**Course Structure for P.G. Programmes**
**For two-year program-P.G. first year passed students**
**For one year program-U.G. 4 years passed students**

**Course Structure for P.G. Programmes**
**Third semester (for two-year program-P.G. first year passed students)**
**First semester (For one year program-U.G. 4 years passed students)**
**[ACADEMIC SESSION 2026-27 Only]**
**Specialization: Organic Chemistry**
**M.Sc. Second Year**
**(I/III Semester)**

| Course/Paper Name | Course Type | Credits |
|---|---|---|
| Organic Synthesis & Photochemistry | DSC - 1 (Theory) | 3 |
| Spectroscopy and Solid State Chemistry | DSC - 2 (Theory) | 3 |
| Bioorganic, Bioorganic & Biophysical Chemistry-I | DSC - 3 (Theory) | 3 |
| Laboratory Core Course Organic-I/III | Core Practical | 4 |
| Organometallic reagents and Organic Synthesis | DSE - 1 (Theory) (Choice No. 1) | 4 |
| Medicinal Chemistry | DSE - 1 (Theory) (Choice No. 2) | |
| Project Related Work and Seminar | Dissertation | 3 |
| | **Total Credits** | **20** |

**Important Note:**

- The students of organic Chemistry specialization will opt for only one paper out of two choices for Elective (Theory) papers in M.Sc. Second Year (I/III Semesters).
- The syllabus for Bioorganic, Bioorganic & Biophysical Chemistry-I is same for all specialization of M.Sc. Chemistry.
- NEP 2020 highly recommended the dissertation/project work at each level/semester. The students should be distributed for the dissertation.in the beginning of I/III Semesters of the PG final year.
- The assessment of the progress on Project Related Work and Seminar under dissertation shall be done in I/III Semesters of M.Sc. Second Year.
- The supervisor and allotted student shall decide the topic of dissertation and the entire work shall be carried out for same topic for complete 01 Year (i.e., 3 + 3 credits in I/III and II/IV Semesters of the Final year of PG program).
- **Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.**
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

**Course Structure for P.G. Programmes**
**Fourth semester (for two-year program-P.G. first year passed students)**
**Second semester (For one year program-U.G. 4 years passed students)**
**[ACADEMIC SESSION 2026-27 Only]**
**Specialization: Organic Chemistry**
**M.Sc. Second Year**
**(II/IV Semester)**

| Course/Paper Name | Course Type | Credits |
|---|---|---|
| Natural Products | Core - 4 (Theory) | 3 |
| Spectroscopy | Core - 5 (Theory) | 3 |
| Bioinorganic, Bioorganic & Biophysical Chemistry-II | Core - 6 (Theory) | 3 |
| Laboratory Core Course Organic-II/IV | Core Practical | 4 |
| Heterocyclic Chemistry | DSE - 2 (Theory) (Choice No. 1) | 4 |
| Environmental Chemistry | DSE - 2 (Theory) (Choice No. 2) | |
| Dissertation and Thesis Evaluation | Dissertation | 3 |
| | **Total Credits** | **20** |

**Important Note:**

- The students of Organic Chemistry specialization will opt for only one paper out of two choices for Elective (Theory) papers in M.Sc. Second Year (II/IV Semesters).
- The syllabus for Spectroscopy, Bioorganic, Bioorganic & Biophysical Chemistry-I, and Environmental Chemistry papers is same for all of the specialization in M.Sc. Chemistry Second Year (II/IV Semesters).
- The dissertation work shall be continued for the same topic chosen in the I/III Semesters of the PG final year. The final presentation and thesis submission will be done for the complete dissertation work in the end of M.Sc. Second Year (II/IV Semesters).
- **Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.**
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Core - 1 (Theory)**
**Paper Name: Organic Synthesis and Photochemistry**

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**Credits: 03**
**Theory: 45 Hours**

**Unit I. Disconnection Approach (5 Hours)**

An introduction to synthons and synthetic equivalents disconnection approach, functional group interconversions, the importance of order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions and amine synthesis.

**Unit II. Protecting Groups (5 Hours)**

Principle of protection of alcohols, amine, carbonyl and carboxyl groups

**Unit III. One Group and Two Group C-C Disconnections (10 Hours)**

Alcohols and carbonyl compounds regioselectivity. Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis. Diels-Alder reaction, 1,3-difunctional compounds, α, β-unsaturated carbonyl compounds, control in carbonyl condensations. Micheal addition and Robinson annelation.

**Unit IV. Determination of Reaction Mechanism (10 Hours)**

Classification, rate constants and life times of reactive energy states-determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions, photo-dissociation, gas-phase photolysis.

**Unit V. Photochemical Reactions (15 Hours)**

Intramolecular reactions of the olefinic bond-geometrical isomerism, cyclisation reactions, rearrangement of 1,4-and 1,5-dienes. Intramolecular reactions of carbonyl compounds-saturated cyclic and acyclic, β,γ-unsaturated and α,β- unsaturated compounds. Cyclohexadienones. Intramolecular cycloaddition reactions-dimerization and oxetane formation. Isomerisation, additions and substitutions. Photo-Fries rearrangement, Barton 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. Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, John Wiley.
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
5. Advanced Organic Chemistry Part B, F.A. Carey and R.J. Sundberg, Plenum Press.
6. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
7. Designing Organic Synthesis, S. Warren, Wiley.
8. Fundamentals of Photochemistry, K.K. Rohtagi-Mukherji, New Age International
9. Molecular Photochemistry, N.J. Turro, W.A. Benjamin
10. Introductory Photochemistry, A. Cox and T. Camp, McGraw Hill
11. Photochemistry, R.P. Kundall and A. Gilbert, Thomson Nelson
12. Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Core - 2 (Theory)**
**Paper Name: Spectroscopy and Solid State Chemistry**

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**Credits: 03**
**Theory: 45 Hours**
**Note: The syllabus of Spectroscopy and Solid State Chemistry is only applicable to Organic Chemistry specialization.**
**The Spectroscopy and Solid State Chemistry paper is Skill-based.**

**Unit I. Ultraviolet and Visible Spectroscopy (10 Hours)**

Effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds.

**Unit II. Infrared Spectroscopy (10 Hours)**

General idea of the vibrational frequencies of aliphatic and aromatic hydrocarbons, amines, carbonyl compounds, acid and acid derivatives and conjugated carbonyl compounds, effect of hydrogen bonding and solvent on IR.

**Unit III. Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD) (5 Hours)**

Definition, deduction of absolute configuration and octant rule for ketones.

**Unit IV. Solid State Chemistry (20 Hours)**

**(a). Solid State Reactions**

General principles, experimental procedures, co-precipitation as a precursor to solid state reactions, kinetics of solid state reactions.

**(b). Organic Solids, Fullerene, Molecular devices**

Electrically conducting solids, organic charge transfer complex, organic metals, magnetism in organic materials, fullerenes and doped fullerenes, organic superconductors, molecular rectifiers, transistors, artificial photosynthetic devices, molecular memory, switches and sensors.

**Books Suggested:**

1. Physical Method for Chemistry, R.S. Drago, Saunders Company.
2. Structural Method in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.
3. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
4. Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.
5. Solid State Chemistry and its Applications, A.R. West, Plenum.
6. Solid State Chemistry, D.K. Chakrabarty, New Age International.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Core - 3 (Theory)**
**Paper Name: Bioinorganic, Bioorganic & Biophysical Chemistry-I**

**Credits: 03**
**Theory: 45 Hours**

**Note: The syllabus of Bioinorganic, Bioorganic & Biophysical Chemistry-I is the same across all specializations.**

**Unit I: Bioinorganic Chemistry** **(15 Hours)**

**(A) Metal Ions in Biological Systems, Na+/K+ Pump:** Essential and trace metals. Role of metal ions in biological processes. Na+/K+ Pump.

**(B) Bioenergetics and ATP Cycles:** DNA Polymerization, glucose storage, metal complexes in transmission of energy; chlorophylls, photo system I and photo system II in cleavage of water. Model systems.

**(C) Transport and Storage of Dioxygen:** Heme proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, hemocyanins and hemerythrin, model synthetic complexes of iron, cobalt and copper.

**Unit II: Bioorganic Chemistry** **(15 Hours)**

**(A) Enzymes & Mechanism of Enzyme Action:** Introduction and historical perspective, chemical and biological catalysis, properties of enzymes, catalytic power, specificity and regulation. Fischer's lock and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling, and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition. Transition-state theory, acid-base catalysis, covalent catalysis, and strain of distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

**(B) Kinds of Reactions Catalysed by Enzymes:** Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate, addition and elimination reactions, enolic intermediates in isomerisation reactions, β-cleavage and condensation, some isomerisation and rearrangement reactions. Enzyme-catalysed carboxylation and decarboxylation.

**Unit III: Biophysical Chemistry** **(15 Hours)**

**(A) Biological Cell and its Constituents, Cell Membrane and Transport of Ions:** Biological cell, Structure and functions of the cell membrane, and ion transport through the cell membrane. Structure and functions of proteins, enzymes, DNA and RNA in living systems.

**(B) Bioenergetics:** Standard free energy change in biological reactions: exergonic, endergonic. Role of ATP in biological systems (Hydrolysis and synthesis of ATP).

**Books Suggested:**

1. Principles of BioinPhysical Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Grey, S.J. Lippard and J.S. Valentine, University Science Books.
3. BioinPhysical Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.

4. Understanding Enzymes, Trevor Palmer, Prentice Hall.
5. Enzyme Chemistry: Impact and Applications, Ed. Collins J Sucking, Chapman and Hall.
6. Enzymes Mechanism Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
7. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
8. Immobilised Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, John Wiley.
9. Enzymatic Reaction Mechanism, C. Walsh, W.H. Freeman.
10. Enzymatic Structure and Mechanism, W.H. Freeman.
11. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
12. Biochemistry, L. Stryer, W.H. Freeman.
13. Biochemistry, J. David Rawn, Neil Patterson.
14. Biochemistry, Voet and Voet, John Wiley.
15. Outlines of Biochemistry, E.E. Conn and P.K. Stumpf, John Wiley.
16. Macromolecules: Structure and function, F. World, Prentice Hall.
17. Biophysical chemistry, J.N. Gurtu, A. Gurtu, Pragati Prakashan, Meerut.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Core Practical**
**Paper Name: Laboratory Core Course Organic-I/III**

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**Credits: 04**
**Practical: 120 Hours**

**Note:** The duration of examination will be of eight hours spread over two days.

Multi-step Synthesis of Organic Compounds

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

Photochemical reaction

Benzophenone → Benzpinacol → Benzpinacolone

Beckmann rearrangement: Benzanilide from benzene

Benzophenone → Benzophenone oxime → Benzanilide

Benzilic acid rearrangement: Benzilic acid from benzoin

Benzoin Benzil Benzilic acid

Synthesis of heterocyclic compounds

Skraup synthesis: Preparation of quinoline from aniline. Fisher-Indole synthesis: Preparation of 2-phenyl indole from phenylhydrazine.

**Qualitative Analysis**

Separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and one solid, two solids and one liquid), using chemical tests and TLC for checking the purity of the separated compounds. Preparation of derivatives and spectral analysis.

**Enzymatic Synthesis**

Enzymatic reduction: Reduction of ethyl acetoacetate using Baker's yeast to yield enantiomeric excess of S (+) ethyl-3-hydroxybutanoate and determine its optical purity.

Biosynthesis of ethanol from sucrose

**Synthesis using microwaves**

Alkylation of diethyl malonate with benzyl chloride.

Synthesis using phase transfer catalyst.

Alkylation of diethyl malonate or ethylacetoacetate with an alkyl halide.

**Books suggested:**


1. Vogel's Text Book of Qualitative Analysis, ELBS.
2. Vogel's Text Book of Quantitative Analysis, ELBS.
3. Vogel's-Textbook-of-Practical-Organic-Chemistry
4. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.
5. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.
6. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn & Bacon, Inc. Boston.
7. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.
8. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Elective - 1 (Theory)**
**Paper Name: Organometallic Reagents and Organic Synthesis**
**(Choice No.: 01)**

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**Credits: 04**
**Theory: 60 Hours**

**Unit I.** **(15 Hours)**

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

**Group I and II metal organic compounds**

Li and Hg compounds.

**Transition metals**

Pd, Ni and Cr compounds.

**Other elements**

Si and B compounds.

**Unit II. Oxidation** **(10 Hours)**

Alcohols, diols, aldehydes, ketones, ketals and carboxylic acids.

Amines, hydrazines, and sulphides.

Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate.

**Unit III. Reduction** **(10 Hours)**

Introduction. Different reductive processes. Reduction of hydrocarbons- alkenes, alkynes and aromatic rings. Reduction of carbonyl compounds (aldehydes, ketones, acids and their derivatives). Epoxides. Reduction of nitro, nitroso, azo and oxime groups. Hydrogenolysis.

