# Karmaveer Bhaurao Patil University, Satara

## Syllabus for

## M. Sc. I (Chemistry)

## Under

## Faculty of Science and Technology

## (As per NEP 2020)

## With effect from Academic Year 2024-2025

# Syllabus for M.Sc. I

## 1. Title: Chemistry (Inorganic, Physical, Organic and Analytical)

## 2. Year of Implementation:

The syllabus will be implemented from June, 2024 onwards.

## 3. Preamble:

This syllabus is framed to give advanced knowledge of Chemistry to postgraduate students at first year of two years of M.Sc. degree course. The goal of the syllabus is to make the study of chemistry, interesting and encouraging to the students for higher studies including research. The new syllabus is based on a basic and applied approach with vigor and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research. The syllabus is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields. The units of the syllabus are well defined, taking into consideration the level and capacity of students.

**4. GENERAL OBJECTIVES OF THE COURSE:**

1. To educate and prepare post graduate students from rural and urban area who will get employment on large scale in academic institutes, R & D and Quality control laboratories of Indian chemical/pharmaceutical industries as well as multinational and forensic Laboratories.
2. To provide students with broad theoretical and applied background in all specialization of Chemistry with emphasis on qualitative and quantitative technique.
3. To provide broad common framework of syllabus to expose our young graduates to the recent and applied knowledge of interdisciplinary branches of chemistry involving applied organic, inorganic, physical, analytical, industrial, pharmaceutical, polymer, nano science & technology.
4. To conduct lesser written tests and to encourage on non-written tests.
5. To focus on encouraging students to conduct various academic activities like midterm tests, online tests, open book tests, tutorial, surprise test, oral, seminar, assignments and seminar presentation.

**Learning outcomes:**

1. A graduate with a Master's degree in Chemistry has in-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods of chemistry.
2. The graduate has expert knowledge of a well-defined area of research with in chemistry. The graduate has specific skills in planning and conducting advanced chemical experiments and applying structural-chemical characterization techniques. Skilled in examining specific phenomena theoretically and/or experimentally, the graduate is able to contribute to the generation of new scientific insights or to the innovation of new applications of chemical research.

**5. Duration:** Two Year

**6. Pattern:** Semester Examination

**7. Medium of Instruction:** English

# Structure of the Course
## Credit Distribution

| Level | Sem | Major | | | | RM | OJT | RP | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | DSC Mandatory | | DSE Elective | | | | | |
| | | T | P | T | P | | | | |
| 6 | I | 12 (3 Papers) | 2 | 2 (1 Paper out of 2) | 2 | 4 | - | - | 22 |
| | II | 12 (3 Papers) | 2 | 2 (1 Paper out of 2) | 2 | - | - | 4 | 22 |
| 6.5 | III | 12 (3 Papers) | 2 | 2 (1 Paper out of 2) | - | - | - | 6 | 22 |
| | IV | 12 (3 Papers) | 2 | 2 (1 Paper out of 2) | 2 | - | 4 | - | 22 |
| **Total** | | **48** | **8** | **8** | **6** | **4** | **4** | **10** | **88** |
| | | **70** | | | | **8** | | **10** | **88** |

# M.Sc. Part I

## Semester I

| Nature of Course | Course Code | Course Title | No. of Hours per Week | Credits |
|---|---|---|---|---|
| Theory | MICT/MOCT/MPCT/MACT 411 | Inorganic Chemistry I | 4 | 4 |
| | MICT/MOCT/MPCT/MACT 412 | Organic Chemistry I | 4 | 4 |
| | MICT/MOCT/MPCT/MACT 413 | Physical Chemistry I | 4 | 4 |
| | MICT/MOCT/MPCT/MACT 414 E-I<br>MICT/MOCT/MPCT/MACT 414 E-II | Analytical Chemistry I<br>Applied Chemistry I | 2 | 2 |
| | MICT/MOCT/MPCT/MACT 415 | Research Methodology (RM) | 4 | 4 |
| Practical | MICP/MOCP/MPCP/MACP 416 | Lab I | 4 | 2 |
| | MICP/MOCP/MPCP/MACP 417 | Lab II | 4 | 2 |

## Semester II

| Nature of Course | Course Code | Course Title | No. of Hours per Week | Credits |
|---|---|---|---|---|
| Theory | MICT/MOCT/MPCT/MACT 421 | Inorganic Chemistry II | 4 | 4 |
| | MICT/MOCT/MPCT/MACT 422 | Organic Chemistry II | 4 | 4 |
| | MICT/MOCT/MPCT/MACT 423 | Physical Chemistry II | 4 | 4 |
| | MICT/MOCT/MPCT/MACT 424 E-I<br>MICT/MOCT/MPCT/MACT 424 E-II | Analytical Chemistry II<br>Applied Chemistry II | 2 | 2 |
| | MICP/MOCP/MPCP/MACP 425 | Research Project (RP) | 8 | 4 |
| Practical | MICP/MOCP/MPCP/MACP 426 | Lab III | 4 | 2 |
| | MICP/MOCP/MPCP/MACP 427 | Lab IV | 4 | 2 |

## M. Sc. Part – I, Semester I

## Discipline Specific Course (DSC) *(Mandatory)*

## MICT/MOCT/MPCT/MACT-411: Inorganic Chemistry I

**Course objectives:** Students should be able to...

1) Understand chemistry of transition elements.
2) Study different organometallic compounds and their chemistry.
3) Learn the Nuclear chemistry and its importance.
4) Acquire the knowledge of nanoscience and nanomaterials

| **Credits 4** | **MICT/MOCT/MPCT/MACT-411: Inorganic Chemistry I** | **No. of hours per unit / Credit** |
|---|---|---|
| **UNIT I** | **Chemistry of Transition Elements** | **15** |
| | 1.1. General discussion on the properties of the transition elements<br>1.2. Coordination chemistry of transition metal ions<br>1.3. Stereochemistry of coordination compounds<br>1.4. Crystal field theory, splitting of orbital's in low field environment with examples.<br>1.5. Crystal field stabilization energy (CFSE), Factors affecting the crystal field parameters, Examples<br>1.6. Spectrochemical series<br>1.7. Jahn-Teller effect<br>1.8. Interpretation of electronic spectra including d-d and charge transfer spectra. | |
| **UNIT II** | **Organometallic Chemistry** | **15 L** |
| | 2.1. Synthesis and bonding in pi-metal organometallic complex<br>2.2. Structure and reactivity of organometallic compounds<br>2.3. Classification of organometallic compounds based on hapticity and polarity of M-C bond<br>2.4. Nomenclature and general characters<br>2.5. 18 electron rule-applications and exceptions<br>2.6. Reactions of organometallic compounds: Oxidative addition, reductive elimination, Insertion and elimination<br>2.7. Organometallics in homogeneous catalysis: Hydrogenation, hydroformylation, isomerization and polymerization | |
| **UNIT III** | **A. Nuclear Chemistry** | **08 L** |
| | 3.A.1. Radioactive decay and equilibrium<br>3.A.2. Nuclear reactions, Q value, cross sections<br>3.A.3. Types of reactions<br>3.A.4. Chemical effects of nuclear transformations<br>3.A.5. Fission and fusion<br>3.A.6. Fission products and fission yields<br>3.A.7. Radioactive techniques | |

