UNIVERSITY OF RAJASTHAN

JAIPUR-302004

FOUR-YEAR UNDERGRADUATE

PROGRAMME

Name of Faculty	**: Science**
Name of Discipline	**: Chemistry**
Type of Discipline	**: Major**
List of Programme offered as Minor Discipline	**: NA**
Offered to Non-Collegiate Students	**: NO**

Programme: UG0806 – Four Year Bachelor of Science

(Chemistry)

(Syllabus as per NEP-2020 and Choice Based Credit System)

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(Academic Year 2025-26 onwards)

SEMESTER-WISE PAPER TITLES WITH DETAILS

UG0806 – Four Year Bachelor of Science (Chemistry)								
#	Level	Semester	Type	Chemistry	Credits			
				Course Title	L	T	P	Total
1.	5	I	MJR	UG0806 – CHM-51T-101 Chemical bonding, Reaction mechanism, Mathematical concepts, Chemical kinetics and Gravimetric analysis.	4	0	0	4
2.	5	I	MJR	UG0806 – CHM-51T-102 – Molecular orbital theory, Weak interactions, Stereochemistry, Gaseous State and Solvent extraction.	4	0	0	4
3.	5	I	MJR	UG0806 – CHM-51P-103 – Practical I	0	0	2	2
4.	5	I	MJR	UG0806 – CHM-51P-104 – Practical II	0	0	2	2
5.	5	II	MJR	UG0806 – CHM-52T-105 – Chemistry of s- & p-block elements and Noble gases, Aliphatic hydrocarbons, Liquid & Solid States and Volumetric Analysis.	4	0	0	4
6.	5	II	MJR	UG0806 – CHM-52T-106 – Chemistry of Transition metals, Aromatic hydrocarbons, Alkyl and Aryl halide, Thermodynamics, Distillation and Polarimetry.	4	0	0	4
7.	5	II	MJR	UG0806 – CHM-52P-107 – Practical I	0	0	2	2
8.	5	II	MJR	UG0806 – CHM-52P-108 – Practical II	0	0	2	2
9.	6	III	MJR	UG0806 – CHM-63T-201 –Coordination Chemistry of Transition metal Complexes with kinetic & thermodynamic aspects, Electronic and Vibrational spectroscopy, Alcohols, Ethers, Phenols and Carbonyl Compounds, Chemical and Ionic Equilibrium, Solutions with their Colligative Properties	4	0	0	4
10.	6	III	MJR	UG0806 – CHM-63T-202 – Concepts of Acid & Bases, Lanthanides and Actinides, Carboxylic Acids and its Functional derivatives, N-containing Organic Compounds, Thermodynamics-II, Phase	4	0	0	4

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				Equilibrium and Electrochemistry-I				
11.	**6**	**III**	**MJR**	**UG0806 – CHM-63P-203 – Practical I**	**0**	**0**	**2**	**2**
12.	**6**	**III**	**MJR**	**UG0806 – CHM-63P-204 – Practical II**	**0**	**0**	**2**	**2**
13.	**6**	**IV**	**MJR**	**UG0806 – CHM-64T-205 – Organic Synthesis via Enolates, NMR Spectroscopy, Heterocyclic Compounds, Fundamentals of Molecular Spectroscopy, Electrochemistry-II**	**4**	**0**	**0**	**4**
14.	**6**	**IV**	**MJR**	**UG0806 – CHM-64T-206 – Water Analysis, Chromatography, Conductometric, Potentiometric and Spectrophotometric Titrations, Nephelometry, Atomic Absorption spectrometry and Atomic Emission Spectroscopy.**	**4**	**0**	**0**	**4**
15.	**6**	**IV**	**MJR**	**UG0806 – CHM-64P-207 – Practical I**	**0**	**0**	**2**	**2**
16.	**6**	**IV**	**MJR**	**UG0806 – CHM-64P-208 – Practical II**	**0**	**0**	**2**	**2**
17.	**7**	**V**	**MJR**	**UG0806 – CHM-75T-301 – Metal ligand bonding, Heterocyclic Compounds, Polynuclear compound, Quantum mechanics, Electro gravimetric, Coulometry.**	**4**	**0**	**0**	**4**
18.	**7**	**V**	**MJR**	**UG0806 – CHM-75T-302 – Nuclear Chemistry, Amino acids, Peptides, Protein, Photochemistry, Physical properties and molecular structures, Polarography Amperometry, Modified voltammetric methods.**	**4**	**0**	**0**	**4**
19.	**7**	**V**	**MJR**	**UG0806 – CHM-75P-303 – Practical I**	**0**	**0**	**2**	**2**
20.	**7**	**V**	**MJR**	**UG0806 – CHM-75P-304 – Practical II**	**0**	**0**	**2**	**2**
21.	**7**	**VI**	**MJR**	**UG0806 – CHM-76T-305 – Bioinorganic chemistry, Metalloporphyrin, Carbohydrate, Organometallic compounds, Phase equilibria, Surface Phenomenon Diffraction Pattern, Automated methods of analysis**	**4**	**0**	**0**	**4**
22.	**7**	**VI**	**MJR**	**UG0806 – CHM-76T-306 – Nitrogen Fixation, Metal enzymes, Inorganic Polymers, Synthetic Dyes & Drugs, Organic Polymers, Macromolecules, Mass Spectrometry, Gas Chromatography HPLC**	**4**	**0**	**0**	**4**
23.	**7**	**VI**	**MJR**	**UG0806 – CHM-76P-307 – Practical I**	**0**	**0**	**2**	**2**
24.	**7**	**VI**	**MJR**	**UG0806 – CHM-76P-308 – Practical II**	**0**	**0**	**2**	**2**
25.	**8**	**VII**	**MJR**	**UG0806 – CHM-87T-401 –**	**4**	**0**	**0**	**4**
26.	**8**	**VII**	**MJR**	**UG0806 – CHM-87T-402 –**	**4**	**0**	**0**	**4**
27.	**8**	**VII**	**MJR**	**UG0806 – CHM-87P-403 – Practical I**	**0**	**0**	**2**	**2**

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PROGRAMME PREREQUISITES/ELIGIBILITY

The students must have earned a minimum of 52 credits (26 × 2 cerdits)

1. For promotion from the current year to next year it is mandatory to pass all the prescribed co-course of the previous year with the minimum of C grade (40 %).