**Unit IV. Rearrangements** **(15 Hours)**

General mechanistic considerations-nature of migration, migratory aptitude, memory effects

A detailed study of the following rearrangements. Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Curtius, Schmidt, Baeyer-Villiger, Shapiro reaction

**Unit V. Metallocenes, Nonbenzenoid and Polycyclic Aromatic Compounds** **(10 Hours)**

General considerations, synthesis and reactions of some representative compounds.

**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. Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, 6th Edn., John Wiley.
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
5. Advanced Organic Chemistry Part B, F.A. Carey and R.J. Sundberg, Plenum Press.
6. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
7. Designing Organic Synthesis, S. Warren, Wiley.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Elective - 1 (Theory)**
**Paper Name: Medicinal Chemistry**
**(Choice No.: 02)**

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**Credits: 04**
**Theory: 60 Hours**

**Unit I. Drug Design** **(20 Hours)**

Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAR) factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors. Elementary treatment of drug receptor interactions. Physico-chemical parameters: lipophilicity, partition coefficient, electronic ionization constant, steric, Shelton and surface activity parameters and redox potentials. Free Wilson analysis, Hansch analysis, relationships between Free-Wilson and Hansch analysis. (Mathematical derivations of equations excluded).

**Unit II. Pharmacokinetics** **(10 Hours)**

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

**Unit III. Pharmacodynamics** **(10 Hours)**

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

**Unit IV. Antineoplastic Agents** **(10 Hours)**

Introduction, cancer chemotherapy, special problems, role of alkylating agents and antimetabolites in treatment of cancer. Carcinolytic antibiotics and mitotic inhibitors. Synthesis of mechlorethamine, cyclophosphamide, melphalan, uracil, mustards, and 6-mercaptopurine. Recent development in cancer chemotherapy. Hormone and natural products.

**Unit V. Antibiotics** **(10 Hours)**

Cell wall biosynthesis inhibitors, β-lactam rings, antibiotics inhibiting protein synthesis. Synthesis of penicillin G, penicillin V, ampicillin, amoxycillin, chloramphenicol, cephalosporin, tetracycline and streptomycin.

**Books suggested:**

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

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Paper Name: Dissertation Related Work and Seminar**

**Credits: 03**

**Note: The Dissertation course is the same across all specializations.**

- Literature review, Basis of the work, Methodology, Practical work, synopsis preparation.
- The topic of the dissertation will be decided by the supervisor as per the interest of the student, considering the availability of resources and the supervisor's expertise.
- Lab work and attendance, synopsis, preliminary assessment of the dissertation related work and presentation on the progress of the dissertation work shall be evaluated.
- Students should be distributed in the I and III semesters of the one-year and two-year PG programs, respectively. This will allow both the student and the supervisor sufficient time to complete dissertation work.
- NEP 2020 highly recommended the dissertation/project work at each level/semester. The students should be distributed for the dissertation in the beginning of I/III Semesters of the PG final year.
- The assessment of the progress on Project Related Work and Seminar under dissertation shall also be done in I/III Semesters of M.Sc. Second Year.
- The supervisor and allotted student shall decide the topic of dissertation and the entire work shall be carried out for the same topic for complete 01 Year (i.e., 3 + 3 credits in I/III and II/IV Semesters of the Final year of PG program).
- The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

| The distribution of marks for the Third Semester dissertation shall be as follows: | |
|---|---|
| **First/Third Semesters of 1 and 2 Year PG Program** | |
| **Sessional Exam (Internal)** | |
| **Assessment** | **Marks** |
| Attendance and literature of review and research tools and techniques | 25 |
| Assessment of resources required for the proposed dissertation topic | 15 |
| **Total Marks** | **40** |
| **End Semester Exam (External)** | |
| **Assessment** | **Marks** |
| Synopsis preparation and assessment of the dissertation related work | 40 |
| Presentation on the progress of the dissertation work | 20 |
| **Total Marks** | **60** |
| **Grand total** | **100** |

**Course Structure for P.G. Programmes**
**Fourth semester (for two-year program-P.G. first year passed students)**
**Second semester (For one year program-U.G. 4 years passed students)**
**[ACADEMIC SESSION 2026-27 Only]**
**Specialization: Organic Chemistry**
**M.Sc. Second Year**
**(II/IV Semester)**

| Course/Paper Name | Course Type | Credits |
|---|---|---|
| Natural Products | Core - 4 (Theory) | 3 |
| Spectroscopy | Core - 5 (Theory) | 3 |
| Bioinorganic, Bioorganic & Biophysical Chemistry-II | Core - 6 (Theory) | 3 |
| Laboratory Core Course Organic-II/IV | Core Practical | 4 |
| Heterocyclic Chemistry | DSE - 2 (Theory) (Choice No. 1) | 4 |
| Environmental Chemistry | DSE - 2 (Theory) (Choice No. 2) | |
| Dissertation and Thesis Evaluation | Dissertation | 3 |
| | **Total Credits** | **20** |

**Important Note:**

- The students of Organic Chemistry specialization will opt for only one paper out of two choices for Elective (Theory) papers in M.Sc. Second Year (II/IV Semesters).
- The syllabus for Spectroscopy, Bioorganic, Bioorganic & Biophysical Chemistry-II, and Environmental Chemistry papers is same for all of the specialization in M.Sc. Chemistry Second Year (II/IV Semesters).
- The dissertation work shall be continued for the same topic chosen in the I/III Semesters of the PG final year. The final presentation and thesis submission will be done for the complete dissertation work in the end of M.Sc. Second Year (II/IV Semesters).
- **Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.**
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Core - 4 (Theory)**
**Paper Name: Natural Products**

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**Credits: 03**
**Theory: 45 Hours**

**Unit I. Terpenoids and Carotenoids** **(10 Hours)**

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule Structures of abietic acid and β-carotene.

**Unit II. Alkaloids** **(5 Hours)**

Isolation, structure and synthesis of ephedrine, quinine.

**Unit III. Steroids** **(10 Hours)**

Structure determination of cholesterol and bile acids (without synthesis). Chemistry of testosterone, estrone and progestrone.

**Unit IV. Pigments** **(10 Hours)**

**(a) Plant Pigments:** Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of cyanidin, and quercetin.

**(b) Porphyrins**

General Introduction of haemoglobin and chlorophyll. Chemistry of chlorophyll (without synthesis). Structure and synthesis of haem.

**Unit V. Prostaglandins** **(10 Hours)**

Occurrence, nomenclature, classification, biogenesis and physiological effects. Synthesis of Key intermediates PGE2 and PGF2α.

**Books Suggested:**

1. Natural Products: Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.
2. Organic Chemistry, Vol 2, I.L. Finar, ELBS.
3. Stereoselective Synthesis: A Practical Approach, M. Nogradi, VCH.
4. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
5. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt. Hostettmann, M.P. Gupta and A. Marston, Harwood Academic Publishers.
6. Introduction to Flavonoids, B.A. Bohm, Harwood Academic Publishers.
7. New Trends in Natural product Chemistry, Atta-ur-Rahman and M.I. Choudhary, Harwood Academic Publishers

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Core - 5 (Theory)**
**Paper Name: Spectroscopy**

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**Credits: 03**
**Theory: 45 Hours**
**Note: The syllabus of Spectroscopy is the same across all specializations.**
**The Spectroscopy paper is Skill-based.**

**Unit I. Electron Spin Resonance Spectroscopy (10 Hours)**

Principle and theory of ESR, electron-nuclear coupling (hyperfine structure), line shape and width in ESR, zero field splitting (ZFS) and Kramer's degeneracy, g factor, Mc Connell relationship, ENDOR and ELDOR, electron-electron coupling. Techniques of measurement of ESR. Application of ESR to organic free radicals and to transitional metal complexes (having unpaired electron) including biological systems.

**Unit II. Nuclear Magnetic Resonance Spectroscopy (15 Hours)**

**(a).** Chemical Shift and chemical shift values for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, carboxylic acids, amines, amides). Chemical exchange in NMR, effects of deuteration in NMR, Karplus curve-variation of coupling constant with dihedral angle.

**(b). Carbon-13 NMR Spectroscopy**

General consideration, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl compounds), coupling constants (Heteronuclear and Homonuclear).

**(c). Nuclear Quadrupole Resonance:** Principle, Theory and applications of NQR.

**Unit III. Mass Spectrometry (10 Hours)**

Principle and theory, fundamental mass equation, odd and even electron ions, base peak, isotopic ions, Nitrogen rule, Index of Hydrogen Deficiency (Degree of Unsaturation), fragmentation patterns, McLafferty rearrangement and RD cleavage, Instrumentation; Ionization methods (EI, CI, ESI, APCI, FAB, MALDI), Analyzers (Quadrupole, Triple Quadrupole, Time of Flight (ToF), and Detectors in Mass Spectrometry. Application of mass spectrometry to the structure elucidation of organic molecules.

**Unit IV. Photoelectron Spectroscopy (10 Hours)**

Basic principles, photoelectric effect, ionization process, Koopman's Theorem, photoelectron spectra of simple molecules, ESCA, chemical information from ESCA, Auger electron spectroscopy-basic idea.

**Books Suggested:**

1. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Horwood.
4. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
5. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley.
6. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata McGraw.
8. Introduction to Spectroscopy, D.L. Pavia, G.M. Lampman, G.S. Kritz, Thompson Asia Pvt. Ltd., Singapore.
9. Electronic spectroscopy, D.N. Sathyanarayan, Universities Press.
10. Interpretation of Mass Spectra, F.W. McLafferty, University Science Books, California.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Core - 6 (Theory)**
**Paper Name: Bioinorganic, Bioorganic & Biophysical Chemistry-II**

**Credits: 03**
**Theory: 45 Hours**

**Note: The syllabus of Bioinorganic, Bioorganic & Biophysical Chemistry-II is the same across all specializations.**

**Unit I: Bioinorganic Chemistry** **(15 Hours)**

**(A). Electron Transfer in Biology**

Structure and function of metalloproteins in electron transport processes: cytochromes and iron-sulfur proteins, synthetic models.

**(B) Nitrogenase**

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems.

**Unit II: Bioorganic Chemistry** **(15 Hours)**

**(A). Co-Enzyme Chemistry**

Cofactors are derived from vitamins, coenzymes, prosthetic groups, and apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic acid, and vitamin B12. Mechanisms of reactions catalysed by the above cofactors.

**(B) Enzyme Models**

Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biomimetic chemistry, crown ethers, cryptates. Cyclodextrins, cyclodextrin-based enzyme models, calixarenes, ionophores, micelles, and synthetic enzymes.

**(C). Biotechnological Applications of Enzymes**

Large-scale production and purification of enzymes; techniques and methods of enzyme immobilisation; use of enzymes in the food and drink industry, brewing and cheese-making; syrups from corn starch; and enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA technology.

**Unit III: Biophysical Chemistry** **(15 Hours)**

**(A). Biopolymer Interactions, Thermodynamics of Biopolymer Solutions**

Forces involved in biopolymer interactions. Electrostatic charge and molecular expansion, hydrophobic forces, and dispersion force interactions. Multiple equilibria and various types of binding processes in biological systems. muscular contraction and energy generation in a mechanochemical system.

**(B). Biopolymers and their Molecular Weights**

Biopolymers and evaluation of their size and shape, Electrophoresis and rotational diffusion. Molecular weight determination: osmotic pressure, viscosity, sedimentation equilibrium and sedimentation velocity methods.

**Books Suggested:**

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Grey, S.J. Lippard and J.S. Valentine, University Science Books.

3. BioinPhysical Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
4. Understanding Enzymes, Trevor Palmer, Prentice Hall.
5. Enzyme Chemistry: Impact and Applications, Ed. Collins J Sucking, Chapman and Hall.
6. Enzymes Mechanism Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
7. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
8. Immobilised Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, John Wiley.
9. Enzymatic Reaction Mechanism, C. Walsh, W.H. Freeman.
10. Enzymatic Structure and Mechanism, W.H. Freeman.
11. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
12. Biochemistry, L. Stryer, W.H. Freeman.
13. Biochemistry, J. David Rawn, Neil Patterson.
14. Biochemistry, Voet and Voet, John Wiley.
15, Biophysical chemistry, J.N. Gurtu, A. Gurtu, Pragati Prakashan, Meerut.
16. Biophysical chemistry, principles and techniques, A. Upadhyay, K. Upadhyay and N. Nath, Himalaya Publishing House.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Core Practical**
**Paper Name: Laboratory Core Course Organic-II/IV**

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**Credits: 04**
**Practical: 120 Hours**

**Note:** The duration of examination will be of eight hours spread over two days.

**I. Extraction of Organic Compounds from Natural Sources**

1. Isolation of caffeine from tea leaves.
2. Isolation of casein from milk (the students are required to try some typical colour reactions of proteins).
3. Isolation of lactose from milk (purity of sugar should be checked by TLC and PC).
4. Isolation of cinchonine from cinchona bark.
5. Isolation of piperine from black pepper.
6. Isolation of lycopene from tomatoes.
7. Isolation of β-carotene from carrots.
8. Isolation of oleic acid from olive oil
9. Isolation of limonene from citrus fruits.

