEROCYCLIC CHEMISTRY– I

(Aromatic & Non-aromatic Heterocycles, Three, Four, Five-membered Heterocycles with Benzo- fused Five-membered Heterocycle)

4 Credit (4 hrs/week)

UNIT-I (15 Lectures)

Nomenclature of Heterocycles

Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused, spiro and bridged heterocycles.

Aromatic Heterocycles

General chemical behaviour of aromatic heterocycles, classification (structural type), criteria of aromaticity (bond lengths, ring current and chemical shifts in 1H NMR-spectra, empirical resonance energy, delocalization energy and Dewar resonance energy, diamagnetic susceptibility exaltations). Heteroaromatic reactivity.

UNIT-II (15 Lectures)

Non-aromatic Heterocycles

Strain - bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interactions. Stereo-electronic effects; anomeric and related effects. Attractive interactions - hydrogen bonding and intermolecular nucleophilic electrophilic interactions.

UNIT – III (15 Lectures)

Small Ring Heterocycles

Three-membered and Four-membered Heterocycles: Synthesis and reactions of aziridines, oxiranes, thiiranes, oxaziridines, azetidines, oxetanes, thietanes and azetedinones.

UNIT-IV (15 Lectures)

Five-membered Heterocycles with Two Heteroatoms

Synthesis and reactions of 1,2- & 1,3-diazoles, oxazoles, thiazoles and azaphospholes.

Three-membered and Four-membered Heterocycles: Synthesis and reactions of benzopyrroles, benzofurans, benzothiophenes and benzimidazoles.

SUGGESTED BOOKS AND REFERENCES:

1. R.R. Gupta, M. Kumar and V. Gupta, Heterocyclic Chemistry Vol. 1& 2. Springer India, 1998 & 1999.
2. T Eicher and S. Hauptmann, The Chemistry of Heterocycles, Wiley-VCH, 2003.
3. J.A. Joule, K. Mills and G.F Smith, Heterocyclic Chemistry, Chapman and Hall, 1995.
4. T.L. Gilchrist, Heterocyclic Chemistry, Longman Scientific & Technical, 1992.
5. G.R. Newkome and W.W. Paudler, Contemporary Heterocyclic Chemistry, Wiley-Inter Science, 1982.
6. R.M. Acheson, An Introduction to the Heterocyclic Compounds, John Wiley, 1977.

CHE: BIO-INORGANIC CHEMISTRY

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
II	CHE 20206-T	Bio-inorganic chemistry	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CE	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The course aims to develop an advanced and deep understanding of Bioinorganic chemistry in terms of Role of metal ions in biological systems, essential and non-essential elements Structure and functions of electron transfer proteins Electron transfer in biology, Photosynthetic pigments, Transport and Storage of Dioxygen & Nitrogen Fixation **Learning Outcomes**. After studying this paper, students would learn- • The knowledge about the essential and non-essential elements and trace elements • The knowledge about the active transport of Na, K, Mg and Ca ions across the biological membrane • The knowledge about the Structure and functions of electron transfer proteins, Cytochromes, iron-sulphur proteins. • The knowledge about the mechanism of photosynthesis Photochemistry of chlorophyll molecules & Cyclic and noncyclic phototphosphorylation.		

	• The knowledge about Structure and function of haemoglobin, myoglobin, haemocyanin and haemerythrin. • The deep knowledge about nitrogen cycle, role of microorganisms in nitrification, nitrogen fixation in soils

CHE: BIO-INORGANIC CHEMISTRY

(Metals in life processes, Transport and Storage of Dioxygen, Photosynthesis, Nitrogen Fixation)

4 Credit (4 hrs/week)

UNIT – I **(15 Lectures)**

Metals in Life Processes:

Role of metal ions in biological systems; essential and non-essential elements- macro minerals and essential trace elements- synergism and antagonism among essential trace elements; active transport of Na, K, Mg and Ca ions across the biological membrane; elements of bioenergetics with special reference to elements of high energy phosphate bond.

UNIT – II **(15 Lectures)**

Electron Carriers and Photosynthesis:

(a) **Electron transfer in biology**: Structure and functions of electron transfer proteins. Cytochromes and respiratory chain, iron-sulphur proteins rubredoxin and ferridoxins. Synthetic models for Fe4S4 cluster only.