PROGRAMME OUTCOMES (POs)

1. **Conceptual knowledge of chemical science:** Students will get acquainted with the conceptual knowledge of chemical science which will help them to understand the subject and it will be beneficial in long run.
2. **Training to manage unusual and unexpected incidents/disasters:** The knowledge of chemical science will help them to deal with unusual incidents in the neighborhood. Sudden explosion by chemicals and excessive misuse of unwanted substances can be managed with basic knowledge of chemistry as well as environmental pollution may be controlled by the students by spreading awareness in the society about the harmful pollutants viz; plastic, pesticides, harmful smog, unused drugs etc.
3. **Laboratory Experimental Skills:** As we know the fact that trials are an essential part of an exploration in our life therefore the students will gain practical experience by conducting experiments, using laboratory instruments and apparatus.
4. **Employment opportunities:** Students will acquire employment in the various national and private R & D sectors such as:
   The students with the strong chemistry background can get jobs in chemical and related industries viz. Agrochemicals, Metallurgical, Fertilizer, Biofertilizer, Textile, Food, Ceramics, Cement, Petrochemicals, Pesticides, Plastics, Polymers, etc.
   The students can find opportunities in Pharmaceutical companies, Forensic Lab, etc. Petroleum, Soil Testing Labs, Environment consulting firms and other sectors such as Analytical Chemist, Chemical Product Officer, Radiologist and Toxicologist.
5. **Integrated M. Sc-Ph.D courses at prestigious institutions:**
   After completing this bachelor's degree course, students can get engaged in integrated M.Sc-PhD courses or can get Master's degree in various interdisciplinary fields at prestigious institutions like CSIR, IISc, IITs, NCL (national chemical laboratories), IISERs, NISER ,etc.

28.	**8**	**VII**	**MJR**	**UG0806 – CHM-87P-404 – Practical II**	**0**	**0**	**2**	**2**
29.	**8**	**VIII**	**MJR**	**UG0806 – CHM-88T-405 –**	**4**	**0**	**0**	**4**
30	**8**	**VIII**	**MJR**	**UG0806 – CHM-88T-406 –**	**4**	**0**	**0**	**4**
31.	**8**	**VIII**	**MJR**	**UG0806 – CHM-88P-407 – Practical I**	**0**	**0**	**2**	**2**
32.	**8**	**VIII**	**MJR**	**UG0806 – CHM-88P-408 – Practical II**	**0**	**0**	**2**	**2**

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Examination Scheme:

- **1 Credit = 25 marks for examination/evaluation.**
- **For Regular Students:**
  - There will be Continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Each course in Semester Grade Point Average (SGPA) has two components - Continuous assessment (20% weightage) and (End of Semester Examination) EoSE (80% weightage).
  - 75% Attendance is mandatory for appearing in EoSE.
  - To appear in the EoSE examination of a course/subject student must appear in the mid-semester examination and obtain at least a C grade in the course/subject.
  - Credit points in a Course/Subject will be assigned only if, the regular student obtains at least a C grade in the CA (Continuous Assessment) and EoSE examination of a Course/Subject.

- **In case of the Non-Collegiate Students**:

  This course is not applicable for non-collegiate students

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Examination scheme for Continuous assessment (CA)

DISTRIBUTION OF CONTINUOUS ASSESSMENT (CA) MARKS

S. No.	CATEGORY	Weightage (out of total internal marks)		THEORY					PRACTICAL		
				CORE (Only Theory)	CORE (Theory + Practical)	AEC	SEC	VAC	CORE (Theory + Practical)	SEC	VAC
	Max Internal Marks			30	20	20	10	10	10	10	10
1	Mid-term Exam	50%		15	10	10	5	5	5	5	5
2	Assignment	25%		7.5	5	5	5	2.5	2.5	2.5	2.5
3	Attendance	25%		7.5	5	5	5	2.5	2.5	2.5	2.5
		Regular Class Attendance	= 75%	3	2	2	1	1	1	1	1
			75 – 80%	4	3	3	1.5	1.5	1.5	1.5	1.5
			80 – 85%	5	4	4	2	2	2	2	2
			> 85%	7.5	5	5	2.5	2.5	2.5	2.5	2.5

Note:

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1. Continuous assessment will be the sole responsibility of the teacher concerned. Under the heading assignment, Interactive sessions or group discussion among students may be conducted or PPT presentation of the selective topics may be assigned by the teacher under the same at college level.)
2. For continuous assessment no remuneration will be paid for paper setting, Evaluation, Invigilation etc.
3. For continuous assessment Paper setting and Evaluation responsibility will be of teacher concern.
4. For continuous assessment no Answer sheets/question papers etc. will be provided by the University.
5. Colleges are advised to keep records of continuous assessment, attendance etc.

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V– Semester

Examination Scheme for EoSE-

CA – Continuous Assessment
EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code / Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	UG0806 – CHM-75T-301 – Metal ligand bonding, Heterocyclic Compounds, Polynuclear compound, Quantum mechanics, electro gravimetric, coulometry.	CA	1 Hr.	CA	20	CA	8
		EoSE	3 Hrs.	EoSE	80	EoSE	32
Theory	UG0806 – CHM-75T-302 – Nuclear Chemistry, Amino acids, Peptides, Protein, Photochemistry, Physical properties and molecular structures, Polarography Amperometry, Modified voltammetric methods.	CA	1 Hr.	CA	20	CA	8
		EoSE	3 Hrs.	EoSE	80	EoSE	32
Practical	UG0806 – CHM-75P-303 – Practical I	CA	1 Hr.	CA	10	CA	4
		EoSE	4 Hrs.	EoSE	40	EoSE	16
	UG0806 – CHM-75P-304 –	CA	1 Hr.	CA	10	CA	4

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Practical	**Practical II**	**EoSE**	**4 Hrs.**	**EoSE**	**40**	**EoSE**	**16**

PART – A: 20 Marks
Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART – B: 60 Marks

Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit internal choice. Each question will carry 15 marks.