**II. Paper Chromatography**

Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values.

**III. Spectroscopy**

Identification of organic compounds by using spectral data (UV, IR, NMR & MS)

**IV. Spectrophotometric or Colorimetric (UV/VIS) Estimations**

1. Amino acids
2. Proteins
3. Carbohydrates
4. Cholesterol
5. Ascorbic acid
6. Aspirin
7. Caffeine

**Books Suggested:**


1. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.
2. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn & Bacon, Inc. Boston.
3. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.
4. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.
5. SOS/C027 Natural Products
6. Introduction to Organic Laboratory Techniques (Third Edition), DL Pavia, GM Lampman and GS Kriz, Saunders College Publishing, Philadelphia, New York.
7. Operational Organic Chemistry, A Laboratory Course, Second Edition, JW Lehman, Allyn & Bacon, Inc. Boston.
8. Microscale Organic Experiments KL Willianson, DC Health & Co. Le Xington.
9. Laboratory Manual of Organic Chemistry, RK Bansal, New Age International, Delhi.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Elective - 2 (Theory)**
**Paper Name: Heterocyclic Chemistry**
**(Choice No.: 01)**

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**Credits: 04**
**Theory: 60 Hours**

**Unit I. Nomenclature of Heterocycles (10 Hours)**

Replacement and Systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles

**Unit II. Aromatic and Non-aromatic Heterocycles (20 Hours)**

General chemical behaviour of aromatic heterocycles, classification (structural type), Heteroaromatic reactivity and tautomerism in 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, aromatic and related effects. Attractive interactions - hydrogen bonding and intermolecular nucleophilic, electrophilic interactions.

**Unit III. Small Ring Heterocycles (05 Hours)**

Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes

**Unit IV. Benzo-Fused Five-Membered Heterocycles (05 Hours)**

Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes

**Unit V. Six-Membered Heterocycles with One, Two or More Heteroatoms (15 Hours)**

Pyridine: Structural properties and synthesis of pyridine and substituted pyridines. Orientation, reactivity and electrophilic substitution reactions of pyridine and substituted pyridines (nitration, sulfonation and halogenation). Nucleophilic substitution reactions in pyridine and substituted pyridines including Chichibabin reaction and other nucleophilic displacement reactions. Factors affecting electrophilic/nucleophilic substitution in pyridine derivatives. Pyridine N-Oxide: Preparation, structure and properties of Pyridine N-Oxide.

Synthesis and reactions of coumarins, chromones, diazines, triazines, tetrazines and thiazines.

**Unit VI. Seven-and Large-Membered Heterocycles (05 Hours)**

Synthesis and reactions of azepines, oxepines, thiepines, diazepines thiazepines, azocines, diazocines, dioxocines and dithiocines

**Books Suggested:**


1. Heterocyclic Chemistry Vol. 1 & 2, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag
2. The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
4. Heterocyclic Chemistry, T.L. Gilchrist, Longman Scietific Technical
5. Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.
6. An introduction to the Heterocyclic Compounds, R.M. Acheson, John Wiley
7. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergamon.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Elective - 2 (Theory)**
**Paper Name: Environmental Chemistry**
**(Choice No.: 02)**

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**Credits: 04**
**Theory: 60 Hours**
**Note: The syllabus of Environmental Chemistry is the same across all specializations.**

**Unit I. Environment** **(10 Hours)**

Introduction, composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere. Biogeochemical cycles of C, N, P, S and O. Bio distribution of elements.

**Unit II. Hydrosphere** **(20 Hours)**

Aquatic pollution- inorganic, organic, pesticides, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters-dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards. Analytical methods for measuring BOD, DO, COD, F, Oils, metals (As, Cd, Cr, Hg, Pb, Se etc.) residual chloride and chlorine demand. Purification and treatment of water.

**Unit III. Soils** **(05 Hours)**

Composition, micro and macro nutrients, Pollution of fertilizers, pesticides and metals.

**Unit IV. Atmosphere** **(10 Hours)**

Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, pollution by chemicals, petroleum, minerals chlorofluorohydrocarbons. Analytical methods for measuring air pollutants. Continuous monitoring instruments.

**Unit V. Industrial Pollution** **(10 Hours)**

Pollution from cement, sugar, distillery, drug; paper and pulp, thermal power plants, nuclear power plants, metallurgy, polymers and drugs etc.

**Unit VI. Environmental Toxicology** **(05 Hours)**

Chemical solutions to environmental problems, biodegradability, principles of decomposition, better industrial processes.

**Books suggested**


1. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
2. Environmental Chemistry, Sharma and Kaur, Krishna Publishers.
3. Environmental Chemistry, A.K. De, Wiley Eastern.
4. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern.
5. Standard Method of Chemical Analysis, F.J. Welcher Vol. III, Van Nostrand Reinhold Co.
6. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
7. Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.
8. Environmental Chemistry, C. Baird, W.H. Freeman.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Organic Chemistry**
**Paper Name: Dissertation and Thesis Evaluation**

**Credits: 03**

**Note: The Dissertation course is the same across all specializations.**

**Note:**

- Practical work, thesis submission, and final presentation on dissertation work.
- The dissertation work shall be continued for the same topic chosen in the I/III Semesters of the PG final year. The final presentation and thesis submission will be done for the complete dissertation work in the end of M.Sc. Second Year (II/IV Semesters).
- Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.
- Students should carry the work of the dissertation project started in the I and III semesters of one-year and two-year PG programs, respectively.
- This will allow both the student and the supervisor sufficient time to work on the dissertation topic and any change suggested during the evaluation of project work during the I and III semesters of one-year and two-year PG programs.
- The internal and external examination will be conducted as per the existing rules and regulations for the MSc practicals.

| The distribution of marks for the Fourth Semester dissertation shall be as follows: | |
|---|---|
| **Second/Fourth Semesters of 1 and 2 Year PG Program** | |
| **Sessional Exam** | |
| **Assessment** | **Marks** |
| Attendance and progress of lab/theoretical work | 20 |
| Report of dissertation work | 20 |
| **Total Marks** | **40** |
| **End Semester Exam** | |
| **Assessment** | **Marks** |
| Assessment of the dissertation related work | 20 |
| Thesis evaluation and the final presentation on the dissertation work | 40 |
| **Total Marks** | **60** |
| **Grand total** | **100** |

# M.Sc. Inorganic Chemistry

# Specialization

# Syllabus for I/III and II/IV Semesters of

# The One and two year PG program

**Course Structure for P.G. Programmes**
**Third semester (for two-year program-P.G. first year passed students)**
**First semester (For one year program-U.G. 4 years passed students)**
**[ACADEMIC SESSION 2026-27 Only]**
**Specialization: Inorganic Chemistry**
**M.Sc. Second Year (I/III Semester)**

| Course Name | Course Type | Credits |
|---|---|---|
| Organometallic Chemistry | Core - 1 (Theory) | 3 |
| Spectroscopy, X-ray & Solid State Reactions | Core - 2 (Theory) | 3 |
| Bioorganic, Bioorganic & Biophysical Chemistry-I | Core - 3 (Theory) | 3 |
| Laboratory Core Course Inorganic-I/III | Core Practical | 4 |
| Analytical Chemistry | Elective - 1 (Theory) (Choice No. 1) | 4 |
| Bioinorganic & Supramolecular Chemistry | Elective - 1 (Theory) (Choice No. 2) | |
| Project Related Work and Seminar | Dissertation | 3 |
| | **Total Credits** | **20** |

**Important Note:**

- The students will opt for only one paper out of two choices for Elective (Theory) papers in M.Sc. Second Year (I/III Semester).
- The syllabus of Analytical Chemistry and Spectroscopy, X-ray & Solid State Reactions papers is the same for Inorganic and Physical specializations.
- The syllabus of Bioinorganic, Bioorganic & Biophysical Chemistry-I is the same across all specializations.
- NEP 2020 highly recommended the dissertation/project work at each level/semester. The students should be distributed for the dissertation.in the beginning of I/III Semesters of the PG final year.
- The assessment of the progress on Project Related Work and Seminar under dissertation shall be done in I/III Semesters of M.Sc. Second Year.
- The supervisor and allotted student shall decide the topic of dissertation and the entire work shall be carried out for same topic for complete 01 Year (i.e., 3 + 3 credits in I/III and II/IV Semesters of the Final year of PG program).
- **Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.**
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

**Course Structure for P.G. Programmes**
**Fourth semester (for two-year program-P.G. first year passed students)**
**Second semester (For one year program-U.G. 4 years passed students)**
**[ACADEMIC SESSION 2026-27 Only]**
**Specialization: Inorganic Chemistry**
**M.Sc. Second Year (II/IV Semester)**

| Course Name | Course Type | Credits |
|---|---|---|
| Inorganic Polymers | Core - 4 (Theory) | 3 |
| Spectroscopy | Core - 5 (Theory) | 3 |
| Bioinorganic, Bioorganic & Biophysical Chemistry-II | Core - 6 (Theory) | 3 |
| Laboratory Core Course Inorganic-II/IV | Core Practical | 4 |
| Photoinorganic Chemistry | Elective - 2 (Theory) (Choice No. 1) | 4 |
| Environmental Chemistry | Elective - 2 (Theory) (Choice No. 2) | |
| Dissertation and Thesis Evaluation | Dissertation | 3 |
| | **Total Credits** | **20** |

**Important Note:**

- The students will opt for only one paper out of two choices for Elective (Theory) papers in M.Sc. Second Year (II/IV Semesters).
- The syllabus for Spectroscopy, Bioorganic, Bioorganic & Biophysical Chemistry-II, and Environmental Chemistry papers is same for all of the specialization in M.Sc. Chemistry Second Year (II/IV Semesters).
- The dissertation work shall be continued for the same topic chosen in the I/III Semesters of the PG final year. The final presentation and thesis submission will be done for the complete dissertation work in the end of M.Sc. Second Year (II/IV Semesters).
- **Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.**
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Core - 1 (Theory)**
**Paper Name: Organometallic Chemistry**

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**Credits: 03**
**Theory: 45 Hours**

**Unit I. Alkyls and Aryls of Transition Metals (10 Hours)**

Alkyls and aryls of transition metals, nature of metal carbon bond, routes of synthesis, stability and decomposition pathways and their structure. Alkyls and aryls of s-block and p-block elements. Comparison of such transition and non-transition element derivatives. Organocopper in organic synthesis.

**Unit II. Compounds of Transition metal-carbon multiple bonds (05 Hours)**

Alkylidenes, alkylydines, low valent carbenes and carbynes-synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis.

**Unit III. Transition Metal π-Complexes (10 Hours)**

Transition Metal π-Complexes with unsaturated organic molecules. Alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes; preparation, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis.

**Unit IV. Metal Compounds with bonds to Hydrogen (05 Hours)**

Transition metal compounds with bonds to hydrogen.

**Unit V. Homogeneous Catalysis (10 Hours)**

Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of olefins (oxo reaction), oxopalladation reaction, activation of C-H bond.

**Unit VI. Fluxional Organometallic Compounds (05 Hours)**

Fluxionality and dynamic equilibria in compounds such as $\eta^2$-olefin, $\eta^3$-allyl and dienyl complexes, their characterization.

**Books Suggested:**


1. Principle and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus,
   J.P. Norton and R.G. Finke. University Science Books.
2. The Organometallic Chemistry of the Transition Metals, R.H. Crabtree, John Wiley.
3. Metallo-organic Chemistry, A.J. Pearson, Wiley.
4. Organometallic Chemistry, R.C. Mehrotra and A. Singh; New Age International.
5. Organometallic Compounds, NLH Green, Chapman & Hall, U.K.
6. Principles of Organometallic Chemistry, G.E. Coates, MLH Green, P. Powell, Chapman & Hall, U.K.
7. Inorganic Chemistry, 3th Ed., G L Miessler and D.A.Tarr, Pearson Education,Inc. (2004)
8. Inorganic Chemistry, 3rd Ed., Shriver & Atkins, Oxford (1999).
10. Inorganic Chemistry, 4th Ed., J.E. Huheey, Harper & Row (2000).

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Core - 2 (Theory)**
**Paper Name: Spectroscopy, X-ray & Solid State Reactions**

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**Credits: 03**
**Theory: 45 Hours**
**Note: The syllabus of Spectroscopy, X-ray & Solid State Reactions is the same for Inorganic and Physical specializations.**
**The Spectroscopy, X-ray & Solid State Reactions paper is Skill-based.**

**Unit I. Ultraviolet and Visible Spectroscopy (05 Hours)**
Instrumentation, source, monochromators, detectors, single and double beam instruments, applications.