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| | **B. Transition Metal Carbonyls and Related Compounds** | **07 L** |
| | 3.B.1. Introduction, Preparation, structure, physical and chemical properties of metal carbonyls,<br>3.B.2. Anionic and cationic carbonyl complexes,<br>3.B.3. Lewis base derivatives of carbonyls,<br>3.B.4. Carbonyl hydrides and Carbonyl halides. | |
| **UNIT IV** | **Nanoscience and Nanomaterials** | **15 L** |
| | 4.1. Introduction to nanoscience and nanotechnology<br>4.2. Historical background<br>4.3. Classification of nanomaterials: 1D, 2D, 3D (with their examples)<br>4.4. Applications of nanotechnology & Nanomaterials<br>4.5. Implications of nanotechnology<br>4.6. Future fantasy and nanotechnology<br>4.7. Experimental methods for preparation of nanomaterials: Chemical and Physical techniques<br>4.8. Size dependent properties of nanoparticles<br>4.9. Characterization techniques for nanomaterials: Principle, instrumentation and applications of XRD, SEM and TEM | |

**Course outcomes:** After completion of the course students will be able to…

1) Apply the theories for coordination compounds and their applications.
2) Demonstrate the bonding in organometallic compounds.
3) Explain the Nuclear transformations and its uses.
4) Demonstrate the nanoscience, nanotechnology and nanomaterials.

**References**


[1] Lee J. D. 2009. *Concise Inorganic Chemistry*. 5th edition. John Wiley & Sons.

[2] Shriver D. F. and Atkins P. W. 1999. *Inorganic Chemistry*. 3rd edition. Oxford.

[3] Huheey J. H. 1972. *Inorganic Chemistry Principles, structure and reactivity*., Harper and Row Publisher, Inc. New York.

[4] Figgis B. N. and Hitachman M. A. 2000. *Ligand field theory and its application.* Wiely VCH publication.

[5] Puri B. R., Sharma L. R. and Kalia K. C. 2007. *Principals of Inorganic Chemistry*, India, Vishal Publishing company.

[6] Arnikar H. J. 1988. *Essentials of Nuclear Chemistry*, Wiley Eastern.

[7] Choppin G., Liljenzin J. O., Rydberg J., 1995. *Radiochemistry and Nuclear Chemistry; Theory and Applications 2nd Edition*. Butterworth-Heinemann

[8] Pradeep T. 2010. *Nano The Essentials: Understanding Nanoscience and Nanotechnology*, Mc Graw Hill Education.

## MICT/MOCT/MPCT/MACT-412: Organic Chemistry I

**Course objectives:** Students should be able to...

1) Know different reactive intermediate also concept of aromaticity
2) Understand the mechanism of different types of substitution reactions.
3) Acquire the knowledge of addition and elimination reactions.
4) Learn the important basic concepts of the stereochemistry.

| **Credits 4** | **MICT/MOCT/MPCT/MACT-412: Organic Chemistry I** | **No. of hours per unit / Credit** |
|---|---|---|
| **UNIT I** | **Reaction Mechanism: Structure and Reactivity** | **15 L** |
| | 1.1 Types of reactions,<br>1.2 Chemical bonding and basis of reactivity- Chemical bond,<br>1.3 Delocalization, conjugation, resonance, hyper conjugation, tautomerism, inductive effects.<br>1.4 **Acidity and basicity:** various structural effects, hard and soft acid and base concept.;<br>1.5 **Aromaticity:** Structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems.<br>1.6 Benzenoid and non-benzenoid compounds, Huckels rule, antiaromaticity, Application to carbocyclic and heterocyclic systems, annulenes, azulenes, tropylium cations, metallocenes, current concepts of aromaticity.;<br>1.7 **Structure and stability of reactive intermediates**, carbenes, nitrenes, carbocations, carbanions and free radicals. | |
| **UNIT II** | **a) Aliphatic Nucleophilic substitutions** | **07 L** |
| | 2.a.1. The $SN^2$, $SN^1$ and $SN^i$ reactions with respects to mechanism and stereochemistry.<br>2.a.2. Nucleophilic substitutions at an allylic, aliphatic trigonal, benzylic, aryl and vinylic carbons.<br>2.a.3. Reactivity effect of substrate structure, effect of attacking nucleophiles, leaving groups and reaction medium.<br>2.a.4. SN reactions at bridge head carbon, competition between $SN^1$ and $SN^2$,<br>2.a.5. Ambident nucleophiles, Neighboring Group Participation. | |
| | **b) Aromatic Electrophilic Substitutions** | **08 L** |
| | 2.b.1. Introduction, the arenium ion mechanism.<br>2.b.2. Orientation and reactivity in Nitration, Sulphonation, Friedel-Crafts and Halogenation in aromatic systems, energy profile diagrams.<br>2.b.3. The ortho/para ratio, ipso attack, concept of aromaticity, orientation in their ring systems.<br>2.b.4. Diazo-coupling,<br>2.b.5. Vilsmeier-reaction,<br>2.b.6. Von-Richter rearrangement. | |

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| **UNIT III** | **a) Addition Reactions** | **08 L** |
| | 3.a.1. Addition to C-C multiple bonds mechanism and stereo chemical aspects of addition reaction. Electrophile, nucleophile and free radicals,<br>3.a.2. Regio and chemo selectivity,<br>3.a.3. Orientation and reactivity,<br>3.a.4. Conjugate addition. | |
| | **b) Elimination Reactions:** | **07 L** |
| | 3.b.1. The $E^1$, $E^2$ and $E^1CB$ mechanisms.<br>3.b.2. Orientation in Elimination reactions.<br>3.b.3. Hoffman Versus Saytzeff elimination,<br>3.b.4. competition between substitution and elimination reactions,<br>3.b.5. Reactivity: effects of substrate structures, attacking base, the leaving group, the nature of medium on elimination reactions.<br>3.b.6. Pyrolytic elimination reactions.<br>3.b.6.1. Chugaev reaction,<br>3.b.6.2. Pyrolysis of acetates. | |
| **UNIT IV** | **Stereochemistry** | **15 L** |
| | 4.1. Introduction:<br>4.2. Molecules with two or more chiral centers:<br>4.3. Configurational nomenclature<br>4.4. Constitutionally unsymmetrical molecules: Erythro-Threo and Syn-Anti systems. Constitutionally symmetrical molecules with odd and even number of chiral centers:<br>4.5. Enantiomeric and meso forms,<br>4.6. concept of stereogenic, chirotopic and pseudo asymmetric centers.<br>4.7. Axial and planar chirality: Principles of axial and planar chirality.<br>4.8. Prochirality: Homotopic, heterotopic and diastereotopic ligands and faces. Identification using substitution and symmetry criteria.<br>4.9. Nomenclature of stereoheterotopic ligands and faces.<br>4.10. Symbols for stereoheterotopic ligands in molecules with one or more prochiral centres, | |

**Course outcomes:** After completion of the course students will be able to…

1) Explore conceptual fact of Chemical bonding and basis of reactivity.
2) Compare the SN2, SN1 and SNi reactions with respects to mechanism, orientation and stereochemistry of aromatic systems.
3) Differentiate between addition reactions and elimination reactions.
4) Draw the configurations of organic molecules.