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Non-Collegiate Students –

<u>This course is not applicable for Non-Collegiate Students</u>

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SYLLABUS

UG0806 – CHM-75T-301 – Metal ligand bonding, Heterocyclic Compounds, Polynuclear compound, Quantum mechanics, Electrogravimetric, Coulometry.

UG0806 – CHM-75T-302 –Nuclear Chemistry, Amino acids, Peptides, Protein, Photochemistry, Physical properties and molecular structures, Polarography Amperometry, Modified voltammetric methods,

UG0806 – CHM-75T-302 - Practical – I

UG0806 – CHM-75T-302 - Practical – II

V – Semester – Chemistry

Semester	Code of the Course	Title of the Course/Paper	NHEQF Level	Credits
V	CHM-75T-301	Metal ligand bonding, Heterocyclic Compounds, Polynuclear compound, Quantum mechanics, Electrogravimetric, Coulometry.	7	4

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V	**CHM-75T-302**	**Nuclear chemistry, Amino acids, Peptides, Protein, Photochemistry, Physical properties and molecular structures, Polarography Amperometry, Modified voltammetric methods,**				**7**	**4**
Vth	**CHM-75P-303**	**Practical -I**				**7**	**2**
Vth	**CHM-75P-304**	**Practical -II**				**7**	**2**
Level of Course	**Type of the Course**	**Credit Distribution**			**Offered to NC Students**	**Course Delivery Method**	
		Theory	**Practical**	**Total**			
6	**Major**	**4+4**	**2+2**	**12**	**No**	**Lecturer, Sixty Lectures**	**Classroom teaching through PPT, Laboratory Exposure**
List of Programme Codes in which offered as Minor Discipline		**-NA-**					
Prerequisites/Eligibility		The students must have earned a minimum of 52 credits (26 × 2 cerdits) OR For promotion from the current year to next year it is mandatory to pass all the prescribed co-course of the previous year with the C grade (40%).					
Course Objectives:		The main aim of this course is to provide students with a theoretical and conceptual understanding of metal ligand bonding, heterocyclic compounds, polynuclear compounds and quantum mechanics aspects in addition to electro-gravimetric, coulometry analytical techniques. Moreover, our aim is to provide clear understanding in the field of nuclear chemistry, amino acids, peptides and protein. Concepts and theories related to the field of photochemistry, physical properties and molecular structure along with polarography, amperometry and modified voltammetric methods are also included to enrich knowledge of students.					

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Detailed Syllabus

CHM-75T-301 – Metal ligand bonding, Heterocyclic Compounds, Polynuclear compound, Quantum mechanics, Electro-gravimetric, Coulometry.

Unit-I

Metal-Ligand Bonding:

Limitations of crystal field theory, molecular orbital theory of octahedral, tetrahedral and square planar complexes, π-bonding and molecular orbital theory.

Metal Carbonyls: preparation, properties and bonding of transition metal carbonyls. Detailed study of mononuclear and polynuclear carbonyls.

15 Lecture

Unit-II

Heterocyclic Compounds: Nomenclature, Five and Six membered heterocyclic compounds,

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Aromatic Character, preparation, reactions, chemical reactivity, orientation (Electrophilic and nucleophilic substitution reactions) basicity of pyrrole, furan, thiophene and pyridine. Condensed five and six membered heterocycles, structure, preparation and reactions of indole, quinoline and isoquinoline.

Polynuclear Compounds: Structure of naphthalene, mechanism and orientation of electrophilic substitution in naphthalene, preparation and properties of naphthalene and anthracene, some important derivatives of naphthalene like naphthols and naphthyl amines. Preparation and reaction of diphenyl, diphenylmethane and triphenylmethane.

15 Lecture

Unit-III

Quantum Mechanics:

Black-body radiation, Planck's radiation law, Photoelectric effect, Heat capacity of solids, Bohr's mode of hydrogen atom (no derivation) and its defects. Compton effect.

De Broglie hypothesis, Heisenberg's uncertainty principle, Sinusoidal wave equation, Operators and their applications, Schrodinger wave equation and its importance, Physical interpretation of the wave function, Normalization and orthogonality of wave functions. Postulates of quantum mechanics, quantum number and their importance, Particle in a one-dimensional box.

Schrodinger's wave equation for particle in three-dimensional box, H-atom, quantum number and their importance, hydrogen like wave functions, radial wave functions and angular wave functions.

M.O. theory, basic ideas, criteria for forming M. O from A.O. Construction of M. Os by LCAO–H_2^+ ion. Calculation of energy levels from wave functions, physical picture of bonding and anti-bonding wave functions, concept of σ, σ*, Π, Π* orbitals and their characteristics, hybrid orbitals- sp, sp^2, sp^3, calculation of co-efficient of A.O.'s used in these hybrid orbitals. Introduction to Valence bond model of H_2, comparison of M.O. and V.B model.

15 Lecture

Unit-IV

Electrogravimetry: Theory, electrode reactions, overpotential, deposition, electrolytic separation of metals, character of the deposit and electrolytic separation of metals with controlled cathode potential. Electrolytic determinations at constant current—Copper and Lead. Electrolytic determinations with controlled cathode potential—Antimony, copper, lead and tin in an alloy.

Coulometry: Coulometry at controlled potential, separation of Ni and Co by coulometric analysis at controlled potential, coulometry at constant current, coulometry titrations.

15 Lecture

Suggested Books and References:

1. Concise Coordination Chemistry by R. Gopalan and V. Ramalingam, Vikas Publishing House Pvt, Ltd.
2. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson, & P.L Gaus, Willey.
3. Concise Inorganic Chemistry by J. D. Lee, Wiley-India.