**Unit II. Infrared Spectroscopy (05 Hours)**
Instrumentation, source, monochromators, optics of double beam instruments, detectors, sample preparation, applications.

**Unit III. X-Ray Diffraction (15 Hours)**
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, Ramchandran diagram.

**Unit IV. Electron Diffraction (10 Hours)**
Scattering intensity vs. scattering angle, Wire equation, measurement technique, elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surfaces.

**Unit V. Neutron Diffraction (05 Hours)**
Scattering of neutrons by solids and liquids, magnetic scattering, measuring techniques. Elucidation of structure of magnetically ordered unit cell.

**Unit VI. Solid State Reactions (05 Hours)**
Solid State Reactions: General principles, experimental procedures, co-precipitation as a precursor to solid state reactions, kinetics of solid state reactions.

**Books Suggested:**


1. Physical Methods for Chemistry, R.S. Drago, Saunders Company.
2. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.
3. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
4. Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.
5. Solid State Chemistry and its Applications, A.R. West, Plenum.
6. Solid State Chemistry, D.K. Chakrabarty, New Age International.
7. Symmetry and Spectroscopy, K. Veera Reddy, New Age International, 1998.
8. Instrumental Methods of Analysis, Willard et al., 7th Edn., CBS Publishers.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Core - 3 (Theory)**
**Paper Name: Bioinorganic, Bioorganic & Biophysical Chemistry-I**

**Credits: 03**
**Theory: 45 Hours**

**Note: The syllabus of Bioinorganic, Bioorganic & Biophysical Chemistry-I is the same across all specializations.**

**Unit I: Bioinorganic Chemistry** **(15 Hours)**

**(A) Metal Ions in Biological Systems, Na+/K+ Pump:** Essential and trace metals. Role of metal ions in biological processes. Na+/K+ Pump.

**(B) Bioenergetics and ATP Cycles:** DNA Polymerization, glucose storage, metal complexes in transmission of energy; chlorophylls, photo system I and photo system II in cleavage of water. Model systems.

**(C) Transport and Storage of Dioxygen:** Heme proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, hemocyanins and hemerythrin, model synthetic complexes of iron, cobalt and copper.

**Unit II: Bioorganic Chemistry** **(15 Hours)**

**(A) Enzymes & Mechanism of Enzyme Action:** Introduction and historical perspective, chemical and biological catalysis, properties of enzymes, catalytic power, specificity and regulation. Fischer's lock and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling, and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition. Transition-state theory, acid-base catalysis, covalent catalysis, and strain of distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

**(B) Kinds of Reactions Catalysed by Enzymes:** Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate, addition and elimination reactions, enolic intermediates in isomerisation reactions, β-cleavage and condensation, some isomerisation and rearrangement reactions. Enzyme-catalysed carboxylation and decarboxylation.

**Unit III: Biophysical Chemistry** **(15 Hours)**

**(A) Biological Cell and its Constituents, Cell Membrane and Transport of Ions:** Biological cell, Structure and functions of the cell membrane, and ion transport through the cell membrane. Structure and functions of proteins, enzymes, DNA and RNA in living systems.

**(B) Bioenergetics:** Standard free energy change in biological reactions: exergonic, endergonic. Role of ATP in biological systems (Hydrolysis and synthesis of ATP).

**Books Suggested:**

1. Principles of BioinPhysical Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Grey, S.J. Lippard and J.S. Valentine, University Science Books.
3. BioinPhysical Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.

4. Understanding Enzymes, Trevor Palmer, Prentice Hall.
5. Enzyme Chemistry: Impact and Applications, Ed. Collins J Sucking, Chapman and Hall.
6. Enzymes Mechanism Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
7. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
8. Immobilised Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, John Wiley.
9. Enzymatic Reaction Mechanism, C. Walsh, W.H. Freeman.
10. Enzymatic Structure and Mechanism, W.H. Freeman.
11. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
12. Biochemistry, L. Stryer, W.H. Freeman.
13. Biochemistry, J. David Rawn, Neil Patterson.
14. Biochemistry, Voet and Voet, John Wiley.
15. Outlines of Biochemistry, E.E. Conn and P.K. Stumpf, John Wiley.
16. Macromolecules: Structure and function, F. World, Prentice Hall.
17. Biophysical chemistry, J.N. Gurtu, A. Gurtu, Pragati Prakashan, Meerut.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Core Practical**
**Paper Name: Laboratory Core Course Inorganic-I/III**

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**Credits: 04**
**Practical: 120 Hours**

**Note:** The duration of examination will be of eight hours spread over two days.

**(A) Preparation of Inorganic Complexes**

Synthesis of selected inorganic compounds/complexes and their characterization by IR, electronic spectra (UV & Visible), NMR, Mossbauer, ESR and magnetic susceptibility etc. measurement. Selection can be made from the following or any other from the existing literature.

i) Cis and Trans isomers of $[Co(en)_2Cl_2]$ Cl
ii) Metal acetylacetonates: $Cr(acac)_3$; Vanadyl acetylacetonate, $Cu(acac)_2.H_2O$ etc.
iii) Cr(III) complexes: $[Cr(H_2O)_6](NO_3)_3.3H_2O$;$[Cr(H_2O)_4Cl_2]$ $Cl.2H_2O$; $[Cr(en)_3]Cl_3$
iv) Tin (IV) iodide, Tin (IV) chloride, Tin (II) iodide.
v) Mixed valence dinuclear complexes of manganese (III, IV).
vi) Preparation of triphenyl phosphine and its transition metal complexes.
vii) Reaction of Cr (III) with multidentate ligand, a kinetic experiment (visible spectra of Cr-EDTA complex). Bromination of Cr $(acac)_3$.
viii) Preparation of copper glycine complex-cis and trans bis glycinato copper (II).
ix) Relative stability of Tin (IV) and Pb (IV), Preparation of ammonium hexachlorostannate, $(NH_4)_2SnCl_6$ and ammonium hexachloroplumbate; $(NH_4)_2$ $PbCl_6$.
x) Other new synthesis reported in literature

**(B) Analysis of ores, alloys and inorganic substances by various chemical methods.**
Quantitative determination of metal ion using volumetric, gravimetric and spectrophotometric methods.

**Books Suggested**

1. Vogel's Text Book of Qualitative Analysis, ELBS.
2. Vogel's Text Book of Quantitative Analysis, ELBS.
3. Synthesis and Characterization of Inorganic Compounds, W.L. Jolly, Prentice Hall.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Elective - 1 (Theory)**
**Paper Name: Analytical Chemistry**
**(Choice No.: 01)**

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**Credits: 04**
**Theory: 60 Hours**
**Note: The syllabus of Analytical Chemistry is the same for Inorganic Chemistry and Physical Chemistry specializations.**

**Unit I: Introduction** **(20 Hours)**

Role of analytical chemistry. Classification of analytical methods: classical and instrumental. Types of instrumental analysis. Selecting an analytical method. Neatness and cleanliness. Laboratory operations and practices. Analytical balance. Techniques of weighing, errors. Volumetric glassware-cleaning and calibration of glassware. Sample preparations-dissolution and decomposition. Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analytical laboratory.

**Unit II: Errors** **(05 Hours)**

Determinate and indeterminate errors, minimisation of determinate errors, random distribution of indeterminate errors.

**Unit III: Statistical data analysis** **(15 Hours)**

Accuracy and precision, significant figures and computations, mean and standard deviation, distribution of random errors, reliability of results, confidence interval, comparison of results, comparison of means of two samples, correlation and regression, linear regression, analysis of variance and rejection of data.

**Unit IV: Applications** **(05 Hours)**

Application of analytical chemistry in the study of water and soil pollutions, analysis of fuel, body fluids and drugs.

**Books Suggested:**

1. Analytical Chemistry, G.D. Christian, J. Wiley.
2. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders.
3. Analytical Chemistry-Principles, J.H. Kennedy, W.B. Saunders.
4. Analytical Chemistry-Principles and Techniques, L.G. Hargis, Prentice Hall.
5. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, W.B. Saunders.
6. Quantitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
7. Environmental Solution Analysis, S.M. Khopkar, Wiley Eastern.
8. Basic Concepts of Analytical Chemistry, S.M. Khopkar, Wiley Eastern.
9. Handbook of Instrumental Techniques for Analytical Chemistry, F. Settle, Prentice Hall.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Elective - 1 (Theory)**
**Paper Name: Bioinorganic & Supramolecular Chemistry**
**(Choice No.: 02)**

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**Credits: 04**
**Theory: 60 Hours**

**Unit I. Metal Storage Transport and Biomineralization (10 Hours)**

Ferritin, Transferrin, and siderophores

**Unit II. Calcium in Biology (10 Hours)**

Calcium in living cells, transport and regulation, molecular aspects of intramolecular processes, extracellular binding proteins.

**Unit III. Metalloenzymes (10 Hours)**

Zinc enzymes-carboxypeptidase and carbonic anhydrase. Iron enzymes-catalase, peroxidase and cytochrome P-450. Copper enzymes-superoxide dismutase. Molybdenum oxatransferase enzymes-xanthine oxidase. Coenzymes vitamin $B_{12}$.

**Unit IV. Metal-Nucleic Acid Interactions (05 Hours)**

Metal ions and metal complex interactions. Metal complexes-nucleic acids.

**Unit V. Metals in Medicine (05 Hours)**

Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs.

**Unit VI. Supramolecular Chemistry (20 Hours)**

Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of co-receptor molecules and multiple recognition. H-bonds in supramolecular structures. Use of H-bond in crystal engineering and molecular recognition. Chelate and macrocyclic effects. Cation binding hosts, binding of anions, binding of neutral molecules, binding of organic molecules. Supramolecular reactivity and catalysis. Transport processes and carrier design. Supramolecular devices, supramolecular photochemistry, supramolecular electronic, ionic and switching devices. Some examples of self-assembly in supramolecular chemistry.

**Books Suggested:**


1. Supramolecular Chemistry, J.M. Lehn, VCH.
2. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
3. Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science.
4. Inorganic Biochemistry, vols I and II. Ed. G.L. Eichhorn, Elsevier.
5. Progress in inorganic Chemistry, vols 18 and 38 ed. J.J. Lippard, Wiley.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Paper Name: Dissertation Related Work and Seminar**

**Credits: 03**

**Note: The Dissertation course is the same across all specializations.**

- Literature review, Basis of the work, Methodology, Practical work, synopsis preparation.
- The topic of the dissertation will be decided by the supervisor as per the interest of the student, considering the availability of resources and the supervisor's expertise.
- Lab work and attendance, synopsis, preliminary assessment of the dissertation related work and presentation on the progress of the dissertation work shall be evaluated.
- Students should be distributed in the I and III semesters of the one-year and two-year PG programs, respectively. This will allow both the student and the supervisor sufficient time to complete dissertation work.
- NEP 2020 highly recommended the dissertation/project work at each level/semester. The students should be distributed for the dissertation in the beginning of I/III Semesters of the PG final year.
- The assessment of the progress on Project Related Work and Seminar under dissertation shall also be done in I/III Semesters of M.Sc. Second Year.
- The supervisor and allotted student shall decide the topic of dissertation and the entire work shall be carried out for the same topic for complete 01 Year (i.e., 3 + 3 credits in I/III and II/IV Semesters of the Final year of PG program).
- The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

| The distribution of marks for the Third Semester dissertation shall be as follows: | |
|---|---|
| **First/Third Semesters of 1 and 2 Year PG Program** | |
| **Sessional Exam (Internal)** | |
| **Assessment** | **Marks** |
| Attendance and literature of review and research tools and techniques | 25 |
| Assessment of resources required for the proposed dissertation topic | 15 |
| **Total Marks** | **40** |
| **End Semester Exam (External)** | |
| **Assessment** | **Marks** |
| Synopsis preparation and assessment of the dissertation related work | 40 |
| Presentation on the progress of the dissertation work | 20 |
| **Total Marks** | **60** |
| **Grand total** | **100** |

**Course Structure for P.G. Programmes**
**Fourth semester (for two-year program-P.G. first year passed students)**
**Second semester (For one year program-U.G. 4 years passed students)**
**[ACADEMIC SESSION 2026-27 Only]**
**Specialization: Inorganic Chemistry**
**M.Sc. Second Year (II/IV Semester)**

| Course Name | Course Type | Credits |
|---|---|---|
| Inorganic Polymers | Core - 4 (Theory) | 3 |
| Spectroscopy | Core - 5 (Theory) | 3 |
| Bioinorganic, Bioorganic & Biophysical Chemistry-II | Core - 6 (Theory) | 3 |
| Laboratory Core Course Inorganic-II/IV | Core Practical | 4 |
| Photoinorganic Chemistry | Elective - 2 (Theory) (Choice No. 1) | 4 |
| Environmental Chemistry | Elective - 2 (Theory) (Choice No. 2) | |
| Dissertation and Thesis Evaluation | Dissertation | 3 |
| | **Total Credits** | **20** |

**Important Note:**

- The students will opt for only one paper out of two choices for Elective (Theory) papers in M.Sc. Second Year (II/IV Semesters).
- The syllabus for Spectroscopy, Bioorganic, Bioorganic & Biophysical Chemistry-II, and Environmental Chemistry papers is same for all of the specialization in M.Sc. Chemistry Second Year (II/IV Semesters).
- The dissertation work shall be continued for the same topic chosen in the I/III Semesters of the PG final year. The final presentation and thesis submission will be done for the complete dissertation work in the end of M.Sc. Second Year (II/IV Semesters).
- **Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.**
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Core - 4 (Theory)**
**Paper Name: Inorganic Polymers**

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**Credits: 03**
**Theory: 45 Hours**

**Unit I.** **(05 Hours)**

Inorganic polymer synthesis, step-growth and step condensation synthesis of metal containing polymers.