**References**

[1] Sykes Peter. 1985. A guide book to mechanism in Organic chemistry. 6th edition.

United States: Orient-Longmens.
[2] Morrison R. T. and Boyd R. N. 2002. Organic Chemistry. 7th edition. Prentice Hall: Ashok Kghosh.
[3] Eliel E. L. 1962. Stereochemistry of Carbon Compounds. 1st edition. McGraw-Hill,: Eliel.
[4] D. Nasipuri. 1994. Stereochemistry of Organic compounds. New Delhi: New age International.
[5] March J. 2007. Advanced Organic Chemistry. Sixth edition. Hooboken: McGraw-Hill.
[6] J. Clayden, N. Greeves, S. Warren. 2014. Organic Chemistry. Sixth edition UK: Oxford University press.

## MICT/MOCT/MPCT/MACT-413: Physical Chemistry I

**Course objectives:** Students should be able to...

1) Understand the application Gibbs-Duhem equation to study partial quantities.
2) Study the photochemistry and fluorescence.
3) Learn the chemistry of macromolecules.
4) Gain the knowledge of basic concepts of Molecular Spectroscopy.

| **Credits 4** | **MICT/MOCT/MPCT/MACT-413: Physical Chemistry I** | **No. of hours perunit / Credit** |
|---|---|---|
| **UNIT I** | **Thermodynamics** | **15 L** |
| | 1.1. Introduction : revision of basic concepts: Entropy and third law of thermodynamics<br>1.2. Methods of determining the absolute entropies of solid, liquid and gases<br>1.3. Entropies of phase transition<br>1.4. Maxwell relations and its applications, thermodynamic equation of state<br>1.5. Ideal and non-ideal solutions<br>1.6. Thermodynamics of non-electrolyte solutions<br>1.7. Raoult'slaw<br>1.8. Duhem-Margules equation and its applications to vapor pressure curves (Binary liquid mixture).<br>1.9. Gibbs-Duhem equation and its applications to study partial molar quantities<br>1.10. Chemical potential, variation of chemical potential with temperature & pressure<br>1.11. Henry's law<br>1.12. Excess and mixing thermodynamic properties<br>1.13. Equilibrium constants and general conditions of equilibrium in terms of thermodynamic potentials<br>1.14. Numerical Problems. | |
| **UNIT II** | **A] Photochemistry** | **08 L** |
| | 2a.1 Absorption of light and nature of electronic spectra<br>2a.2 Electronic transition<br>2a.3 Frank Condon principle<br>2a.4 Selection rules<br>2a.5 Photo-dissociation<br>2a.6 Pre-dissociation<br>2a.7 Photo-physical phenomena<br>2a.8 Electronic structure of molecules<br>2a.9 Molecular orbital<br>2a.10 Electronically excited singlet states<br>2a.11 Designation based on multiplicity rule<br>2a.12 Life time of electronically excited state<br>2a.13 Construction of Jablonski diagram | |

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| | 2a.14 Electronic transitions and intensity of absorption bands<br>2a.15 Photo-physical pathways of excited molecular system (radiative and nonradiative)<br>2a.16 Photochemistry of environment: Green house Effect. | |
| | **B] Fluorescence Spectroscopy** | **07 L** |
| | 2b.1 Introduction<br>2b.2 Delayed fluorescence and phosphorescence<br>2b.3 Fluorescence quenching: concentration quenching<br>2b.4 Quenching by excimer and exciplex emission,<br>2b.5 Fluorescence resonance energy transfer between photo-excited donor and acceptor systems.<br>2b.6 Stern-Volmer relation, Bimolecular collisional quenching<br>2b.7 Critical energy transfer distances<br>2b.8 Energy transfer efficiency<br>2b.9 Examples and analytical significance | |
| **UNIT III** | **Macromolecules** | **15 L** |
| | 3.1 Macromolecules: Mechanism of polymerization<br>3.2 Molecular weight of a polymer (Number and mass average)<br>3.3 viscosity average molecular weights<br>3.4 Degree of polymerization and molecular weight<br>3.5 Methods of determining molecular weights (Osmometry, viscometer, light scattering ,diffusion and ultracentrifugation)<br>3.6 Chemistry of polymerization: Ceiling temperature, Free radical polymerization (Initiation, propagation and termination)<br>3.7 Kinetics of free radical polymerization, step growth polymerization (Poly condensation)<br>3.8 Molecular weight distribution,<br>3.9 Kinetics of step polymerization and cationic and anionic polymerization<br>3.10 Electronically conducting polymers<br>3.11 Thermodynamics of polymer solutions: Flory-Huggins Theory.<br>3.12 Glass transition temperature and molecular weight, factors influencing Glass transition temperature, determination of glass transition temperature<br>3.13 Numerical problems | |
| **UNIT IV** | **Molecular Spectroscopy** | **15 L** |
| | 4.1 Recapitulation: Width and intensity of spectral transitions<br>4.2 Fourier transform<br>4.3 Signal-to-noise ratio<br>4.4 Microwave spectroscopy<br>4.5 Rotation spectra of diatomic molecules-rigid and non-rigid molecules<br>4.6 Stark effect.<br>4.7 Infra-red spectroscopy: Harmonic and anharmonic oscillator<br>4.9 Electronic spectroscopy of molecules: Born – Oppenheimer approximation | |

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| | 4.10 Electronic spectra of diatomic molecules and it's applications. | |

**Course outcomes:** After completion of the course students will be able to…

1) Classify the thermodynamics terms.
2) Interpret the electronic structure of molecules, molecular orbitals, electronically excited singlet states, designation based on multiplicity rule.
3) Explain prompt phenomenon of fluorescence, delayed fluorescence, and phosphorescence.
4) Describe the principle of microwave spectroscopy, rotation spectra of diatomic molecules.

**References**


[1] Atkins P. W. 2006. *Physical Chemistry.* 8th edition. Oxford University press.

[2] Glasstone S. and Nostrand D. Van. 1965. *Thermodynamics for Chemists*. New Delhi: Affiliated East-West press.

[3] Srivastava R. C., Saha S. K. and Jain A. K. 2004. *Thermodynamics, A Core Course*. 2nd edition. Prentice-Hall of India.

[4] Nash L. K. 1974. *Elements of statistical thermodynamics*. 2nd edition. Addison Wesley.

[5] Banewell C. N. and Cash E. Mc. 1994. *Fundamentals of molecular spectroscopy*. 4thedition. Elaine M. Mc Cash department of chemistry university of York.

[6] Deshpande D. D. 2000. *Physical Chemistry of macromolecules*. Vishal Publications.

[7] Billmeyer F. W.1971. *Polymer Chemistry.* Jr, John-Wiley & Sons.