(b) **Photosynthetic pigments**: Photochemistry of chlorophyll molecules, mechanism of photosynthesis, Calvin cycle and Quantum efficiency. Function of photosystem- I and photosystem-II. Cyclic and noncyclic phototphosphorylation.

UNIT – III **(15 Lectures)**

Transport and Storage of Dioxygen:

Haem proteins and oxygen uptake. Structure and function of haemoglobin, mygolobin. Structural model for dioxygen binding-co-operativity, Perutz mechanism and Bohr effect; non-haem oxygen carriers in some lower animals, haemocyanin and haemerythrin. Model synthetic complexes of iron, cobalt and copper.

UNIT – IV **(15 Lectures)**

Nitrogen Fixation:

Nitrogen in biosphere, nitrogen cycle, role of microorganisms in nitrification, nitrogen fixation in soils. Biological nitrogen fixation and its mechanism, nitrogenase, Chemical nitrogen fixation and other nitrogenase model systems.

SUGGESTED BOOKS AND REFRENCES:

1. S. J. Lippard and J. M. Berg, Principles of Bioinogranic Chemistry, University Science Books, Mill Valley,
   CA, 1994.
2. H.v.I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, Bioinorganic Chemistry, University Science Books, Mill Valley, CA (USA), 1994.
3. P.S. Kalsi and J.P. Kalsi, Bio-organic, Bio-inorganic and Supramolecular Chemistry, New Age International, 2010
4. G.L. Eichhorn (ed.), Inorganic Biochemistry vol. I and II, Elsevier Scientific Publishing Co., Amsterdam, 1973.
5. Stephen J. Lippard (ed.), Progress in Inorganic Chemistry, Vol 18 and 38, Wiley, 2009.

CHE: Introduction to Research Methodology

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
II	IRM	Introduction to Research Methodology	8	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	IRM	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	The course aims to: 1. Develop understanding of scientific research principles, ethics and methodologies. 2. Equip students with skills to formulate hypotheses, research questions and experimental designs. 3. Train students in data collection, statistical analysis and scientific writing. 4. Develop competence in handling research tools: referencing, plagiarism checks and data presentation. 5. Prepare students for dissertation/project work using modern research practices. **Learning Outcomes:** After successful completion, students will be able to:			

	1. Explain concepts, types and approaches of biological research. 2. Formulate research problems, hypotheses and suitable methodologies. 3. Apply statistical tools for data analysis and interpretation. 4. Prepare scientific reports, theses and research articles using standard formats. 5. Demonstrate ethical and responsible conduct in research and publication.

CHE: Introduction to Research Methodology

Credits: 04hrs in a week

UNIT - I (15 Lectures)

Introduction to Research

Meaning, nature, scope and significance of research, Types of research: basic, applied, qualitative, quantitative, interdisciplinary, Scientific temper and scientific method

Research Problem & Hypothesis

Identification of research problem, Criteria of good research problem, Types of hypotheses, characteristics, formulation

Research Design

Experimental, descriptive, exploratory, diagnostic, cross-sectional & longitudinal designs

Variables: independent, dependent, controlled, confounding

Sampling Methods

Probability & non-probability sampling, Sample size determination, Errors in sampling

Laboratory and Field Research in Zoology

Experimental setups, field surveys, population studies, Safety, ethics, biosafety levels, permits

UNIT II (15 Lectures)

Data Collection Techniques

Primary and secondary data, Questionnaires, interviews, surveys, Observational methods, Experimental data acquisition

Measurement & Scaling Techniques

Nominal, ordinal, interval, ratio scales, Reliability and validity

Introduction to Biostatistics

Types of data, sampling distribution, Measures of central tendency (mean, median, mode), Measures

of dispersion (SD, variance, SE)

Statistical Tests

t-test, chi-square test, ANOVA (conceptual understanding), Correlation & regression, Non-parametric tests (Mann–Whitney, Kruskal–Wallis)

Data Representation

Tables, graphs, charts, Histogram, polygon, scatter plot

UNIT III (15 Lectures)