4. Inorganic Chemistry by Catherine E. Housecroft, & Alan G Sharpe, Pearson Education Ltd.
5. Principles of Inorganic Chemistry by Puri, Sharma & Kalia, Vishal Publishing Co.
6. Concepts and Models of Inorganic Chemistry, B.E. Douglas, D. McDaniel, & J. Alexander, Wiley.
7. Organic Chemistry by R. T. Morrison & R. N. Boyed, Prentice Hall.
8. Reaction Mechanism in Organic Chemistry by S. M. Mukherji & S. P. Singh, TRINITY Press.
9. Organic Chemistry by I. L. Finar, (Vol. I & II) ELBS.
10. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania, Vishal Publishing Co.
11. A Text Book of Physical Chemistry: A. S. Negi and S. C. Anand, New Age International Publishers.
12. Elements of Physical Chemistry, P. Atkins and J. De Paula, Oxford.
13. Instrumental Methods of Chemical analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House.
14. Instrumental Methods of Chemical Analysis by V.K. Ahluwalia, Springer.
15. Instrumental Methods of Chemical analysis by B. K. Sharma, Goel Publishing House, Meerut.
16. Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta & Kevin A. Schug, Wiley.
17. Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West & Douglas A. Skoog, Cengage Learning India Pvt. Ltd.

Suggested E-resources:

All the above suggested books are available as e- books.

Online Lecture Notes and Course Materials:

All prescribed courses are available in digital form in the form of e-books, Adobe Acrobat documents (PDF), web pages etc.

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Detailed Syllabus

CHM-75T-302 – Nuclear Chemistry, Amino acids, Peptides, Protein, Photochemistry, Physical properties and structure of Molecules, Polarography, Amperometry, Modified voltammetric methods.

Unit I

Nuclear Chemistry:

Fundamental particles of nucleus (nucleon), concept of nuclides, representation of nuclides,

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isotopes, isobars and isotones with specific examples. Applications of radioisotopes, size concept in nucleus and atom. Qualitative idea of the stability of nucleus (n/p ratio). Shell and liquid drop model.

Radioactivity: Natural and artificial radioactivity, disintegration series, disintegration rates, half-life, average life, nuclear binding energy, mass defects, Einstein's mass energy relations, artificial transmutation, nuclear reactions, spallation's, nuclear fission and fusion, nuclear reactors, hazards of radioactive emanations.

15 Lecture

Unit II

Amino Acids, Peptides and Proteins: Classification, structure and stereochemistry of amino acids. Physical properties, zwitter ion structure, isoelectric point and electrophoresis. Preparation and reaction of α-amino acids.

Structure and nomenclature of peptides and proteins. Classification of proteins, peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid- phase peptide synthesis. Structure of peptides and proteins. Levels of protein structure. Protein denaturation/renaturation.

15 Lecture

Unit III

Photochemistry:

Absorption of light, Grothus –Dropper law. Einstein law of photochemical equivalence. Quantum yield of photochemical reactions, reasons for high and low quantum yield of photochemical equations. Primary and secondary processes, Photochemical reactions such as (1) $H_2 + Cl_2$ reaction (2) photolysis of ammonia (3) hydrolysis of monochloro acetic acid.

Consequences of light absorption phosphorescence, fluorescence, chemiluminescence and photosensitization.

Physical Properties and Molecular Structure:

Optical activity, polarization - (Clausius - Mossotti equation), Orientation of dipoles in an electric field, Dipole moment, Induced dipole moment, Measurement of dipole moment, temperature method and refractivity method, Dipole moment and structure of molecules, magnetic properties paramagnetism, diamagnetism and ferromagnetism.

Unit-IV

Polarography: Principle and experimental set-up. Diffusion current and Half-wave potential. Qualitative and quantitative applications of polarography in analytical chemistry.

(i) Wave height concentration graph.
(ii) Internal standard (piloton method)
(iii) Standard addition method.
(iv) Use of polarography: Zn and Cu analysis in brass,
(v) Dissolved oxygen in sample.

Amperometry: Amperometric titrations, technique of amperometric titrations with the dropping mercury electrode, titration with the rotating platinum micro electrode, biamperiometric titrations.

Modified Voltammetric methods: Current sampled (TAST) Polarography, Pulse

polarography, Differential pulse polarography, Cyclic Voltammetry, Sinusoidal, Alternating current polarography, Stripping Voltammetry.

15 Lecture

Suggested Books and References:

1. Essentials of Nuclear Chemistry by H.J. Arnikar, New Age International Publishers.
2. Basic Inorganic Chemistry, F.A. Cotton, G. Wilkinson, & P.L Gaus, Willey.
3. Concise Inorganic Chemistry by J. D. Lee, Wiley-India.
4. Inorganic Chemistry by Catherine E. Housecroft, & Alan G Sharpe, Pearson Education Ltd.
5. Principles of Inorganic Chemistry by Puri, Sharma & Kalia, Vishal Publishing Co.
6. Concepts and Models of Inorganic Chemistry, B.E. Douglas, D. McDaniel, & J. Alexander, Wiley.
7. A.C. Deb, Fundamentals of Biochemistry.
8. M.N. Hughes, Inorganic Chemistry of Biological Processes.
9. Smith et.*al,* Principles of Biochemistry.
10. Christopher K. Mathews, Kensal E. van Holde and Kevin G Ahern, Biochemistry (2nd Edn)
11. Organic Chemistry by R. T. Morrison & R. N. Boyed, Prentice Hall
12. Reaction Mechanism in Organic Chemistry by S. M. Mukherji & S. P. Singh, TRINITY Press.
13. Organic Chemistry by I. L. Finar, (Vol. I & II) ELBS.
14. Physical Chemistry by R. J. Silbey, R. A. Alberty & M. G. Bawendi, John Wiley & Sons.
15. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania, Vishal Publishing Co.
16. A Text Book of Physical Chemistry: A. S. Negi and S. C. Anand, New Age International Publishers.
17. Advanced Physical Chemistry by Gurdeep Raj, Goel Publishing House.
18. Elements of Physical Chemistry, P. Atkins and J. De Paula, Oxford.
19. Instrumental Methods of Chemical analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House.
20. Instrumental Methods of Chemical Analysis by V.K. Ahluwalia, Springer.
21. Instrumental Methods of Chemical analysis by B. K. Sharma, Goel Publishing House, Meerut.
22. Analytical Chemistry by Gary D. Christian, Purnendu K. Dasgupta & Kevin A. Schug, Wiley.
23. Fundamentals of Analytical Chemistry by F. James Holler, Stanley R Crouch, Donald M. West & Douglas A. Skoog, Cengage Learning India.