**Unit II.** **(05 Hours)**

Condensation of functionalised metal containing species, condensation through bridged ligand coordination, bridging ligand formation during condensation, synthesis of main group condensation
polymer.

**Unit III.** **(05 Hours)**

Polycarboranes, polycarbosilanes, polythalocyanines, polysiloxanes.

**Unit IV.** **(05 Hours)**

Chain polymerisations, radical and cationic polymerisations.

**Unit V.** **(05 Hours)**

Inorganic polymer characterization, methods of characterizing average molecular masses.

**Unit VI.** **(10 Hours)**

Glass transition temperature measurement, spectroscopic characterization specific to inorganic polymers, use of NMR and EPR in characterization of inorganic polymers, use of electronic, vibrational, Mossbauer spectroscopies in charaterization of inorganic polymers, visco-elasticity measurements. Crystallinity characterization.

**Unit VII.** **(05 Hours)**

Polymer elastomers, inorganic dental polymers, adhesives, inorganic high temperature fluids and lubricants.

**Unit VIII.** **(05 Hours)**

Inorganic polymer conductivity, metal containing polymers, metal containing polymers in non linear optics, luminescent inorganic polymers.

**Books suggested**

1. Inorganic and Organometallic Polymers, Ronald D. Archer, Wiley VCH, 2001.
2. Inorganic Polymers, J. E. Mark et al., Prentice Hall, 1992.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Core - 5 (Theory)**
**Paper Name: Spectroscopy**

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**Credits: 03**
**Theory: 45 Hours**
**Note: The syllabus of Spectroscopy is the same across all specializations.**
**The Spectroscopy paper is Skill-based.**

**Unit I. Electron Spin Resonance Spectroscopy (10 Hours)**

Principle and theory of ESR, electron-nuclear coupling (hyperfine structure), line shape and width in ESR, zero field splitting (ZFS) and Kramer's degeneracy, g factor, Mc Connell relationship, ENDOR and ELDOR, electron-electron coupling. Techniques of measurement of ESR. Application of ESR to organic free radicals and to transitional metal complexes (having unpaired electron) including biological systems.

**Unit II. Nuclear Magnetic Resonance Spectroscopy (15 Hours)**

**(a).** Chemical Shift and chemical shift values for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, carboxylic acids, amines, amides). Chemical exchange in NMR, effects of deuteration in NMR, Karplus curve-variation of coupling constant with dihedral angle.

**(b). Carbon-13 NMR Spectroscopy**

General consideration, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl compounds), coupling constants (Heteronuclear and Homonuclear).

**(c). Nuclear Quadrupole Resonance:** Principle, Theory and applications of NQR.

**Unit III. Mass Spectrometry (10 Hours)**

Principle and theory, fundamental mass equation, odd and even electron ions, base peak, isotopic ions, Nitrogen rule, Index of Hydrogen Deficiency (Degree of Unsaturation), fragmentation patterns, McLafferty rearrangement and RD cleavage, Instrumentation; Ionization methods (EI, CI, ESI, APCI, FAB, MALDI), Analyzers (Quadrupole, Triple Quadrupole, Time of Flight (ToF), and Detectors in Mass Spectrometry. Application of mass spectrometry to the structure elucidation of organic molecules.

**Unit IV. Photoelectron Spectroscopy (10 Hours)**

Basic principles, photoelectric effect, ionization process, Koopman's Theorem, photoelectron spectra of simple molecules, ESCA, chemical information from ESCA, Auger electron spectroscopy-basic idea.

**Books Suggested:**

1. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Horwood.
4. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
5. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley.
6. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata McGraw.
8. Introduction to Spectroscopy, D.L. Pavia, G.M. Lampman, G.S. Kritz, Thompson Asia Pvt. Ltd., Singapore.
9. Electronic spectroscopy, D.N. Sathyanarayan, Universities Press.
10. Interpretation of Mass Spectra, F.W. McLafferty, University Science Books, California

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Core - 6 (Theory)**
**Paper Name: Bioinorganic, Bioorganic & Biophysical Chemistry-II**

**Credits: 03**
**Theory: 45 Hours**

**Note: The syllabus of Bioinorganic, Bioorganic & Biophysical Chemistry-II is the same across all specializations.**

**Unit I: Bioinorganic Chemistry** **(15 Hours)**

**(A). Electron Transfer in Biology**

Structure and function of metalloproteins in electron transport processes: cytochromes and iron-sulfur proteins, synthetic models.

**(B) Nitrogenase**

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems.

**Unit II: Bioorganic Chemistry** **(15 Hours)**

**(A). Co-Enzyme Chemistry**

Cofactors are derived from vitamins, coenzymes, prosthetic groups, and apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic acid, and vitamin B12. Mechanisms of reactions catalysed by the above cofactors.

**(B) Enzyme Models**

Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biomimetic chemistry, crown ethers, cryptates. Cyclodextrins, cyclodextrin-based enzyme models, calixarenes, ionophores, micelles, and synthetic enzymes.

**(C). Biotechnological Applications of Enzymes**

Large-scale production and purification of enzymes; techniques and methods of enzyme immobilisation; use of enzymes in the food and drink industry, brewing and cheese-making; syrups from corn starch; and enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA technology.

**Unit III: Biophysical Chemistry** **(15 Hours)**

**(A). Biopolymer Interactions, Thermodynamics of Biopolymer Solutions**

Forces involved in biopolymer interactions. Electrostatic charge and molecular expansion, hydrophobic forces, and dispersion force interactions. Multiple equilibria and various types of binding processes in biological systems. muscular contraction and energy generation in a mechanochemical system.

**(B). Biopolymers and their Molecular Weights**

Biopolymers and evaluation of their size and shape, Electrophoresis and rotational diffusion. Molecular weight determination: osmotic pressure, viscosity, sedimentation equilibrium and sedimentation velocity methods.

**Books Suggested:**

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Grey, S.J. Lippard and J.S. Valentine, University Science Books.

3. BioinPhysical Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
4. Understanding Enzymes, Trevor Palmer, Prentice Hall.
5. Enzyme Chemistry: Impact and Applications, Ed. Collins J Sucking, Chapman and Hall.
6. Enzymes Mechanism Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
7. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
8. Immobilised Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, John Wiley.
9. Enzymatic Reaction Mechanism, C. Walsh, W.H. Freeman.
10. Enzymatic Structure and Mechanism, W.H. Freeman.
11. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
12. Biochemistry, L. Stryer, W.H. Freeman.
13. Biochemistry, J. David Rawn, Neil Patterson.
14. Biochemistry, Voet and Voet, John Wiley.
15, Biophysical chemistry, J.N. Gurtu, A. Gurtu, Pragati Prakashan, Meerut.
16. Biophysical chemistry, principles and techniques, A. Upadhyay, K. Upadhyay and N. Nath, Himalaya Publishing House.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Core Practical**
**Paper Name: Laboratory Core Course Inorganic-II/IV**

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**Credits: 04**
**Practical: 120 Hours**

**Note:** The duration of examination will be of eight hours spread over two days.

**I. Spectrophotometric Determinations**

(a). Manganese/chromium/vanadium in steel sample.
(b). Nickle/molybdenum/tungsten/vanadium/uranium by extractive Spectrophotometric method.
(c). Fluoride/nitrite/phosphate.
(d). Iron-phenanthroline complex: Job's Method of continuous variation.
(e). Zirconium-alizarin Red-S complex: Mole-ratio method.
(f). Copper-ethylene diamine complex: Slope –ratio method.

**II. Flame Photometric Determinations**

(a). Sodium and Potassium when present together.
(b). Lithium/Calcium/barium/strontium.
(c). Cadmium and magnesium in tap water.

**III. Chromatographic separations: Paper or TLC and determination of Rf values:**

**(**a). Cadmium and Zinc.
(b). Silver, Lead and Mercury.
(c), Magnesium, Iron, Nickel, Cobalt

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Elective - 2 (Theory)**
**Paper Name: Photoinorganic Chemistry**
**(Choice No.: 01)**

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**Credits: 04**
**Theory: 60 Hours**

**Unit I. Basics of photochemistry (15 Hours)**

Absorption, excitation, photochemical laws, electronically excited states-life times, measurements of the times. Flash photolysis, stopped flow techniques. Energy dissipation by radiative and non-radiative process, absorption spectra, Franck-Condon principle, photochemical stages-primary and secondary processes.

**Unit II. Properties of Excited States (05 Hours)**

Structure, dipole moment, acid-base strengths, reactivity. Photochemical kinetics-calculation of rates of radiative processes. Biomolecular deactivation-quenching.

**Unit III. Excited States of Metal Complexes (10 Hours)**

Excited states of metal complexes: Comparison with organic compounds, electronically excited states of metal complexes. Charge-transfer spectra, charge transfer excitations, methods for obtaining chargetransfer spectra.

**Unit IV. Ligand Field Photochemistry (10 Hours)**

Photosubstitution, photo oxidation and photo reduction, lability and selectivity, zero vibrational levels of ground state and excited state, energy content of excited state, zero-zero spectroscopic energy, development of the equations for redox potentials of the excited states.

**Unit V. Redox Reactions by Excited Metal Complexes (15 Hours)**

Energy transfer under conditions of weak interaction and strong interaction-exciplex formation; conditions of the excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates (2,2'-bipyridine and 1,10-phenanthroline complexes), illustration of reducing and oxidizing character of $Ruthenium^{2+}$, (bipyridyl complex, comparison with $Fe(bipy)_3$); role of spin-orbit coupling, life time of these complexes. Application of redox processes of electronically excited states for catalytic purpose, transformation of low energy reactants into high-energy products, chemical energy into light.

**Unit VI. Metal Complex Sensitizers (05 Hours)**

Metal complex sensitizer, electron relay, metal colloid system, semiconductor supported metal or oxide systems, water photolysis, nitrogen fixation and carbon dioxide reduction.

**Books Suggested:**


1. Concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley.
2. Inorganic Photochemistry, J. Chem. Educ., vol. 60, no. 10, 1983.
3. Progress in Inorganic Chemistry, vol. 30, ed. S.J. Lippard, Wiley.
4. Co-ordination Chem. Revs., 1975, 15, 321; 1981, vol. 39, 121, 131; 1990, 97, 313.
5. Photochemistry of Co-ordination Compounds, V. Balzari and V. Carassiti, Academic Press.
6. Elements of Inorganic Photochemistry, G.J. Ferraudi, Wiley.
7. Fundamentals of Photochemistry, K.K. Rohtagi-Mukherji, Wiley-Eastern.
8. Essentials of Molecular Photochemistry, A. Gilbert and J. Baggott, Blackwell Publication.
9. Molecular Photochemistry, N.J. Turro, W.A. Benjamin.
10. Introductory Photochemistry, A. Cox.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Elective - 2 (Theory)**
**Paper Name: Environmental Chemistry**
**(Choice No.: 02)**

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**Credits: 04**
**Theory: 60 Hours**
**Note: The syllabus of Environmental Chemistry is the same for all specializations.**

**Unit I. Environment** **(10 Hours)**

Introduction, composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere. Biogeochemical cycles of C, N, P, S and O. Bio distribution of elements.

**Unit II. Hydrosphere** **(20 Hours)**

Aquatic pollution- inorganic, organic, pesticides, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters-dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards. Analytical methods for measuring BOD, DO, COD, F, Oils, metals (As, Cd, Cr, Hg, Pb, Se etc.) residual chloride and chlorine demand. Purification and treatment of water.

**Unit III. Soils** **(05 Hours)**

Composition, micro and macro nutrients, Pollution of fertilizers, pesticides and metals.