# Discipline Specific Elective (DSE) *(Elective)*

## MICT/MOCT/MPCT/MACT-414 E-I: Analytical Chemistry I

**Course objectives:** Students should be able to...

1) Know what is error and different types of errors.
2) Familiar with different types of chromatographic techniques.
3) Understand fluorescence and phosphorescence with respect to analytical applications.
4) Learn Thermal Analysis, TGA, DTA and DSC.

| **Credits 2** | **MICT/MOCT/MPCT/MACT-414 E-I: Analytical Chemistry I** | **No. of hours perunit / Credit** |
|---|---|---|
| **UNIT I** | **Errors and Treatment in Analytical Chemistry** | **7 L** |
| | 1.1 Errors, Determinant, constant and indeterminate.<br>1.2 Accuracy and precision, Distribution of random errors.<br>1.3 Average deviation and standard deviation, variance and confidence limit.<br>1.4 Significance figures and computation rules.<br>1.5 Least square method. | |
| **UNIT II** | **Chromatographic Methods** | **8 L** |
| | 2.1 General principle, classification of chromatographic methods.<br>2.2 Nature of partition forces.<br>2.3 Chromatographic behavior of solutes.<br>2.4 Column efficiency and resolution.<br>2.5 Gas Chromatography: instrumentation, detector, optimization of experimental conditions.<br>2.6 Thin layer chromatography: coating of materials, preparative TLC. | |
| **UNIT III** | **Luminescence Spectrometry** | **7 L** |
| | 3.1 Introduction of Luminescence Spectrometry<br>3.2 Comparison of absorption and fluorescence methods<br>3.3 Theory of Luminescence Spectrometry, fluorimetry.<br>3.4 Instrumentation, applications of fluorimetry<br>3.5 Applications of Phosphometry | |
| **UNIT IV** | **Thermal Analysis** | **8 L** |
| | Introduction to thermal analysis, types of thermal analysis, significance of thermal analysis in Analytical Chemistry, effect of heat on materials, chemical decomposition, phase transformation etc.<br>**A) Thermogravimetry Analysis(TGA),**<br>4.a.1. Principle, instrumentation, working, types of TGA, factors influencing TGA, curve to show nature of decomposition reactions, the product and qualities of compounds expelled, TGA in controlled atmosphere, TGA curves, analysis, research and analytical | |

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| | implications of TGA.<br>**B) Differential Thermal Analysis (DTA),**<br>4.b.1. Instrumentation, methodology, application and research implications. Thermometric titrations method and applications Problems: Simple problems based on TGA, DTA and DSC. | |

**Course outcomes:** After completion of the course students will be able to…

1) Explain the Errors, Average derivation and standard derivation.
2) Perform chromatographic methods, like Gas, Ion exchanges etc.
3) Apply the knowledge of fluorescence methods and its applications.
4) Classify and compare thermo gravimetry analysis and differential thermal analysis.

**References**


[1] H. H. Willard, L. L. Mirrit, J. A. Dean.1988. *Instrumental Methods of analysis* (CBS): Wads worth Publishing Company,

[2] Chatwal and Anand, 1980 *Instrumental Methods of Analysis.* Himalaya Pub. House, India,

[3] D. Skoog and D.West. 2006. *Principal of Instrumental Analysis* 6th edition Cengage Learning.

[4] H. K. Kaur. 2016. *Instrumental methods of chemical analysis.* Pragati Prakashan Meerut.

[5] El-Zeiny Ebeid, Mohamed Zakaria 2021 *Thermal Analysis from Introductory Fundamentals to Advanced Applications*. 1st Edition.


## MICT/MOCT/MPCT/MACT-414 E-II: Applied Chemistry I

**Course objectives:** Students should be able to...

1) Study about preparation of Thin Film Materials.
2) Acquire the knowledge of Light-Emitting Polymers.
3) Learn the techniques of Biophysical Chemistry.
4) Understand Spread sheets and Calculations Used in Analytical Chemistry.

| Credits 2 | MICT/MOCT/MPCT/MACT-414 E-II: Applied Chemistry I | No. of hours perunit / Credit |
|---|---|---|
| **UNIT I** | **Thin Film Materials** | **7 L** |
| | 1.1. Introduction, Definition of thin films,<br>1.2. Preparation of Thin Film Materials,<br>1.3. Methods: Spray Pyrolysis, Physical Vapor Deposition (PVD), Sputtering, DC Glow discharge and Low-pressure sputtering<br>1.4. Chemical Vapor Deposition (CVD) and Chemical Bath Deposition (CBD) | |

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| **UNIT II** | **Organic Light Emitting Material-I** | **8 L** |
| | 2.1. Introduction, Poly (p-Phenylene Vinylenes),<br>2.2. Synthetic Routes to Poly (p-Phenylene Vinylenes),<br>2.3. Substituted Poly (p-Phenylene Vinylene) Homopolymers,<br>2.4. Alkoxy-Substituted Poly (p-Phenylene Vinylenes) | |
| **UNIT III** | **Biophysical Chemistry** | **7 L** |
| | 3.1. Introduction to biophysical chemistry: amino acids, peptides, proteins, enzymes, nucleic acids.<br>3.2. Introduction to primary, secondary, tertiary and quaternary structures, acid-base properties.<br>3.3. Intermolecular forces: H-bonding, Vander Waals forces, Lenard -Jones potential,<br>3.4. Columbic interactions, 1-4 interactions, hydrophobic hydration and interaction. | |
| **UNIT IV** | **Spreadsheets and Calculations Used in Analytical Chemistry** | **8 L** |
| | 4.1. Keeping Records and Making Calculations,<br>4.2. More Complex Examples,<br>4.3. Some Important Units of Measurement,<br>4.4. Unified Atomic Mass Units and the Mole,<br>4.5. The Factor - Label Approach to Example solutions and Their Concentrations,<br>4.6. Chemical Stoichiometry. | |

**Course outcomes:** After completion of the course students will be able to…

1) Explain definition, methods and application of Thin film Materials.
2) Derive the synthesis of Light Emitting Polymers.
3) Apply concept of Biophysical techniques and applications.
4) Draw of Spreadsheets, Units of Measurement and Calculations used in Analytical Chemistry.

**References**


[1] Maissel L. I., Glang R. 1970. *Handbook of Thin Film Technology*, Mc Graw Hill.
[2] Holland L. 1956. *Vacuum Deposition of Thin Films*, Wiley.
[3] Li Z., Meng H. 2014. *Organic light emitting materials and devices*. CRC Publisher, United Kingdom.
[4] Nelson D. L., Cox M. M., Freeman W. H. 2013. *Lehninger Principle of Biochemistry*, 6th edition. W. H. Freeman and Company.
[5] Allen J. P. 2008. *Biophysical Chemistry*, Wiley-Blackwell.
[6] Holler F. J., Crouch S. R. 1996. *Skoog and West's Fundamental of Analytical Chemistry.* 9th edition. Cengage Learning India Pvt. Ltd.