Suggested E-resources:

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Online Lecture Notes and Course Materials:

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Detailed Syllabus

CHM-75P-303: Practical I **4 Hrs./week**

Inorganic Chemistry

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Qualitative analysis of mixture containing **eight radicals** one of which should be a rare metal ion. The mixture may contain radicals of any combination **including interfering acid radicals and insolubles.**

Organic Chemistry

Quantitative Estimations

(i) Determination of neutralization equivalent of an organic acid.
(ii) Determination of Saponification value of an ester/oil.
(iii) Estimation of glucose by titration with Fehling's solution/ Benedict solution.

Physical Chemistry

Chemical Dynamics experiments:

(i) Determine the effect of ionic strength on the rate of persulphate iodide reaction.
(ii) Determine the order of hydrolysis of ethyl acetate by sodium hydroxide

Viva-- Voce **5 marks**

Practical Record **5 marks**

Suggested Books and References:

1. Vogel's textbook of practical organic chemistry including Qualitative organic Analysis, by A. I. Vogel Longman, London and New York. Prentice Hall.
2. Vogel's Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, ELBS.
3. Advance Practical Inorganic Chemistry by Gurdeep Raj, Goel Publishing House.
4. Advanced Practical Physical Chemistry J. B. Yadav, Goel Publishing House.
5. Practical Physical Chemistry B. D Khosla, S. Chand & Company.
6. Advanced Practical Organic Chemistry by N K Vishnoi, Vikas Publishing House PVT LTD
7. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis V. K Ahluwalia. Universities Press, Hyderabad.
8. Advanced Practical Organic Chemistry by N K Vishnoi, Vikas Publishing House

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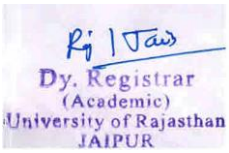
Detailed Syllabus



CHM-75P-304: Practical II 4 Hrs./week

Inorganic Chemistry

Quantitative estimation of ***any three*** **of** the following mixtures by volumetric and gravimetric methods.

a) Copper-Zinc

b) Zinc-Nickel

c) Silver-Copper

d) Silver-Nickel

e) Silver-Zinc

f) Copper-Nickel

Organic Chemistry

Qualitative organic analysis

Analysis of an organic mixture containing two solid components using water, $NaHCO_3$ and NaOH for separation and preparation of suitable derivatives.

Physical Chemistry

Determine the velocity constant of hydrolysis of ethyl acetate by sodium hydroxide (saponification of an ester).

Viva voce **5 marks**

Practical Record **5 marks**

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Suggested Books and References:

1. Advanced Practical Physical Chemistry J. B. Yadav, Goel Publishing House.
2. Practical Physical Chemistry B. D Khosla, S. Chand & Company.
3. Advanced Practical Organic Chemistry by N K Vishnoi, Vikas Publishing House PVT LTD
4. 4.Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, V. K Ahluwalia. Universities Press, Hyderabad.
5. Advanced Practical Organic Chemistry by N K Vishnoi, Vikas Publishing House PVT LTD
6. Vogel's Qualitative Inorganic Analysis, A. I. Vogel Prentice Hall.
7. Vogel's Textbook of Quantitative Chemical Analysis, A. I. Vogel, Pearson Education Ltd.
8. Laboratory Techniques in Organic Chemistry by V. K Ahluwalia, I K International, N

Suggested E-resources:

Online Lecture Notes and Course Materials:

Course Learning Outcomes

By the end of this degree programme, student will achieve the essential conceptual knowledge in the field of metal ligand bonding, heterocyclic compounds, polynuclear compound, quantum mechanics in addition to electro-gravimetric and coulometry analytical techniques.

Furthermore, student will gain knowledge related to nuclear chemistry, amino acids, peptides, protein, photochemistry along with physical properties and molecular structures. Concepts related to the field of basic and applied polarography, amperometry, modified voltammetric methods will enrich the knowledge of student and further they will be able to conduct experiments and demonstrate efficiency with appropriate lab skills, techniques and instrumentations. It will also fruitful for the students to gain awareness in physical science so that students will be benefited in the long run.

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VI – Semester

Examination Scheme for EoSE-

CA – Continuous Assessment

EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code / Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	UG0806–CHM-76T-305– Bioinorganic chemistry, Carbohydrate, Organometallic compounds, Phase equilibria, Surface Phenomenon, Diffraction Pattern, Automated methods of analysis.	CA	1 Hr.	CA	20	CA	8
		EoSE	3 Hrs.	EoSE	80	EoSE	32
Theory	UG0806 – CHM-76T- 306 – Inorganic Polymers, Synthetic Dyes & Drugs, Organic Polymers, Macromolecules, Mass spectrometry, Gas Chromatography and HPLC	CA	1 Hr.	CA	20	CA	8
		EoSE	3 Hrs.	EoSE	80	EoSE	32
Practical	UG0806 – CHM-76P-307 – Practical I	CA	1 Hr.	CA	10	CA	4
		EoSE	4 Hrs.	EoSE	40	EoSE	16
Practical	UG0806 – CHM-76P-308 – Practical II	CA	1 Hr.	CA	10	CA	4
		EoSE	4 Hrs.	EoSE	40	EoSE	16

The question paper (EoSE) will consist of two parts A & B

PART – A: 20 Marks

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART – B: 60 Marks

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Part B of the question paper shall be divided into four units comprising question number 2-5. There will be one question from each unit internal choice. Each question will carry 15 marks.