**Unit IV. Atmosphere** **(10 Hours)**

Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, pollution by chemicals, petroleum, minerals chlorofluorohydrocarbons. Analytical methods for measuring air pollutants. Continuous monitoring instruments.

**Unit V. Industrial Pollution** **(10 Hours)**

Pollution from cement, sugar, distillery, drug; paper and pulp, thermal power plants, nuclear power plants, metallurgy, polymers and drugs etc.

**Unit VI. Environmental Toxicology** **(05 Hours)**

Chemical solutions to environmental problems, biodegradability, principles of decomposition, better industrial processes.

**Books suggested**


1. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
2. Environmental Chemistry, Sharma and Kaur, Krishna Publishers.
3. Environmental Chemistry, A.K. De, Wiley Eastern.
4. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern.
5. Standard Method of Chemical Analysis, F.J. Welcher Vol. III, Van Nostrand Reinhold Co.
6. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
7. Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.
8. Environmental Chemistry, C. Baird, W.H. Freeman.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Inorganic Chemistry**
**Paper Name: Dissertation and Thesis Evaluation**

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**Credits: 03**

**Note: The Dissertation course is the same across all specializations.**

**Note:**

- Practical work, thesis submission, and final presentation on dissertation work.
- The dissertation work shall be continued for the same topic chosen in the I/III Semesters of the PG final year. The final presentation and thesis submission will be done for the complete dissertation work in the end of M.Sc. Second Year (II/IV Semesters).
- Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.
- Students should carry the work of the dissertation project started in the I and III semesters of one-year and two-year PG programs, respectively.
- This will allow both the student and the supervisor sufficient time to work on the dissertation topic and any change suggested during the evaluation of project work during the I and III semesters of one-year and two-year PG programs.
- The internal and external examination will be conducted as per the existing rules and regulations for the MSc practicals.

| The distribution of marks for the Fourth Semester dissertation shall be as follows: | |
|---|---|
| **Second/Fourth Semesters of 1 and 2 Year PG Program** | |
| **Sessional Exam** | |
| **Assessment** | **Marks** |
| Attendance and progress of lab/theoretical work | 20 |
| Report of dissertation work | 20 |
| **Total Marks** | **40** |
| **End Semester Exam** | |
| **Assessment** | **Marks** |
| Assessment of the dissertation related work | 20 |
| Thesis evaluation and the final presentation on the dissertation work | 40 |
| **Total Marks** | **60** |
| **Grand total** | **100** |

# M.Sc. Physical Chemistry

# Specialization

# Syllabus for I/III and II/IV Semesters of the One and Two year PG program

**P.G. First Year (for Two-year P.G. program)**
**First Semester for 2-year P.G. program**

**Course Structure for P.G. Programmes**
**Third semester (for two-year program-P.G. first year passed students)**
**First semester (For one-year program, U.G. 4 years passed students)**
**[ACADEMIC SESSION 2026-27 Only]**
**Specialization: Physical Chemistry**
**M.Sc. Second Year**
**(I/III Semester)**

| Course Name | Course Type | Credits |
|---|---|---|
| Advanced Chemistry of Materials | Core - 1 (Theory) | 3 |
| Spectroscopy, X-ray & Solid State Reactions | Core - 2 (Theory) | 3 |
| Bioinorganic, Bioorganic & Biophysical Chemistry- I | Core - 3 (Theory) | 3 |
| Laboratory Core Course Physical-I/III | Core Practical | 4 |
| Analytical Chemistry | Elective - 1 (Theory) (Choice No. 1) | 4 |
| Liquid State | Elective - 1 (Theory) (Choice No. 2) | |
| Project Related Work and Seminar | Dissertation | 3 |
| | **Total Credits** | **20** |

**Important Note:**

- The students will opt for only one paper out of two choices for Elective (Theory) papers in M.Sc. Second Year (I/III Semester).
- The syllabus of Analytical Chemistry and Spectroscopy, X-ray & Solid State Reactions papers is the same for Inorganic and Physical specializations.
- The syllabus of Bioinorganic, Bioorganic & Biophysical Chemistry-I is the same across all specializations.
- NEP 2020 highly recommended the dissertation/project work at each level/semester. The students should be distributed for the dissertation.in the beginning of I/III Semesters of the PG final year.
- The assessment of the progress on Project Related Work and Seminar under dissertation shall be done in I/III Semesters of M.Sc. Second Year.
- The supervisor and allotted student shall decide the topic of dissertation and the entire work shall be carried out for same topic for complete 01 Year (i.e., 3 + 3 credits in I/III and II/IV Semesters of the Final year of PG program).
- **Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.**
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

**Course Structure for P.G. Programmes**
**Fourth semester (for two-year program-P.G. first year passed students)**
**Second semester (For one-year program, U.G. 4 years passed students)**
**[ACADEMIC SESSION 2026-27 Only]**
**Specialization: Physical Chemistry**
**M.Sc. Second Year**
**(II/IV Semester)**

| **Course Name** | **Course Type** | **Credits** |
|---|---|---|
| Advanced Quantum Chemistry | Core - 4 (Theory) | 3 |
| Spectroscopy | Core - 5 (Theory) | 3 |
| Bioinorganic, Bioorganic & Biophysical Chemistry-II | Core - 6 (Theory) | 3 |
| Laboratory Core Course Physical-II/IV | Core Practical | 4 |
| Polymer | Elective - 2 (Theory) (Choice No. 1) | 4 |
| Environmental Chemistry | Elective - 2 (Theory) (Choice No. 2) | |
| Dissertation and Thesis Evaluation | Dissertation | 3 |
| | **Total Credits** | **20** |

**Important Note:**

- The students will opt for only one paper out of two choices for Elective (Theory) papers in M.Sc. Second Year (II/IV Semesters).
- The syllabus for Spectroscopy, Bioorganic, Bioorganic & Biophysical Chemistry-II, and Environmental Chemistry papers is same for all of the specialization in M.Sc. Chemistry Second Year (II/IV Semesters).
- The dissertation work shall be continued for the same topic chosen in the I/III Semesters of the PG final year. The final presentation and thesis submission will be done for the complete dissertation work in the end of M.Sc. Second Year (II/IV Semesters).
- **Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.**
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Core - 1 (Theory)**
**Paper Name: Advanced Chemistry of Materials**

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**Credits: 03**
**Theory: 45 Hours**

**Unit I: Advanced Polymeric Materials (08 Hours)**

Ultra-high molecular weight polyethene**,** high-temperature and fire-resistant polymers, liquid crystal polymers, polymer nanocomposite materials, conducting and ferro-electric polymers, shape memory polymers, Biopolymers: polymeric bio-implants and drug delivery biopolymers.

**Unit II: Glasses, Ceramics, Composites and Nanomaterials (10 Hours)**

Glassy state, glass formers, glass modifiers, and applications. Ceramic structures, mechanical properties, and clay products. Refractories, characterisations, properties and applications. Microscopic composites; dispersion-strengthened and particle-reinforced, fibre-reinforced composites, macroscopic composites. Nanocrystalline phase, preparation procedures, special properties, and applications.

**Unit III: Thin Films and Langmuir-Blodgett Films (07 Hours)**

Preparation techniques: evaporation/sputtering, chemical processes, MOCVD, sol-gel, etc. Langmuir-Blodgett (LB) film, growth techniques, photolithography, properties and applications of thin and LB films.

**Unit IV: Liquid Crystals (10 Hours)**

Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases; smectic-nematic transition and clearing temperature-homeotropic, planar and schlieren textures, twisted nematics, chiral nematics, molecular arrangement in smectic C phases, optical properties of liquid crystals. Dielectric susceptibility and dielectric constants. Lyotropic phases and their description of ordering in liquid crystals.

**Unit V: High Critical Temperature (Tc) Superconductors (10 Hours)**

Defect perovskites, high Tc superconductivity in cuprates, normal state properties; anisotropy; temperature dependence of electrical resistance; optical phonon modes, superconducting state; heat capacity; coherence length, elastic constants, position lifetimes, microwave absorption-pairing and multigap structure in high Tc materials, applications of high Tc materials.

**Books Suggested**


1. Solid State Physics, N.W. Ashcroft and N.D. Mermin, Saunders College.
2. Material Science and Engineering, An Introduction, W.D. Callister, Wiley.
3. Principles of the Solid State, H.V. Keer, Wiley Eastern.
4. Materials Science, J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS.
5. Thermotropic Liquid Crystals, Ed., G.W. Grey, John Wiley.
6. Handbook of Liquid Crystals, Kelker and Hatz, Chemie Verlag.
7. Inorganic Materials: Recent Advances, Editors D.Bahadur *et al.,* Narosa
8. Ion Conducting Materials: Theory and Applications, Editor A. R. Kulkarni, Narosa
9. Advances in Polymer Materials and Technology, S. Anandhan and S. Bandyopadhyay, CRC Press, Boca Raton.
10. M. Chanda, S. K. Roy, Industrial Polymers, Specialty Polymers, and their Applications, CRC Press, USA.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialisation: Physical Chemistry**
**Core - 2 (Theory)**
**Paper Name: Spectroscopy, X-ray & Solid State Reactions**

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**Credits: 03**
**Theory: 45 Hours**

**Note: The syllabus of Spectroscopy, X-ray & Solid State Reactions is the same for Inorganic and Physical specializations.**

**Unit I. Ultraviolet and Visible Spectroscopy** **(05 Hours)**

Instrumentation, source, monochromators, detectors, single and double beam instruments, applications.

**Unit II. Infrared Spectroscopy** **(05 Hours)**

Instrumentation, source, monochromators, optics of double beam instruments, detectors, sample preparation, applications.

**Unit III. X-Ray Diffraction** **(15 Hours)**

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, Ramchandran diagram.

**Unit IV. Electron Diffraction** **(10 Hours)**

Scattering intensity vs. scattering angle, Wire equation, measurement technique, elucidation of structure of simple gas phase molecules. Low energy electron diffraction and structure of surfaces.

**Unit V. Neutron Diffraction** **(05 Hours)**

Scattering of neutrons by solids and liquids, magnetic scattering, measuring techniques. Elucidation of structure of magnetically ordered unit cell.

**Unit VI. Solid State Reactions** **(05 Hours)**

Solid State Reactions: General principles, experimental procedures, co-precipitation as a precursor to solid state reactions, kinetics of solid state reactions.

**Books Suggested:**


1. Physical Methods for Chemistry, R.S. Drago, Saunders Company.
2. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S.Cradock,
   ELBS.
3. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto,Wiley.
4. Inorganic Electronic Spectroscopy, A.P.B. Lever, Elsevier.
5. Solid State Chemistry and its Applications, A.R. West, Plenum.
6. Solid State Chemistry, D.K. Chakrabarty, New Age International.
7. Symmetry and Spectroscopy, K. Veera Reddy, New Age International, 1998.
8. Instrumental Methods of Analysis, Willard et al., 7th Edn., CBS Publishers.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Core - 3 (Theory)**
**Paper Name: Bioinorganic, Bioorganic & Biophysical Chemistry-I**

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**Credits: 03**
**Theory: 45 Hours**
**Note: The syllabus of Bioinorganic, Bioorganic & Biophysical Chemistry-I is the same across all specializations.**

**Unit I: Bioinorganic Chemistry** **(15 Hours)**

**(A) Metal Ions in Biological Systems, Na+/K+ Pump:** Essential and trace metals. Role of metal ions in biological processes. Na+/K+ Pump.

**(B) Bioenergetics and ATP Cycles:** DNA Polymerization, glucose storage, metal complexes in transmission of energy; chlorophylls, photo system I and photo system II in cleavage of water. Model systems.

**(C) Transport and Storage of Dioxygen:** Heme proteins and oxygen uptake, structure and function of haemoglobin, myoglobin, hemocyanins and hemerythrin, model synthetic complexes of iron, cobalt and copper.

**Unit II: Bioorganic Chemistry** **(15 Hours)**

**(A) Enzymes & Mechanism of Enzyme Action:** Introduction and historical perspective, chemical and biological catalysis, properties of enzymes, catalytic power, specificity and regulation. Fischer's lock and Koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling, and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible inhibition. Transition-state theory, acid-base catalysis, covalent catalysis, and strain of distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

**(B) Kinds of Reactions Catalysed by Enzymes:** Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Transfer of sulphate, addition and elimination reactions, enolic intermediates in isomerisation reactions, β-cleavage and condensation, some isomerisation and rearrangement reactions. Enzyme-catalysed carboxylation and decarboxylation.

**Unit III: Biophysical Chemistry** **(15 Hours)**

**(A) Biological Cell and its Constituents, Cell Membrane and Transport of Ions:** Biological cell, Structure and functions of the cell membrane, and ion transport through the cell membrane. Structure and functions of proteins, enzymes, DNA and RNA in living systems.