## MICT/MOCT/MPCT/MACT-415: Research Methodology (RM)

**Course objectives:** Students should be able to...

1) Understand the idea about need of Research Design.
2) Acquire the knowledge for implementation of Sample Survey.
3) Learn to prepare and process the data.
4) Study about Sampling and Non-Sampling Error.

| **Credits 4** | **MICT/MOCT/MPCT/MACT-415: Research Methodology (RM)** | **No. of hours per unit / Credit** |
|---|---|---|
| **UNIT I** | **Research Design** | **15 L** |
| | 1.1. Meaning of Research Design,<br>1.2. Need of Research Design,<br>1.3. Features of Good Design,<br>1.4. Important Concept Relating to Research Design,<br>1.5. Different Research Design,<br>1.6. Basic principles of Experimental Designs,<br>1.7. Important Experimental Designs. | |
| **UNIT II** | **Design of Sample Surveys** | **15 L** |
| | 2.1. Introduction, Sample Design,<br>2.2. Sampling and Non-Sampling Errors,<br>2.3. Sample Survey and Census Survey,<br>2.4. Types of Sampling Designs,<br>2.5. Non-probability Sampling and Probability Sampling<br>2.6. Complex Random sampling designs. | |
| **UNIT III** | **Data Preparation and process** | **15 L** |
| | 3.1. Data Preparation Process.<br>3.2. Questionnaire Checking<br>3.3. Editing, Coding, Classification,<br>3.4. Tabulation, Graphical Representation,<br>3.5. Data Cleaning,<br>3.6. Data Adjusting,<br>3.7. Some Problems in Analysis<br>3.8. Measure of Central Tendency,<br>3.9. Measure of Dispersion,<br>3.10.Measure of Skewness,<br>3.11.Kurtosis | |
| **UNIT IV** | **Research Report and Ethics** | **15 L** |
| | 4.1. Research report and its structure,<br>4.2. Components of journal article.<br>4.3. Explanation of various components.<br>4.4. Structure of components and its importance.<br>4.5. Components of thesis and dissertations. | |

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| | 4.6. Referencing styles and bibliography.<br>4.7. Plagiarism Definition, different forms,<br>4.8. Consequences, unintentional plagiarism,<br>4.9. Copyright infringement, collaborative work. | |

**Course outcomes:** After completion of the course students will be able to…

1) Classify the research data.
2) Explain different types of research.
3) Differentiate the complex random sampling.
4) Collect data about their research.

**References**


[1] Hibbert D. B., Gooding J. J. 2006. *Data analysis for chemistry*. Oxford University Press.

[2] Topping J. 1984. *Errors of observation and their treatment.* Fourth Ed., Chapman Hall, London.

[3] Harris D. C., 2007. *Quantitative chemical analysis*. 6th Ed., Freeman.

[4] Denscombes M., 2010. *The Good Research Guide: For small-scale social research projects*. Maiden-Read: Open University Press.

[5] Dornyei Z., 2007. *Research Methods in Applied Linguistics.* Oxford: Oxford University Press.

[6] Kothari C. R., 1980. *Research Methodology: Research and techniques.* New Delhi: New Age International Publishers.

[7] Kumar R. 2011. *Research Methodology: a step-by-step guide for beginners.* 3rd edition, London, UK: TJ International Ltd, Padstow, Corwall.

[8] Chemical safety matters – IUPAC – IPCS, 1992. Cambridge University Press.

## MICP/MOCP/MPCP/MACP-416: Lab-I

**Course objectives:** Students should be able to...

1) Learn about ore and its complete analysis.
2) Understand about the preparation of coordination complexes.
3) Acquire the knowledge about single stage preparation of organic products.
4) Study the estimation of organic compounds.

| Credits 2 | MICP/MOCP/MPCP/MACP-416: Lab-I | No. of hours per unit / Credit 60 |
|---|---|---|
| | 1) Determination of Silica and Iron from Hematite ore (6 Hr).<br>2) Determination of Sn & Pb from Solder metal alloy (6 Hr).<br>3) Preparation of Potassium hexathiocyanatochromate (III) tetrahydrate.<br>4) Preparation of pentamminechlorocobalt (III) chloride.<br>5) Preparation of hexathiourealead (II) nitrate.<br>6) Preparation of Copper ferrite.<br>7) Percentage purity of Lead form Hexathiourealead (II) nitrate.<br>8) Preparation of ZnO nanoparticles.<br>9) One stage preparation of 5, 5 - Diphenyl hydentoine.<br>10) One stage preparation of 7-Hydroxy 4-methyl coumarin.<br>11) Beginlli reaction: Micorwave assisted synthesis of Dihydropyrimidone.<br>12) Aromatic Electrophilic substitutions: Synthesis of p-Nitroaniline and p-Bromoaniline.<br>13) Preparation of 2,3-diphenylquinoxaline from benzil and OPD.<br>14) Preparation of benzimidazole derivative.<br>15) Preparation of m-nitroacetophenone from acetophenone.<br>16) Preparation of Schiff's base from acetophenone.<br>17) Extraction and separation of organic compound from plant extract.<br>18) Estimation of formaldehyde. | 60 |

**Course outcomes:** After completion of the course students will be able to…

1) Conduct different ore analysis having different metal compositions.
2) Differentiate the coordination complexes.
3) Perform the estimations and preparations of organic compounds.
4) Apply the knowledge of different practicals from Inorganic and Organic Chemistry to projects.

**References**


[1] Vogel A. I. 1980. *A text book of Quantitative Inorganic Analysis including elementary instrumental analysis*, Longman Sc & Tech.

[2] Palmer W. G. 1948. *Experimental Inorganic Chemistry.* Cambridge University Press.

[3] Vogel. 1948. *A text book of practical organic chemistry*, Thetford: Lowe And Brydone Printers.
[4] Mann and Saunders 1960. *Practical organic chemistry.* United states of America: Longman Inc.
[5] Viswanathan B. and Raghavan P. S. 1983. *A. I. Vogel Chemistry*. London. McGraw-Hill.
[6] Athawale A. D. and Parul Mathur, 2001. *Vogelical C Chemistry*. New Age International Private limited.

## MICP/MOCP/MPCP/MACP-417: Lab-II

**Course objectives:** Students should be able to...

1) Learn about relative strength and dissociation constants of acids.
2) Understand about solubility of salts.
3) Acquire the knowledge about drug samples.
4) Study the estimation of compounds by using different instruments.

| Credits 2 | MICP/MOCP/MPCP/MACP-417: Lab-II | No. of hours per unit / Credit 60 |
|---|---|---|
| | 1) To determination relative strength of chloroacetic acid and acetic acid by conductivity measurement.<br>2) Determination of the acid and base dissociation constant of an amino acid and hence isoelectric point of the acid.<br>3) Kinetics of reaction between bromate and iodide.<br>4) To determine the molar extinction coefficient and unknown concentration of given sample colorimetrically.<br>5) To determine radius of molecule by viscosity measurement.<br>6) To determine the solubility product and solubility of sparingly soluble salts of silver (AgCl, AgBr, AgI)<br>7) To construct phase diagram of three component containing ethanol, benzene, water.<br>8) To determine $pK_a$ value of given weak monobasic acid by emf measurement.<br>9) To investigate the adsorption of acetic acid from aqueous solution by activated charcoal.<br>10) To determine the normality and strength of each acid in the given mixture of strong acid and weak acid conductometrically.<br>11) Determination of calcium from given drug sample.<br>12) Determination of total hardness of water sample<br>13) To estimate the amount of isoniazide from the pharmaceutical tablet.<br>14) To determine the acid value of given oil.<br>15) To estimate the quantity of Ibuprofane from given | 60 |

| | | |
|---|---|---|
| | Pharmaceutical tablet.<br>16) To determine the solubility of calcium oxalate in presence of different concentrations of KCl<br>17) To determine the solubility of Calcium oxalate in presence of different concentration of HCl.<br>18) To verify Beer-Lambert's Law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of given sample Spectrophotometrically.<br>19) To estimate the amount of D-glucose in a given solution colorimetrically.<br>20) To determine the iron potentiometrically by titrating with potassium dichromate. | |

**Course outcomes:** After completion of the course students will be able to…

1) Conduct different analysis of acids.
2) Perform different estimations of compounds.
3) Handle variety of instrumentations.
4) Apply the knowledge of different practicals from Physical and Analytical Chemistry to projects.