Non-Collegiate Students –

<u>This course is not applicable for Non-Collegiate Students</u>.

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VI– Semester – Chemistry

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
VI	CHM-76T-305	Bioinorganic Chemistry, Carbohydrate, Organometallic compounds, Phase equilibria, Surface Phenomenon, Diffraction Pattern, Automated methods of analysis				7	4
VI	CHM-76T-306	Inorganic Polymers, Synthetic Dyes & Drugs, Organic Polymers, Macromolecules, Mass spectrometry, Gas Chromatography HPLC				7	4
VI	CHM-76P-307	Practical lab I				7	2
VI	CHM-76P-308	Practical lab II				7	2
Level of Course	Type of the Course	Credit Distribution			Offered to NC Students	Course Delivery Method	
		Theory	Practical	Total			
7	Major	4+4	2+2	12	No	Lecturer, Sixty Lectures	PPT, Laboratory Exposure
List of Programme Codes in which offered as Minor Discipline		-NA-					
Prerequisites/Eligibility		Every student automatically promoted from the Vth to VIth semester.					
Course Objectives:		**Course Objectives:** The main objective of this course is to provide deep understanding in the bioinorganic chemistry, carbohydrate, organometallic chemistry. Phase equilibria and surface phenomenon are also incorporated to provide interdisciplinary nature of the fields. Moreover, some instrumental methods of chemical analyses such as diffraction patterns, automated methods of analyses are included in the course to enrich the student's knowledge. Apart from the above, inorganic polymers, synthetic dyes & drugs, organic polymers, mass spectrometry, electrochemistry, gas chromatography and HPLC. are also incorporated to					

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	provide interdisciplinary nature of the fields.

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Detailed Syllabus

UG0806 CHM-76T-305: Bioinorganic chemistry, Carbohydrate, Organometallic compounds, Phase equilibria, Surface Phenomenon, Diffraction Pattern, Automated methods of analysis.

Unit-I

Bioinorganic Chemistry:
Role of bulk and trace metal ions in biological systems with special reference to Na, K, Mg, Ca, Fe, Cu and Zn.
Metalloporphyrin: Chlorophylls and their role in photosynthesis. Hemoglobin and Myoglobin and their role as oxygen carriers.
Nitrogen fixation: Mechanism, nitrogenase enzyme, dinitrogen complexes as models for nitrogen fixation.
Metalloenzymes: General discussion of enzymes, functions of metal ions, inhibition (explanation based on coordination chemistry), carboxypeptidase-A and cytochrome-C

15 Lecture

Unit-II

Carbohydrates: Introduction, classification, constitution and reaction of glucose and fructose, mutarotation and its mechanism, cyclic structure, pyranose and furanose forms, Haworth projection formulae, configuration of monosaccharides, determination of ring size, conformational analysis of monosaccharides, Epimerization, chain lengthening and chain shortening in aldoses. Interconversion of aldoses and ketoses.
Disaccharides: Structure determinations of maltose, lactose and sucrose.
Polysaccharides: Structure of starch and cellulose, glycosidic linkages.
Organometallic Compounds: Definition and classification of organometallic compounds. Synthesis, properties and structures of organometallic compounds of Lithium, Magnesium and Zinc.

Unit-III

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Phase Equilibrium:
Solid solutions: Compound formation with congruent melting point (Mg-Zn) and benzophenone – dimethylamine, incongruent melting point NaCl-H_2O, picric acid and benzene, $FeCl_3$ – H_2O and $CuSO_4$- H_2O system.
Liquid-Liquid mixtures: Ideal liquid mixtures, Raoult's law and Henry's law, non – ideal system, azeotropes HCl-H_2O and ethanol-water system.
Particularly miscible liquids: Phenol-water, trimethylamine - water, nicotine-water system, lower and upper consulate temperature, effect of impurities on consulate temperature.
Immiscible liquids – Steam distillation.

Surface phenomenon, micelles: Surface active agents, classification of surface-active agents, micellization, hydrophilic interaction, critical micellar concentration (CMC), factors affecting CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization. Phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

Adsorption: Gibbs adsorption isotherm, determination of surface area (BET) equation, surface films on liquids (electrokinetic phenomenon), catalytic activity at surface, electrode/electrolyte interface. **15 Lecture**

. **Unit-IV**

Diffraction Pattern: Fundamental, principles, instrumentation, use of X-ray, electron and neutron in diffractometry and applications of X-ray, electron and neutron diffractometry in biological and analytical techniques. Applications of X-rays in CT scan.
Automated Methods of analysis: Automatic instruments and automation. Automation of sampling and preliminary sample treatment for air, water and soil, continuous flow method. Discrete methods, Automatic Anlaysis based on Multilayer Films.
NMR Spectroscopy: Theory of nuclear magnetic resonance, experimental methods of NMR spectroscopy, applications of proton NMR including applications in MRI technique. Structure elucidation of simple organic molecules on the basis of ^1H NMR and mass spectral data.
15 Lecture

Suggested Books and References:

1. Bioorganic, bioinorganic and supramolecular chemistry by Kalsi and Ashu , New Age International.
2. Bioinorganic Chemistry by Ankita Das, Asim K Das and Mahua Das. Books & Allied.
3. Principal of bioinorganic Chemistry by Stphen J. Lippard, Jerem M. Berg, Universal Science Books.