**(B) Bioenergetics:** Standard free energy change in biological reactions: exergonic, endergonic. Role of ATP in biological systems (Hydrolysis and synthesis of ATP).

**Books Suggested:**

1. Principles of BioinPhysical Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Grey, S.J. Lippard and J.S. Valentine, University Science Books.
3. BioinPhysical Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.

4. Understanding Enzymes, Trevor Palmer, Prentice Hall.
5. Enzyme Chemistry: Impact and Applications, Ed. Collins J Sucking, Chapman and Hall.
6. Enzymes Mechanism Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
7. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
8. Immobilised Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, John Wiley.
9. Enzymatic Reaction Mechanism, C. Walsh, W.H. Freeman.
10. Enzymatic Structure and Mechanism, W.H. Freeman.
11. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
12. Biochemistry, L. Stryer, W.H. Freeman.
13. Biochemistry, J. David Rawn, Neil Patterson.
14. Biochemistry, Voet and Voet, John Wiley.
15. Outlines of Biochemistry, E.E. Conn and P.K. Stumpf, John Wiley.
16. Macromolecules: Structure and function, F. World, Prentice Hall.
17. Biophysical chemistry, J.N. Gurtu, A. Gurtu, Pragati Prakashan, Meerut.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Core Practical**
**Paper Name: Laboratory Core Course Physical-I/III**

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**Credits: 04**

**Practical: 120 Hours**

**Note:** The duration of examination will be of eight hours spread over two days.

1. Verification of Lambert-Beer's law
2. Temperature coefficient of a reaction.
3. Energy of activation of a reaction.
4. Entropy of a reaction.
5. Determination of pH by Electrical Conductivity/E.M.F
6. Determination of the degree of hydrolysis of aniline hydrochloride by the pH method.
7. Determination of percentage composition of optical substances in the given binary mixture by Polarimeter.
8. Hydrolysis of the salts by Electrical Conductivity/E.M.F.
9. Determination of the dissociation constant of a weak acid by potentiometry.
10. Determination of the Fluorescence quantum yield of an unknown molecule.

**Books suggested:**


1. Practical Physical Chemistry, A. Findary, T.A. kitchner (Longmans, Green and Co.)
2. Experiments in Physical Chemistry, J.M. Wilson, K.J. Newcombe, A.r. Denko. R.M.W. richett (Pergamon Press).
3. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co., Delhi.)
4. Advanced Practical Physical Chemistry, J.B Yadav (Krishna Prakashan Media Pvt. Ltd)
5. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
6. Practical Physical Chemistry, S.R. Palit and S.K. De, Science Book Agency.
7. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
8. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman
9. Systematic experimental Physical Chemistry, T.K. Chandershekhar & S.K. Rajbhoj
10. Experimental Physical Chemistry, V.D.Athawale and Parul Mathur, New Age International
11. Practical Physical Chemistry, B.P. Levitt and Zindley's, Longman.
12. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw Hill.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Elective - 1 (Theory)**
**Paper Name: Analytical Chemistry**
**(Choice No.: 01)**

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**Credits: 04**
**Theory: 60 Hours**

**Note: The syllabus of Analytical Chemistry is the same for Inorganic and Physical specializations.**

**Unit I: Introduction** **(20 Hours)**

Role of analytical chemistry. Classification of analytical methods: classical and instrumental. Types of instrumental analysis. Selecting an analytical method. Neatness and cleanliness. Laboratory operations and practices. Analytical balance. Techniques of weighing, errors. Volumetric glassware-cleaning and calibration of glassware. Sample preparations-dissolution and decomposition. Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analytical laboratory.

**Unit II: Errors** **(05 Hours)**

Determinate and indeterminate errors, minimisation of determinate errors, random distribution of indeterminate errors.

**Unit III: Statistical data analysis** **(15 Hours)**

Accuracy and precision, significant figures and computations, mean and standard deviation, distribution of random errors, reliability of results, confidence interval, comparison of results, comparison of means of two samples, correlation and regression, linear regression, analysis of variance and rejection of data.

**Unit IV: Applications** **(05 Hours)**

Application of analytical chemistry in the study of water and soil pollutions, analysis of fuel, body fluids and drugs.

**Books Suggested:**

1. Analytical Chemistry, G.D. Christian, J. Wiley.
2. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders.
3. Analytical Chemistry-Principles, J.H. Kennedy, W.B. Saunders.
4. Analytical Chemistry-Principles and Techniques, L.G. Hargis, Prentice Hall.
5. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, W.B. Saunders.
6. Quantitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
7. Environmental Solution Analysis, S.M. Khopkar, Wiley Eastern.
8. Basic Concepts of Analytical Chemistry, S.M. Khopkar, Wiley Eastern.
9. Handbook of Instrumental Techniques for Analytical Chemistry, F. Settle, Prentice Hall.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Elective - 1 (Theory)**
**Paper Name: Liquid State**
**(Choice No.: 02)**

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**Credits: 04**
**Theory: 60 Hours**

**Unit I: General Properties of Liquids (15 Hours)**

(A) Liquids as dense gases, liquids as disordered solids, some thermodynamics relations, internal pressure and its significance in liquids. Equations of state, critical constants. Different types of intermolecular forces in liquids, different potential functions for liquids. Additivity of pair potential approximation.

(B) A classical partition function for liquid for liquids, correspondence principle, configuration integral, configuration properties.

**Unit II: Theory of Liquids (10 Hours)**

Theory of liquids, partition function method or model approach, single cell models, communal energy and entropy, LTD model, significant structure model.

**Unit III: Distribution Function and Related Equations (13 Hours)**

Radial distribution function method, equation of state in terms of RDF, Molecular distribution functions, pair distribution function. Relationship between pair distribution function and pair potential function. The IBG equation, the HNC equation, the PY equation, and cluster expansion.

**Unit IV: Methods for Structure Determination & Computational Techniques (10 Hours)**

Spectroscopic techniques for liquid dynamic structure studies, Neutron and X-ray scattering spectroscopy. Computation Techniques- Monte Carlo and molecular dynamics methods.

**Unit V: Supercooled and Ionic Liquids. (12 Hours)**

Supercooled and ionic liquids, theories of transport properties; non-Arrhenius behaviour of transport properties, Cohen-Turnbull free volume model, configurational entropy model, Macedo-Litovitz hybrid model, glass transition in supercooled liquids.

**Books Suggested**

1. An Introduction to Liquid State, P.A. Egeistaff, Academic Press.
2. The Dynamic Liquid State, A.F.M. Barton, Longman.
3. Introduction to Statistical Thermodynamics, T.L. Hill, Addison-Wesley.
4. The Liquid State, J.A. Pryde.
5. Significant Liquid Structures, H. Eyring and M.S. John.

**M.Sc. Second Year (I/III Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Paper Name: Dissertation Related Work and Seminar**

**Credits: 03**

**Note: The Dissertation course is the same across all specializations.**

- Literature review, Basis of the work, Methodology, Practical work, synopsis preparation.
- The topic of the dissertation will be decided by the supervisor as per the interest of the student, considering the availability of resources and the supervisor's expertise.
- Lab work and attendance, synopsis, preliminary assessment of the dissertation related work and presentation on the progress of the dissertation work shall be evaluated.
- Students should be distributed in the I and III semesters of the one-year and two-year PG programs, respectively. This will allow both the student and the supervisor sufficient time to complete dissertation work.
- NEP 2020 highly recommended the dissertation/project work at each level/semester. The students should be distributed for the dissertation in the beginning of I/III Semesters of the PG final year.
- The assessment of the progress on Project Related Work and Seminar under dissertation shall also be done in I/III Semesters of M.Sc. Second Year.
- The supervisor and allotted student shall decide the topic of dissertation and the entire work shall be carried out for the same topic for complete 01 Year (i.e., 3 + 3 credits in I/III and II/IV Semesters of the Final year of PG program).
- The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

| The distribution of marks for the Third Semester dissertation shall be as follows: | |
|---|---|
| **First/Third Semesters of 1 and 2 Year PG Program** | |
| **Sessional Exam (Internal)** | |
| **Assessment** | **Marks** |
| Attendance and literature of review and research tools and techniques | 25 |
| Assessment of resources required for the proposed dissertation topic | 15 |
| **Total Marks** | **40** |
| **End Semester Exam (External)** | |
| **Assessment** | **Marks** |
| Synopsis preparation and assessment of the dissertation related work | 40 |
| Presentation on the progress of the dissertation work | 20 |
| **Total Marks** | **60** |
| **Grand total** | **100** |

**Course Structure for P.G. Programmes**
**Fourth semester (for two-year program-P.G. first year passed students)**
**Second semester (For one-year program, U.G. 4 years passed students)**
**[ACADEMIC SESSION 2026-27 Only]**
**Specialization: Physical Chemistry**
**M.Sc. Second Year**
**(II/IV Semester)**

| Course Name | Course Type | Credits |
|---|---|---|
| Advanced Quantum Chemistry | Core - 4 (Theory) | 3 |
| Spectroscopy | Core - 5 (Theory) | 3 |
| Bioinorganic, Bioorganic & Biophysical Chemistry-II | Core - 6 (Theory) | 3 |
| Laboratory Core Course Physical-II/IV | Core Practical | 4 |
| Polymer | Elective - 2 (Theory) (Choice No. 1) | 4 |
| Environmental Chemistry | Elective - 2 (Theory) (Choice No. 2) | |
| Dissertation and Thesis Evaluation | Dissertation | 3 |
| | **Total Credits** | **20** |

**Important Note:**

- The students will opt for only one paper out of two choices for Elective (Theory) papers in M.Sc. Second Year (II/IV Semesters).
- The syllabus for Spectroscopy, Bioorganic, Bioorganic & Biophysical Chemistry-II, and Environmental Chemistry papers is same for all of the specialization in M.Sc. Chemistry Second Year (II/IV Semesters).
- The dissertation work shall be continued for the same topic chosen in the I/III Semesters of the PG final year. The final presentation and thesis submission will be done for the complete dissertation work in the end of M.Sc. Second Year (II/IV Semesters).
- **Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.**
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Core - 4 (Theory)**
**Paper Name: Advanced Quantum Chemistry**

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**Credits: 03**
**Theory: 45 Hours**
***(Pre-requisite: Mathematics at least up to First Year B.Sc. level is necessary. At least one PC among 4 students should be available)***

**Unit I: Theoretical and Computational Treatment of Atoms and Molecules (08 Hours)**
Born-Oppenheimer approximation. Slater-Condon rules, Hartree-Fock equation, Koopmans and Brillouin theorem, Roothan equation, Gaussian basis sets.

**Unit II: Configuration Interaction and MC-SCF (07 Hours)**
Introduction to CI; full and truncated CI theories, size consistency, Introductory treatment of coupled cluster and MC-SCF methods.

**Unit III: Semi-Empirical Theories (10 Hours)**
A review of the Huckel, EHT and PPP treatments, ZDO approximation, and detailed treatment of CNDO and INDO theories. A discussion of electronic energies and properties. An introduction to MOPAC and AMI with hands-on experience on a personal computer.

**Unit IV: Density Functional Theory (10 Hours)**
Derivation of Hohenberg-Kohn theorem, Kohn-Sham formulation, N- and V-representabilities; review of the performance of the existing local (e.g. Slater Xa and other methods) and non-local functionals, treatment of chemical concepts with the density functional theory.

**Unit V: Computer Experiments (10 Hours)**
Computer experiments using quantum-chemistry software packages such as GAUSSIAN/GAMESS/MOPAC and modelling software, e.g., MM2/AMBER/CHARM, etc.

**Books Suggested**


1. Modern Quantum Chemistry, N.S. Ostlund and A. Szabo, McGraw-Hill.
2. Quantum chemistry, Ira N. Levine, Pearson Prentice Hall ; PHI Learning
3. Quantum Chemistry, R.K. Prasad, New Age International (P) Limited
4. 2. Methods of Molecular Quantum Mechanics, R. McWeeney and B.T. Sutcliffe, Academic Press
5. Density Functional Theory of Atoms and Molecules, R.G. Parr and W. Yang, Oxford.
6. Exploring Chemistry with Electron Structure Methods, J.B. Foresman and E. Frish, Gaussian Inc.
7. Semi-empirical MO Theory, J. Pople and D.L. Beveridge.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Core - 5 (Theory)**
**Paper Name: Spectroscopy**

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**Credits: 03**
**Theory: 45 Hours**
**Note: The syllabus of Spectroscopy is the same across all specializations.**
**The Spectroscopy Paper is skill-based.**

**Unit I. Electron Spin Resonance Spectroscopy (10 Hours)**

Principle and theory of ESR, electron-nuclear coupling (hyperfine structure), line shape and width in ESR, zero field splitting (ZFS) and Kramer's degeneracy, g factor, Mc Connell relationship, ENDOR and ELDOR, electron-electron coupling. Techniques of measurement of ESR. Application of ESR to organic free radicals and to transitional metal complexes (having unpaired electron) including biological systems.