**References**


[1] Vogel A. I. 1980. *A text book of Quantitative Inorganic Analysis including elementary instrumental analysis*, Longman Sc & Tech.

[2] Palmer W. G. 1948. *Experimental Inorganic Chemistry.* Cambridge University Press.

[3] Vogel. 1948. *A text book of practical organic chemistry*, Thetford: Lowe And Brydone Printers.

[4] Mann and Saunders 1960. *Practical organic chemistry.* United states of America: Longman Inc.

[5] Kitchner J. A. 1954. *Findlay's Practical Chemistry*. V$^{th}$ edition. Longmans, Green and Co,

[6] Viswanathan B. and Raghavan P. S. 1983. *A. I. Vogel Chemistry*. London. McGraw-Hill.

[7] Athawale A. D. and Parul Mathur, 2001. *Vogelical C Chemistry*. New Age International Private limited.

[8] Rajbhoj S. W. and Chondhekar T. K. 2013. III$^{rd}$ edition Anjali Publication.

## M. Sc. Part – I, Semester II
## Discipline Specific Course (DSC) *(Mandatory)*
## MICT/MOCT/MPCT/MACT-421: Inorganic Chemistry II

**Course objectives:** Students should be able to...

1) Acquire the knowledge of chemistry of non-transition elements.
2) Understand stereochemistry and bonding in main group compounds.
3) Learn the chemistry of f-block elements.
4) Study the Group Theory and Molecular Symmetry.

| **Credits 4** | **MICT/MOCT/MPCT/MACT-421: Inorganic Chemistry II** | **No. of hours perunit / Credit** |
|---|---|---|
| **UNIT I** | **Chemistry of Non-transition Elements and their compounds** | **15 L** |
| | 1.1. General discussion on the properties of the non–transition elements<br>1.2. Polymorphism in carbon, phosphorous and Sulphur<br>1.3. Synthesis, properties and structure of boranes<br>1.4. Synthesis, properties and structure of Carboranes<br>1.5. Silicates<br>1.6. Sulphur–nitrogen compounds<br>1.7. Structure and bonding in oxyacid of Nitrogen, Sulphur, and halogens<br>1.8. Interhalogens<br>1.9. Psudohalides | |
| **UNIT II** | **A) Stereochemistry and bonding in Main group compounds** | **08 L** |
| | 2.A.1. Hybridization and structure of molecules<br>2.A.2. VSEPR Theory<br>2.A.3. pπ-pπ and pπ-dπbonds<br>2.A.4. Bent rule<br>2.A.5. Walsh Diagram<br>2.A.6. Back bonding<br>2.A.7. Some simple reactions of covalently bonded molecules (atomic inversion, Berry Pseudorotation, Nucleophilic displacement, free radical reaction) | |
| | **B) Bioinorganic Chemistry** | 07 |
| | 2.B.1. Mineral origin of life<br>2.B.2. Transition metal ions in biology<br>2.B.3. Structure and properties of metalloproteins<br>2.B.4. Porphyrines<br>2.B.5. Cytochromes<br>2.B.6. Ferrodoxins and iron Sulphur proteins<br>2.B.7. Ion transport across membranes<br>2.B.8. Nitrogen fixation nitrogenase. | |

| UNIT III | Chemistry of f-block elements (Lanthanides and Actinides) | 15 L |
|---|---|---|
| | 3.1. Occurrence, properties of the f-block elements<br>3.2. Colour, oxidation state, Spectral and magnetic properties of lanthanides and actinides<br>3.3. Lanthanide contraction<br>3.4. Use of lanthanide compounds as shift reagents<br>3.5. Compounds of lanthanides<br>3.6. Photoluminescence properties of lanthanide compounds<br>3.7. Modern methods of separation of lanthanides and actinides,<br>3.8. Applications of lanthanide and actinide compounds in Industries | |
| **UNIT IV** | **Group Theory and Molecular Symmetry** | **15 L** |
| | 4.1. Symmetry operations<br>4.2. Symmetry elements<br>4.3. Point group and its classification (Cn-type, Dn-type, Special-type)<br>4.4. Schoenflies symbol for point groups<br>4.5. Determination of point group for $AB_2$ (Bent), $AB_3$ (Trigonal pyramid), $AB_3$ (Trigonal Planar), $AB_4$ (Square planar), $AB_5$ (Trigonal bipyramidal), $AB_6$ (Octahedral), $CO_2$, HCl, CO.<br>4.6. Symmetry and dipole moment of molecule<br>4.7. Symmetry and optical active Group and its Properties<br>4.8. Group multiplication table<br>4.9. Reducible and Irreducible representations<br>4.10. Great orthogonally theorem (without proof) and its importance<br>4.11. Construction of character table for $C_2v$ & $C_3v$ point groups<br>4.12. Mulliken symbol ismrules for irreduciblerep resentations & its illustrations. | |

**Course outcomes:** After completion of the course students will be able to…

1) Understand chemistry of non-transition elements for their coordination compounds.
2) Explore conceptual fact of atom and molecule.
3) Demonstrate the spectral and magnetic properties.
4) Explain the symmetry operations.

**References**


[1] Wells F. 1984. *Structural Inorganic Chemistry*, 5th edition. Oxford University Press.

[2] Chand Manas 2019. *Atomic Structure and Chemical bonding.* Dreamtech Press.

[3] Datta R. L. and Syamal. 2007. *Elements of magneto chemistry.* Second edition. Eastwest press pvt ltd.

[4] Cotton A., Wilkinson R. G. 2021. *Advanced Inorganic chemistry.* Wiley.

[5] Sisler S. 2000. *Chemistry in nonaqueous solvent*, USA, Reinhold Publisher Corporation.

[6] Drago R. 2012. *Physical method in Inorganic Chemistry*, Affiliatedeast-West Press Pvt. Ltd.