Research Tools & ICT in Research

Reference management tools: Zotero, Mendeley, Plagiarism detection tools: Turnitin, iThenticate, Data analysis software: Excel, SPSS/R (conceptual)

Scientific Writing

Structure of thesis & dissertation, Writing research papers: IMRAD format, Abstract, introduction, methods, results, discussion formatting

Referencing Styles

APA, MLA, Chicago, Vancouver, Citation rules, bibliography preparation

Presentation Skills

Seminar and conference presentation, Poster presentation techniques

Communication Skills in Research

Technical reports, Review articles, short communications

UNIT IV (15 Lectures)

Research Ethics

Ethical principles in biological sciences, Animal ethics: CPCSEA guidelines, Human ethics: Informed consent, confidentiality

Plagiarism & Academic Integrity

Types of plagiarism, Preventive strategies, Ethical authorship and contribution

Intellectual Property Rights (IPR)

Patents, copyrights, trademarks, Patent filing basics, biological materials & patent issues

Funding & Research Project Management

Grant writing, Funding agencies (DST, DBT, CSIR, UGC, SERB, ICAR), Budgeting, timeline development, Maintaining lab records, research notebooks

Research Dissemination

Peer review process, Journal selection, impact factor, h-index, Open access, predatory journals

Suggestive Readings:

1. Kothari, C.R. & Garg, G. (2019). *Research Methodology: Methods and Techniques.* New Age International Publishers.
2. Creswell, J.W. & Creswell, J.D. (2017). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches.* Sage Publications.
3. Sokal, R.R. & Rohlf, F.J. (2012). *Biometry: The Principles and Practice of Statistics in Biological Research.* W.H. Freeman & Co.
4. Wayne W. Daniel & Chad L. Cross. (2018). *Biostatistics: A Foundation for Analysis in the Health Sciences.* Wiley.
5. Day, R. & Gastel, B. (2012). *How to Write and Publish a Scientific Paper.* Cambridge University Press.
6. Laurel D. Hansen & Mark VanBaalen. (2015). *Research Methods in Biology.* Cambridge Scholars Publishing.
7. Graf, J. (2004). *Introduction to Research Methods: A Hands-On Approach.* Sage Publications.
8. Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA). Guidelines for Laboratory Animal Facility (Latest Edition).
9. Open-access Manuals:
    - *UGC Research and Publication Ethics (RPE) Guidelines*
    - *DBT/ICMR Ethical Guidelines for Biomedical Research*

CHE: GREEN AND SUSTAINABLE CHEMISTRY

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
II	IEC	GREEN & SUSTAINABLE CHEMISTRY	4	4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	IEC	Lectures (4 hrs in a week), including diagnostic and formative assessment during lecture hours.		
Pre-requisites	Chemistry courses at the UG level			
Objectives of the course	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 analysts. **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 process.			

	• 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. • To increase the knowledge about concept of ultrasound assisted green synthesis, electrochemical synthesis & microwave induced green synthesis.

SEC: GREEN AND SUSTAINABLE CHEMISTRY

4 Credit (4 hrs/week)

UNIT-I (15 Lectures)

Introduction, principle and concepts of Green Chemistry

Need the green chemistry, Inception and evolution of green chemistry, twelve principles of green chemistry with their explanations and examples, designing a green synthesis using these principles, green chemistry in day-to-day life.

UNIT-II (15 Lectures)

Non-traditional greener alternative approaches

Different approaches to green synthesis: (a) Uses of green reagents in organic synthesis Dimethyl carbonate, polymer supported reagents per acids and chromic acid (b) Green catalysts, role of catalysis in sustainable development, homogeneous and heterogenous catalysts, Introduction. advantages and applications of (1) Nanocatalysts, (ii) Phase transfer catalysts, (iii) Biocatalysts, (iv) Organo-catalysts, in organic synthesis.

UNIT-III (15 Lectures)

Applications of non-conventional energy sources

Introduction of microwave induced synthesis: Microwave activation, equipment, time and energy benefits, limitations; Organic transformations under microwaves- Fries rearrangement, Diels-Alder reaction, decarboxylation, saponification of ester, alkylation of reactive methylene compounds: Heterocyclic synthesis- β-Lactams, pyrrole, quinoline.