**Unit II. Nuclear Magnetic Resonance Spectroscopy (15 Hours)**

**(a).** Chemical Shift and chemical shift values for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, carboxylic acids, amines, amides). Chemical exchange in NMR, effects of deuteration in NMR, Karplus curve-variation of coupling constant with dihedral angle.

**(b). Carbon-13 NMR Spectroscopy**

General consideration, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl compounds), coupling constants (Heteronuclear and Homonuclear).

**(c). Nuclear Quadrupole Resonance:** Principle, Theory and applications of NQR.

**Unit III. Mass Spectrometry (10 Hours)**

Principle and theory, fundamental mass equation, odd and even electron ions, base peak, isotopic ions, Nitrogen rule, Index of Hydrogen Deficiency (Degree of Unsaturation), fragmentation patterns, McLafferty rearrangement and RD cleavage, Instrumentation; Ionization methods (EI, CI, ESI, APCI, FAB, MALDI), Analyzers (Quadrupole, Triple Quadrupole, Time of Flight (ToF), and Detectors in Mass Spectrometry. Application of mass spectrometry to the structure elucidation of organic molecules.

**Unit IV. Photoelectron Spectroscopy (10 Hours)**

Basic principles, photoelectric effect, ionization process, Koopman's Theorem, photoelectron spectra of simple molecules, ESCA, chemical information from ESCA, Auger electron spectroscopy-basic idea.

**Books Suggested:**

1. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Horwood.
4. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
5. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley.
6. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata McGraw.
8. Introduction to Spectroscopy, D.L. Pavia, G.M. Lampman, G.S. Kritz, Thompson Asia Pvt. Ltd., Singapore.
9. Electronic spectroscopy, D.N. Sathyanarayan, Universities Press.
10. Interpretation of Mass Spectra, F.W. McLafferty, University Science Books, California

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Core - 6 (Theory)**
**Paper Name: Bioinorganic, Bioorganic & Biophysical Chemistry-II**

**Credits: 03**
**Theory: 45 Hours**

**Note: The syllabus of Bioinorganic, Bioorganic & Biophysical Chemistry-II is the same across all specializations.**

**Unit I: Bioinorganic Chemistry (15 Hours)**

**(A). Electron Transfer in Biology**

Structure and function of metalloproteins in electron transport processes: cytochromes and iron-sulfur proteins, synthetic models.

**(B) Nitrogenase**

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems.

**Unit II: Bioorganic Chemistry (15 Hours)**

**(A). Co-Enzyme Chemistry**

Cofactors are derived from vitamins, coenzymes, prosthetic groups, and apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic acid, and vitamin B12. Mechanisms of reactions catalysed by the above cofactors.

**(B) Enzyme Models**

Host-guest chemistry, chiral recognition and catalysis, molecular recognition, molecular asymmetry and prochirality. Biomimetic chemistry, crown ethers, cryptates. Cyclodextrins, cyclodextrin-based enzyme models, calixarenes, ionophores, micelles, and synthetic enzymes.

**(C). Biotechnological Applications of Enzymes**

Large-scale production and purification of enzymes; techniques and methods of enzyme immobilisation; use of enzymes in the food and drink industry, brewing and cheese-making; syrups from corn starch; and enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA technology.

**Unit III: Biophysical Chemistry (15 Hours)**

**(A). Biopolymer Interactions, Thermodynamics of Biopolymer Solutions**

Forces involved in biopolymer interactions. Electrostatic charge and molecular expansion, hydrophobic forces, and dispersion force interactions. Multiple equilibria and various types of binding processes in biological systems. muscular contraction and energy generation in a mechanochemical system.

**(B). Biopolymers and their Molecular Weights**

Biopolymers and evaluation of their size and shape, Electrophoresis and rotational diffusion. Molecular weight determination: osmotic pressure, viscosity, sedimentation equilibrium and sedimentation velocity methods.

**Books Suggested:**

1. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
2. Bioinorganic Chemistry, I. Bertini, H.B. Grey, S.J. Lippard and J.S. Valentine, University Science Books.

3. BioinPhysical Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
4. Understanding Enzymes, Trevor Palmer, Prentice Hall.
5. Enzyme Chemistry: Impact and Applications, Ed. Collins J Sucking, Chapman and Hall.
6. Enzymes Mechanism Ed, M.I. Page and A. Williams, Royal Society of Chemistry.
7. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
8. Immobilised Enzymes: An Introduction and Applications in Biotechnology, Michael D. Trevan, John Wiley.
9. Enzymatic Reaction Mechanism, C. Walsh, W.H. Freeman.
10. Enzymatic Structure and Mechanism, W.H. Freeman.
11. Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
12. Biochemistry, L. Stryer, W.H. Freeman.
13. Biochemistry, J. David Rawn, Neil Patterson.
14. Biochemistry, Voet and Voet, John Wiley.
15, Biophysical chemistry, J.N. Gurtu, A. Gurtu, Pragati Prakashan, Meerut.
16. Biophysical chemistry, principles and techniques, A. Upadhyay, K. Upadhyay and N. Nath, Himalaya Publishing House.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Core Practical**
**Paper Name: Laboratory Core Course Physical-II/IV**

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**Credits: 04**
**Practical: 120 Hours**

**Note:** The duration of examination will be of eight hours spread over two days.

1. Determination of transport number.
2. Determination of liquid junction potential.
3. Determination of the charge on colloidal particle.
4. Determine the composition of the binary mixture by Colorimetry/Spectrophotometry
5. Polarography.
6. Decomposition of potential determination.
7. Validity of Freundlich's adsorption isotherm.
8. Validity of Langmuir's adsorption isotherm.
9. Determination of partial molar volume of solute.
10. Determination of CMC of surfactants.

**Books suggested:**


1. Practical Physical Chemistry, A. Findary, T.A. kitchner (Longmans, Green and Co.)
2. Experiments in Physical Chemistry, J.M. Wilson, K.J. Newcombe, A.r. Denko. R.M.W. richett (Pergamon Press).
3. Senior Practical Physical Chemistry, B.D. Khosla and V.S. Garg (R. Chand and Co., Delhi.)
4. Advanced Practical Physical Chemistry, J.B Yadav (Krishna Prakashan Media Pvt. Ltd)
5. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
6. Practical Physical Chemistry, S.R. Palit and S.K. De, Science Book Agency.
7. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
8. Findley's Practical Physical Chemistry, B.P. Lavitt, Longman
9. Systematic experimental Physical Chemistry, T.K. Chandershekhar & S.K. Rajbhoj
10. Experimental Physical Chemistry, V.D.Athawale and Parul Mathur, New Age International
11. Practical Physical Chemistry, B.P. Levitt and Zindley's, Longman.
12. Experiments in Physical Chemistry, Shoemaker and Gailand McGraw Hill.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Elective - 2 (Theory)**
**Paper Name: Polymer**
**(Choice No.: 01)**

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**Credits: 04**
**Theory: 60 Hours**

**Unit I: Kinetics of Polymerization** **(12 Hours)**

Basic concepts of polymerisation, mechanism, and Kinetics of chain growth. Polymerisation: free-radical, cationic, anionic and coordination Polymerisation. Mechanism and Kinetics of Step-Growth Polymerisation. Comparison between chain and step-growth Polymerization.

**Unit II: Molecular Weight of Polymers** **(20 Hours)**

Significance of average molecular mass. Number-average, weight-average, and viscosity-average molecular weights. Polydispersity and molecular weight distribution curves. Molecular weight determination of polymers: Viscosity, Osmotic pressure - Membrane osmometer, high speed osmometer and vapour pressure osmometer. Sedimentation or ultracentrifugation: sedimentation velocity method, sedimentation equilibrium method. Light scattering: Scattering of light by small molecules and polymer solutions, asymmetric scattering, Debye method, Zimm plot method and comparison of Zimm and Debye methods.

**Unit III: Structure and Properties** **(16 Hours)**

Morphology and order in crystalline polymers, configurations of polymer chains. Crystal structure of polymers, strain-induced morphology, crystallisation, and melting. Polymer structure and physical properties, crystalline melting point Tm, melting points of homogeneous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, Tg. Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross-linking. Property requirements and polymer utilisation.

**Unit IV: Polymer Processing** **(12 Hours)**

Plastic, elastomers and fibres. Compounding. Processing techniques: Calendering, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, reinforcing and fibre spinning.

**Books Suggested**

1. Textbook of Polymer Science, F.W. Billmeyer Jr, Wiley.
2. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Sreedhar, Wiley-Eastern.
3. Functional Monomers and Polymers, K. Takemoto, Y. inaki and R.M. Ottanbrite.
4. Contemporary Polymer Chemistry, H.R. Alcock and F.W. Lambe, Prentice Hall.
5. Physics and Chemistry of Polymers, J.M.G. Cowie, Blackie Academic and Professional.
6. Principles of Polymerization, George Odian, John Wiley & Sons

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Elective - 2 (Theory)**
**Paper Name: Environmental Chemistry**
**(Choice No.: 02)**

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**Credits: 04**
**Theory: 60 Hours**
**Note: The syllabus of Environmental Chemistry is the same across all specializations.**

**Unit I. Environment** **(10 Hours)**

Introduction, composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere. Biogeochemical cycles of C, N, P, S and O. Bio distribution of elements.

**Unit II. Hydrosphere** **(20 Hours)**

Aquatic pollution- inorganic, organic, pesticides, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters-dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards. Analytical methods for measuring BOD, DO, COD, F, Oils, metals (As, Cd, Cr, Hg, Pb, Se etc.) residual chloride and chlorine demand. Purification and treatment of water.

**Unit III. Soils** **(05 Hours)**

Composition, micro and macro nutrients, Pollution of fertilizers, pesticides and metals.

**Unit IV. Atmosphere** **(10 Hours)**

Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, O and their effect, pollution by chemicals, petroleum, minerals chlorofluorohydrocarbons. Analytical methods for measuring air pollutants. Continuous monitoring instruments.

**Unit V. Industrial Pollution** **(10 Hours)**

Pollution from cement, sugar, distillery, drug; paper and pulp, thermal power plants, nuclear power plants, metallurgy, polymers and drugs etc.

**Unit VI. Environmental Toxicology** **(05 Hours)**

Chemical solutions to environmental problems, biodegradability, principles of decomposition, better industrial processes.

**Books suggested**


1. Environmental Chemistry, S.E. Manahan, Lewis Publishers.
2. Environmental Chemistry, Sharma and Kaur, Krishna Publishers.
3. Environmental Chemistry, A.K. De, Wiley Eastern.
4. Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern.
5. Standard Method of Chemical Analysis, F.J. Welcher Vol. III, Van Nostrand Reinhold Co.
6. Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
7. Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Creatchman, Gordon and Breach Science Publication.
8. Environmental Chemistry, C. Baird, W.H. Freeman.

**M.Sc. Second Year (II/IV Semesters of 1 and 2 Year PG Program)**
**M.Sc. Chemistry**
**Specialization: Physical Chemistry**
**Paper Name: Dissertation and Thesis Evaluation**

**Credits: 03**

**Note: The Dissertation course is the same across all specializations.**

**Note:**

- Practical work, thesis submission, and final presentation on dissertation work.
- The dissertation work shall be continued for the same topic chosen in the I/III Semesters of the PG final year. The final presentation and thesis submission will be done for the complete dissertation work in the end of M.Sc. Second Year (II/IV Semesters).
- Refer to the syllabus/suggestions/mark's distribution for Dissertation on the respective pages given below for I/III and II/IV Semesters.
- The students should be distributed in the I/III Semesters of Final year of PG program for the dissertation to effectively execute the dissertation course in second year of the PG program. The evaluation of the dissertation work shall be carried out separately in the third and fourth semester jointly by the supervisor and an external examiner appointed by the Head of the Department similar to the existing rules for external M.Sc. practical.
- Students should carry the work of the dissertation project started in the I and III semesters of one-year and two-year PG programs, respectively.
- This will allow both the student and the supervisor sufficient time to work on the dissertation topic and any change suggested during the evaluation of project work during the I and III semesters of one-year and two-year PG programs.
- The internal and external examination will be conducted as per the existing rules and regulations for the MSc practicals.

| The distribution of marks for the Fourth Semester dissertation shall be as follows: | |
|---|---|
| **Fourth Semester** | |
| **Sessional Exam** | |
| **Assessment** | **Marks** |
| Attendance and progress of lab/theoretical work | 20 |
| Report of dissertation work | 20 |
| **Total Marks** | **40** |
| **End Semester Exam** | |
| **Assessment** | **Marks** |
| Assessment of the dissertation related work | 20 |
| Thesis evaluation and the final presentation on the dissertation work | 40 |
| **Total Marks** | **60** |
| **Grand total** | **100** |