## MICT/MOCT/MPCT/MACT-422: Organic Chemistry II

**Course objectives:** Students should be able to...

1) Get knowledge regarding various important name reactions.
2) Understand the important oxidizing and reducing agents.
3) Know of concept and synthetic applications of hydroboration, enamines and yilides.
4) Learn importance of organometallic compounds.

| **Credits 4** | **MICT/MOCT/MPCT/MACT-422: Organic Chemistry II** | **No. of hours perunit / Credit** |
|---|---|---|
| **UNIT I** | **Study of Organic reactions:**<br>Mechanism of condensation reaction involving enolates<br>1.a.1. Benzoin<br>1.a.2. Stobbe<br>1.a.3. Demjanov reaction<br>1.a.4. Robinson annulation<br>1.a.5. Chichibabin<br>1.a.6. Simon-Smith<br>1.a.7. Ulhmann<br>1.a.8. Mc-Murry<br>1.a.9. Dakin,<br>1.a.10. Curtius<br>1.a.11. Lossen<br>1.a.12. Suzuki coupling reactionn. | **15 L** |
| **UNIT II** | **Oxidation and Reduction :**<br>**a) Oxidation**<br>2.a.1. $CrO_3$,<br>2.a.2. PDC,<br>2.a.3. PCC,<br>2.a.4. $KMnO_4$,<br>2.a.5. $MnO_2$,<br>2.a.6. Swern,<br>2.a.7 $H_2O_2$<br>2.a.8. $Pb(OAc)_4$, $NaIO_4$ and $HIO_4$,<br>2.a.9. Pd-C,<br>2.a.10. m-CPBA,<br>2.a.11. $O_3$<br>2.a.12. Etard oxidation, | **15 L**<br><br><br>**08 L** |
| | **b) Reduction**<br>2.b.1. General mechanism and selectivity,<br>2.b.2. important applications of the following reducing reagents:<br>2.b.3. Metal hydride reduction: Boron reagents ($NaBH_4$, $NaCNBH_3$, $Na(OAc)_3BH$),<br>2.b.4 Aluminium reagents ($LiAlH_4$, DIBAL-H, RedAl), | **07 L** |

| | | |
|---|---|---|
| | 2.b.5 Reduction with $H_2$/Pd-C,<br>2.b.6 Wilkinson's catalyst<br>2.b.7 Wolff Kishner reduction. | |
| **UNIT III** | **Hydroboration, Enamines and Ylides**<br>**a) Hydroboration:**<br>3.a.1. Various hydroborating agents their Mechanism<br>3.a.2 Synthetic Applications of,<br>i) 9- BBN,<br>ii)Thexyl borane,<br>iii)Diisamyl borane | **15 L**<br><br>**05 L** |
| | **b) Enamins:**<br>3.b.1 Formation of enamines.<br>3.b.2 Reactivity of enamines. | **05 L** |
| | **c) Ylides:**<br>3.c.1. Phosphorus ylide.<br>3.c.2. Nitrogen ylide.<br>3.c.3. Sulphur ylide. | **05 L** |
| **UNIT IV** | **Study of Organometallic compounds:**<br>4.1 Organo-lithium<br>4.2 Organo-cobalt<br>4.3 Organo -Fe<br>4.4 Organo -Ce,<br>4.5 Organo -Ti,<br>4.6 Organo- Cd.<br>4.7 Use of lithium dialkyl cuprate, their addition to carbonyl and unsaturated carbonyl compounds. | **15 L** |

**Course outcomes:** After completion of the course students will be able to…

1) Sketch the reaction mechanism for various reactions.
2) Describe mechanism of oxidizing and reducing reagents.
3) Discuss the applications of reactions and reagents to industrial important molecules.
4) Recognize applications of organometallic compounds in organic synthesis.

**References**


[1] Carruthares W. 2004. Some modern methods of Organic synthesis-Cambridge: Cambridge University press.
[2] Brown. S.C. 1962. Hydroboration. New York: Wiley.
[3] Stone G. A. and West R. 1995.Advances in Organometallic Chemistry Finar, Organic Chemistry Vol. I & Vol. II-(Longman: Pearson,2002)
[4] Carey R. R. and Sundburg R. J. 2007.Advanced Organic chemistry.2nd Ed. USA: Springer science.
[5] Adams R. 1957. Organic reactions. John wiley and sons.
[6] Norman R. O. C. 1968. Principles of organic synthesis. first edition. Oxford: Methuen,
[7] House H. O. 1965. Modern synthetic reactions. New York: Benjamin.
[8] Fieser and Fieser. 1967. Reagents in Organic synthesis. John Wiley.

## MICT/MOCT/MPCT/MACT-423: Physical Chemistry II

**Course objectives:** Students should be able to...

1) Understand the various operators and Schrodinger equation.
2) Recall the concepts of statistical thermodynamics.
3) Learn the theoretical principle of Huckel theory of inter-ionic attraction.
4) Acquire the knowledge of homogeneous and heterogeneous catalysis.

| **Credits 4** | **MICT/MOCT/MPCT/MACT-423: Physical Chemistry II** | **No. of hours perunit / Credit** |
|---|---|---|
| **UNIT I** | **Quantum Chemistry** | **15 L** |
| | 1.1. Introduction: Wave particle duality of matter<br>1.2. De Broglie's hypothesis, Uncertainty principle, Schrodinger equation<br>1.3. conditions for acceptable wave functions and its interpretation<br>1.4. Operators: algebra of operators, linear operator, commutator, angular momentum operator, ladder operator and operator related theory<br>1.5. Normalization and orthogonality<br>1.6. Eigen functions and Eigen values<br>1.7. postulate of quantum mechanics<br>1.8. Solutions of wave equation for a free particle and particle in a box problem<br>1.9. Transition dipole moment integral and selection rule<br>1.10. symmetric and antisymmetric wave functions<br>1.11. Pauli Exclusion Principle<br>1.12. spectroscopic term symbols. | |
| **UNIT II** | **Statistical Thermodynamics** | **15 L** |
| | 2.1 Stirling Approximation<br>2.2 Weights and configurations<br>2.3 The most probable configuration<br>2.4 Ensembles, ensemble average and time average of property.<br>2.6 Maxwell-Boltzmann (MB)distribution law<br>2.7 Partition function and its significance.<br>2.8 Rotational, translational, vibrational and electronic partition functions<br>2.9 Relationship between partition function and thermodynamic properties<br>2.10 Thermodynamic probability and entropy: Boltzmann –Planck equation<br>2.11 Application to mono atomic gases-Sackur-Tetrode equation and applications to di atomic molecules<br>2.12 Limitations of Maxwell-Boltzmann statistics<br>2.13 Numerical Problems. | |