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4. Basic Organometallic Chemistry by B D Gupta, A. J. Elias, Universities Press
5. Organometallic Chemistry and Catalysis by Didier Astruc, Springer.
6. Organic Chemistry by S. S, Gupta, Oxford University Press.
7. Organic Reaction Mechanisms by V. K. Ahluwalia, Narosa Publishing House, New Delhi.
8. Organic Chemistry – Reactions and Reagents Complete Theoretical Organic Chemistry, by O. P Agarwal, Covering Goel Publishing House, Meerut.
9. Organic Chemistry by R.T Morrison. & R. N Boyed., Prentice Hall.
10. Organic Chemistry by I. L Finar, (Vol. I & II) ELBS.
11. Advanced Organic Chemistry by A Bahl. & B. S Bahl., S. Chand.
12. Organic Chemistry by C. N Pillai., Oxford University Press.
13. Modern Organic Chemistry by M. K Jain & S.C. Sharma, Vishal Publishing Co.
14. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure by J March, & M. B Smith Wiley.
15. Solutions, Phase Equilibrium, Conductance & Electrochemistry by Puri, Sharma, Pathania and Kaur, Vishal Publishing Co.
16. Phase equilibrium, Phase Diagrams and Phase transformations: Their thermodynamic Basis 2nd edition Cambridge University Press.
17. Fundamentals of Molecular Spectroscopy by C. N. Banwell, Campus Book House.
18. Spectrometric Identification of Organic Compounds by Robert Silverstein, Wiley.
19. Fundamentals of Molecular Spectroscopy by P. S. Sindhu, New Age International.
20. Introduction to Spectroscopy – Fifth Edition by Pavia, Lampman, Kriz & Vyvyan Cengage India Private Limited.
21. Modern Spectroscopy – Fourth Edition by J. Michael Hollas, John Wiley & Sons.\
22. Spectroscopy by B. K. Sharma, Goel Publishing House.

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Detailed Syllabus

CHM-76T-306: 4 Hrs./week **Inorganic Polymers, Synthetic Dyes & Drugs, Organic Polymers, Macromolecules, Mass spectrometry, Gas Chromatography & HPLC.**

Unit-I

Inorganic Polymers: Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones, phosphonitrilic halides and condensed phosphates.
Metal Clusters: Higher boranes, carboranes, metalloboranes and metallocarboranes, metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

15 Lecture

Unit-II

Synthetic Dyes: Colour and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of Methyl orange, Congo red, Malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.
Sulpha drugs and their mechanism of action, Synthesis of sulphadiazine, sulphapyridine, sulphalhiazole, sulphaguanidine and sulphamethazole.
Polymers and polymerization: Addition and condensation polymerization, their mechanism, copolymerization, coordination polymerization, Ziegler-Natta catalyst, plastics, thermoplastic and thermosetting resins, plasticizers, polystyrene, PVC, polyacrylates, polyacrylonitrile, dacron, terylene, nylon-66, bakelite, melamine and polyurethanes. Synthetic and natural rubber.

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. **15 Lecture**

Unit-III

Macromolecules: Linear, branches, network and homopolymer. Polymer classification, number average and weight average, molecular weight determination methods of polymers by (1) osmotic pressure (2) viscosity (3) light scattering. Properties of macromolecules

Catalysis: The simple catalysis mechanism $S + C \rightarrow SC \rightarrow P + C$. Its mathematical treatment and its consequences. Specific and general acid – base catalysis, enzyme catalysis, surface catalysis and Langmuir adsorption isotherm, mechanism of surface catalysis.

15 Lecture

Unit-IV

Mass spectrometry: Instrumentation and technique, Elementary idea about electron impact, chemical ionization and matrix assisted laser desorption ionization (MALDI), mass spectrometer techniques. Determination of molecular formula, mass spectra of simple organic compounds.

Factors affecting fragmentation, ion analysis, ion abundance, fragmentation modes, mass spectral fragmentation of simple organic compounds: alkanes, primary alcohols, aliphatic ketones, aldehydes and carboxylic acids, Types of peaks- molecular ion peak, isotopic peak, base peak, metastable peak, doubly charged ion, Mc Lafferty rearrangement and retro Diels-Alder reaction, nitrogen rule.

Gas Chromatography and HPLC: Introduction, gas chromatographs, detectors, programmed temperature gas chromatography, quantitative analysis by GLC, gas-solid chromatography. High performances liquid chromatographic methods - Adsorption Chromatography. Liquid-liquid partition chromatography, Ion exchange, HPLC, exclusion chromatography

15 Lecture

Suggested Books and References:

1) Concise Inorganic Chemistry by J.D. Lee, Wiley.
2) Inorganic Chemistry by Catherine E. Housecraft and Alan G. Sharpe, Pearson.
3) Selected Topics in Inorganic Chemistry by Wahid U. Malik, G. D. Tuli and R. D. Madan, S. Chand, New Delhi.
4) Advanced Inorganic Chemistry: Volume I & II by Satya Prakash, G. D. Tuli, S. K. Basu and R. D. Madan, S. Chand, New Delhi.
5) Principles of Inorganic Chemistry by Puri, Sharma & Kalia, Vishal Publishing Co.
6) Organic Chemistry by I. L. Finar, Pearson.
7) Organic Chemistry by R.T. Morrison, R.N. Boyd & S.K. Bhattacharjee, Pearson.
8) Dyes and Drugs by Harold H. Trimm, William Hunter Jr., Taylor & francs Ltd.
9) Introduction synthetic drugs and dyes by R.S. Rao, Gomathi Shridhar, Himalya Publishing House.
10) Polymer Chemistry: Synthesis and Charactrisation By Prashant D. Ashtaputrey & Santosh D. Ashtaputrey, Prints Publication PVT. Ltd.
11) Principles of Physical Chemistry by B. R. Puri, L. R. Sharma & M. S. Pathania, Vishal Publishing Co.