Introduction of ultrasound assisted green synthesis: Instrumentation, physical aspects, applications in organic transformations,

Electrochemical synthesis: Introduction, synthesis of sebacic acid and adiponitrile

UNIT-IV (15 Lectures)

Environmentally Benign Solutions to Organic Solvents

Ionic liquids as green solvents: Introduction, properties and types of ionic liquids, Synthetic applications Diels-Alder reaction, epoxidation and Heck reaction.

Aqueous phase reactions: Enhancement of selectivity, efficiency. Synthetic applications - 1,3-Dipolar Cycloadditions, Carbon-Carbon bond-forming processes and bromination reactions.

Fluorous solvents in green chemistry: Scope, definition and their synthetic applicability.

Role of supercritical carbon dioxide in green chemistry.

Ethyl lactate as a renewable green solvent: Properties and applications.

SUGGESTED BOOKS AND REFERENCES:

1. PAG Blackie, Organic synthesis in water, Springer
2. P.T. Anastas, J.C. Warues, Green Chemistry, theory and practice, Oxford University Press.
3. M. Lancaster, Green Chemistry: An introductory text, Royal Society of Chemistry.
4. V. Polshettiwar, T. Asefa, G. Hutchings, Nanocatalysis: Synthesis and applications, Wiley.
5. M.A. Ryaa, M. Tinnesand, Introduction to Green Chemistry, American Chemical Society.
6. P.T. Anastas, Handbook of Green Chemistry, John Wiley& Sons
7. VK. Alluwalia, M. Kidwai, New Treads in Green Chemistry, Springer.

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CHE: CHEMISTRY CORE LAB-2

Semester	Code of the course	Title of the course/paper	NHEQF Level	Credits
II	CHE 20209-P	CHEMISTRY CORE LAB-2	08	4/4
Level of Course	**Type of course**	**Delivery type of the course**		
Advance	CC + CE	Practical (08 hrs in a week), including diagnostic and formative assessment during practical hours.		
Pre-requisites	Chemistry courses of the Undergraduate level or equivalent.			
Objectives of the course	This course aims - • To enable students to preparation of different inorganic complexes and their identification through different technique. • To provide hands-on experience in Separation of Organic binary mixtures. identification of components using chemical tests, IR spectra for functional group identification and preparation of derivatives			

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	• To provide hands-on experience chemical kinetics through the determination of reaction rate of different reactions as well as order of the reaction in laboratory

CHE: CHEMISTRY CORE LAB-2

4 Credits (08 hrs/week)

Inorganic Preparations: Following selected inorganic compounds and their studies by IR spectra, Mössbauer, ESR and Magnetic susceptibility measurements. Handling of air and moisture sensitive compounds under vacuum.

I Sodium thiosulphate, $Na_2 S_2O_3.5H_2O$

II Tetraamine cupric sulphate $[Cu (NH_3)_4 SO_4] H_2O$

III N.N-bis(salicylaldehyde)ethylenediamine,

IV Copper glycine complex-cis-and trans-bis(glycinato)Copper (II)

V Cis- and trans-dichlorobis(ethylenediamine) cobalt (III) chloride, $[Co(en)_2Cl_2] Cl$

VI. $[Ni(NH_3)_6] Cl_2$

Purification techniques and Qualitative analysis

a. Demonstrations of purification, drying and storage of solvents using various techniques-distillation, steam distillation, vacuum distillation, etc.

b. Separation of Organic binary mixtures [(one liquid and one solid) or (two solids)) using H O & HCl and identification of components using chemical tests, IR spectra for functional group identification and preparation of derivatives

Experiments based on-

Chemical Kinetics

1. Determination of the primary salt effect on the kinetics of ionic reactions and testing of the Bronsted relationship (iodide ion is oxidized by persulphate ion).
2. Determination of the effect of (a) Change of temperature (b) Change of concentration of reactant and catalyst and (c) ionic strength of the media on the velocity constant of hydrolysis of an ester/ionic reaction.
3. Determination of the velocity constant of hydrolysis of an ester/ionic reaction in micellar media
4. Determination of the rate constant for the oxidation of iodide ions by peroxide studying the kinetics as an iodine clock reaction.

Reference Books:

प्रभारी अकादमिक प्रकोष्ठ