12) Advanced Physical Chemistry by Gurdeep Raj, Goel Publishing House.
13) Physical Chemistry by W. Atkins, Oxford University Press.
14) Physical Chemistry by R. J. Silby and R. A. Alberty, John Wiley & Sons.
15) Fundamentals of Molecular Spectroscopy by C. N. Banwell, Campus Book House.
16) Spectrometric Identification of Organic Compounds by Robert Silverstein, Wiley.
17) Fundamentals of Molecular Spectroscopy by P. S. Sindhu, New Age International.
18) Introduction to Spectroscopy – Fifth Edition by Pavia, Lampman, Kriz & Vyvyan Cengage India Private Limited.
19) Modern Spectroscopy – Fourth Edition by J. Michael Hollas, John Wiley & Sons.
20) Spectroscopy by B. K. Sharma, Goel Publishing House.
21) Instrumental Methods of Chemical analysis (Analytical Chemistry), Chatwal, RGurdeep, S Anand, Himalaya Publishing House.
22) Analytical Chemistry Chatwal, R. Gurdeep, Himalaya Publishing House.
23) Skoog and West's Fundamentals of Analytical Chemistry by M. Donald, A Douglas, F. Holler James, F. West et al, 2022, Cengage Learning India Pvt. Ltd.

Detailed Syllabus

CHM-76P-307: Practical- I 4 Hrs./week

Ex. 1 Inorganic Preparations and its characterization (*any four*):

a) Bis (dimethylglyoximato) nickel(II) complex, $[Ni(dmg)_2]$

b) Potassium trioxalatochromate(III), $K_3[Cr(C_2O_4)_3]$

c) Potassium trioxalatoferrate(III), $K_3[Fe(C_2O_4)_3]$

a) Tetraamminecopper(II) sulphate, $[Cu(NH_3)_4]SO_4$

b) Potassium c*is*-diaquabis(oxalato)chromate(III) dihydrate, K[*cis*-$Cr(H_2O)_2(C_2O_4)_2].2H_2$

Ex.2 Two step preparations of simple compounds: The students are expected to perform at least three of the following preparations.

- (i)Preparation of p-aminoazobenzene from aniline.
- (ii)Preparation of p-nitroaniline from acetanilide.

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- (iii)Preparation of sym-tribromobenzene from aniline.
- (iv)Preparation of m-nitroaniline from nitrobenzene.
- (v) Preparation of acetanilide from acetophenone (Beckmann rearrangement).
- (vi) Preparation of anthranilic acid from phthalic anhydride.
- (vii) Preparation of eosin from phthalic anhydride.

Physical Chemistry:
Spectrophotometery or Colourimetry:

Verify Lambert Beer Law & determine the concentration of the given aqueous solution of unknown concentration of salt. ($KMnO_4$, $CuSO_4$, $K_2Cr_2O_7$)

(any two exercise, $2 \times 15 = 30$ marks)

Viva voce	**5 marks**
Practical Record	**5 marks**

Suggested Books and References:

1. Advanced Practical Physical Chemistry J. B. Yadav, Goel Publishing House.
2. Practical Physical Chemistry B. D Khosla, S. Chand & Company.
3. Advanced Practical Organic Chemistry by N K Vishnoi, Vikas Publishing House PVT LTD
4. 4.Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, V. K Ahluwalia. Universities Press, Hyderabad.
5. Advanced Practical Organic Chemistry by N K Vishnoi, Vikas Publishing House PVT LTD
6. Vogel's Qualitative Inorganic Analysis, A. I. Vogel Prentice Hall.
7. Vogel's Textbook of Quantitative Chemical Analysis, A. I. Vogel, Pearson Education Ltd.
8. Laboratory Techniques in Organic Chemistry by V. K Ahluwalia, I K International

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Detailed Syllabus

CHM-76P-308: Practical -II **4 Hrs./week**

Conductometry:

a) To find out the strength of strong acid by titrating it against strong alkali.
b) To find out the strength of weak acid by titrating it against a strong alkali.
c) To find out the strength of hydrochloric acid and acetic acid in a mixture of both, by titrating it against sodium hydroxide.
d) Determination of equivalent conductivity of an electrolyte at different dilutions.

B) Spectrophotometery or Colourimetry:

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1. Verify Lambert Beer Law & determine the concentration of the given aqueous solution of unknown concentration of salt ($KMnO_4$, $CuSO_4$, $K_2Cr_2O_7$)

(C) pH metric titrations:

2. To find out the strength of strong acid by titrating it against strong base.
3. To find out the strength of strong acid by titrating it against weak base.
4. To find out the strength of weak acid by titrating it against strong base.
5. Find out the strength of HCl and CH_3COOH in a mixture of both by titating it against NaOH.

Determination of DO, COD and BOD of different water samples.

Viva voce **15 marks**
Practical Record **5 marks**

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Suggested Books and References:

1. Vogel's Qualitative Inorganic Analysis, A. I. Vogel Prentice Hall.
2. Advanced Practical Physical Chemistry J. B. Yadav, Goel Publishing House.
3. Practical Physical Chemistry B. D Khosla, S. Chand & Company.
4. Advanced Practical Organic Chemistry by N K Vishnoi, Vikas Publishing House PVT LTD
5. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, V. K Ahluwalia. Universities Press, Hyderabad.
6. Advanced Practical Organic Chemistry by N K Vishnoi, Vikas Publishing House PVT LTD
7. Vogel's Textbook of Quantitative Chemical Analysis, A. I. Vogel, Pearson Education Ltd
8. Laboratory Techniques in Organic Chemistry by V. K Ahluwalia, I K International

Suggested E-resources:

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All the above suggested books are available as **e- books.**

Course Learning Outcomes:

By the end of this course, students will be able to understand bioinorganic chemistry including the role of metals and their coordination environments. Students will also achieve the essential knowledge in the fields of carbohydrates, organometallic chemistry along with phase equilibria and surface phenomenon, some instrumental methods of chemical analyses such as diffraction pattern, automated methods of analysis.

Furthermore, they will get awareness about syntheses and applications of inorganic polymers, synthetic dyes & drugs and organic polymers including uses of mass spectrometry, electrochemistry, gas chromatography and HPLC analytical techniques in chemistry.

With the completion of this degree programme, student will achieve the essential conceptual knowledge in the field of chemical sciences and will be able to conduct experiments and demonstrate efficiency with appropriate lab skills, techniques and instrumentations.

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