| | | |
|---|---|---|
| **UNIT III** | **Electrochemistry** | **15 L** |
| | 3.1 Debye - Huckel theory of inter-ionic attraction<br>3.2 ionic atmosphere<br>3.3 time of relaxation<br>3.4 relaxation and electro-phoretic effects,<br>3.5 Debye-Huckel-Onsagar equation and its validity for dilute solutions and at appreciably concentrated solutions<br>3.6 Abnormal ionic conductance of hydroxyl and hydrogen ions<br>3.7 Activity coefficients: forms of activity coefficients and their interrelationship<br>3.8 Debye-Huckel limiting law and activity coefficients of dilute electrolytic solutions and its applications to concentrated solutions<br>3.9 Debye-Huckel-Bronsted equations<br>3.10 Quantitative and qualitative verification of Debye-Huckel limiting law<br>3.11 Bjerrum theory of ion-ion association<br>3.12 Types of electrode<br>3.13 Determination of activity coefficients of an electrolyte using concentration cells<br>3.14 degree of dissociation of mono basic weak acid (approximate and accurate), instability constant of silver ammonia complex<br>3.15 Acid and alkaline storage batteries. | |
| **UNIT IV** | **Chemical Kinetics** | **15 L** |
| | 4.1. Experimental methods of following kinetics of a reaction, chemical and physical (measurement of pressure, volume, EMF, conductance, diffusion current and absorbance) methods and examples<br>4.2. Steady state approximation and study of reaction between NO2 and F2<br>4.3. decomposition of ozone, and nitrogen pentoxide.<br>4.4. Ionic reaction: Primary and secondary salt effect,<br>4.5. Homogeneous catalysis: acid and base catalyzed reactions,<br>4.6. Michaelis–Menten enzyme catalysis<br>4.7. Heterogeneous catalysis: Adsorption of gas on a surface and its kinetics<br>4.8. Catalyzed hydrogen- deuterium exchange reaction. | |

**Course outcomes:** After completion of the course students will be able to…

1) Explore applications of commutator, linear operators, uncertainty principle.
2) Explain Boltzmann-Plank equation, Sackur-tetrode equation, ensembles, ensemble average and time average of property.
3) Apply Debye-Huckel theory of inter-ionic attraction to explain ionic atmosphere, time of relaxation.
4) Discuss the experimental methods of following kinetics of a reaction including

chemical and physical methods.

## References


[1] Chandra A. K. 1988. *Introductory Quantum Chemistry*, Tata McGraw-Hill publishing company ltd.

[2] Atkins P. W. 1998. *Physical Chemistry.* 6th edition. Oxford University press.

[3] Prasad R. K. 1997. *Quantum Chemistry*. New Age International pvt. Ltd. Publishers New Delhi.

[4] Rohatgi-Mukharjii K. K. 2017. *Fundamentals of Photochemistry*. New age international Pvt ltd publications.

[5] Wells C. H. J. 1972. *Introduction to Molecular Photochemistry*. Chapmanand Hall.

[6] Glasstone S. 1940. *Text book of Physical Chemistry*. Frink chemical laboratory, Princeton university.

# Discipline Specific Elective (DSE) *(Elective)*

## MICT/MOCT/MPCT/MACT-424 E-I: Analytical Chemistry II

**Course objectives:** Students should be able to...

1) Understand interpretation of IR, NMR and mass spectra.
2) Familiar with ESR, IR, NMR and Mass techniques.
3) Familiar with Mossbauer and ESR Spectroscopy.
4) Know atomic absorption and emission spectroscopy.

| **Credits 2** | **MICT/MOCT/MPCT/MACT-424 E-I: Analytical Chemistry II** | **No. of hours perunit / Credit** |
|---|---|---|
| **UNIT I** | **Nuclear Magnetic Resonance (NMR):** | **7 L** |
| | 1.1. Recapitulations of NMR,<br>1.2. Elementary ideas of NMR Integration<br>1.3. Larmor frequency,<br>1.4. Absorption of radio frequency.<br>1.5. Instrumentation (FT-NMR). Sample preparation, chemical shift,<br>1.6. Factor affecting chemical effect, spin-spin coupling, coupling constant, Cosy, Nosy, DEPT,$^{19}$F, $^{1}$H,$^{13}$C,$^{31}$P, and$^{14}$NNMR.<br>1.7. First order coupling, applications to simple structural problems. | |
| **UNIT II** | **Infrared Spectroscopy (IR)** | **8 L** |
| | 2.1. Introduction, instrumentation of Infrared Spectroscopy<br>2.2. Fundamental modes of vibrations,<br>2.3. Fundamental group region,<br>2.4. Sampling technique, selection rules,<br>2.5. Types of bonds,<br>2.6. Absorption of common functional groups.<br>2.7. Factors affecting frequencies, applications. | |
| **UNIT III** | **Mass spectroscopy (MS):** | **7 L** |
| | 3.1. Instrumentation, working of mass spectrometer (double beam).<br>3.2. Formation of different types of ions<br>3.3. Mclafferty rearrangements<br>3.4. Nitrogen rule, C-13 rule, fragmentation of alkanes, alkyl aromatics, alcohols and ketones, simple applications,<br>3.5. Simple structural problems based on IR, UV, NMR and MS. | |
| **UNIT IV** | **Flame Atomic Absorption Spectrometry** | **8 L** |
| | 4.1. Introduction and Principe<br>4.2. Instrumentation, Single and double beam AAS,<br>4.3. Preparation of samples<br>4.4. Measurement of atomic absorption<br>4.5. Calibrating solution and methods of Calibration<br>4.6. Advantages of atomic absorption<br>4.7. Disadvantage and limitation of atomic absorption. | |

**Course outcomes:** After completion of the course students will be able to…

1) Discuss the principles of various spectroscopic techniques.
2) Acquire the knowledge of sampling technique, selection rules.
3) Classify the spectral parameters and bonding structures of molecules.
4) Differentiate between AAS and FES, and ICP-AES.

**References**


[1] Silversteine and Basser, 2014 *Spectrometric Identification of Organic Compounds.* 8th edition Wiley, NewYork,(Unit II)

[2] Willard, Merrit, Dean and Settle, 1998 *Instrumental Methods of analysis,* Wadsworth Publishing Co Inc,(Unit I and II )

[3] V. G. Kalalawe and M. V. Kanetkar 2022. *Advent Academic Publishing Chemical Science,* Education (Unit III)

[4] V. M. Parikh, 1974 *Absorption spectroscopy of organic molecules,* Addison-Wesley Pub. Co,U.S.(Unit IV)

[5] A. I. Vogel, 1980 *A Text book of Qualitative Inorganic Analysis*-Longman Sc & Tech, (Unit I,II,IV)

[6] D. A. Skoog and D.M. West, 2020 *Fundamentals of Analytical Chemistry*, Holt Rinehart and Winston Inc, Cengage Learning India Pvt. Ltd.


## MICT/MOCT/MPCT/MACT-424 E-II: Applied Chemistry II

**Course objectives:** Students should be able to...

1) Learn about fabrication of Metal matrix composites
2) Acquire the knowledge of Organic Light-Emitting Diodes.
3) Study the mechanism of action of peptides.
4) Understand knowledge of Statistical Data, variance, errors and sampling.

| **Credits 2** | **MICT/MOCT/MPCT/MACT-424 E-II: Applied Chemistry II** | **No. of hours perunit / Credit** |
|---|---|---|
| **UNIT I** | **Metal matrix composites** | **7 L** |
| | 1.1. Fabrication, interface,<br>1.2. Properties and applications,<br>1.3. Dispersion strengthened,<br>1.4. Particle reinforced,<br>1.5. Fiber and laminate reinforced composites,<br>1.6. Fiber reinforced super alloy composites,<br>1.7. Superconducting composites Introduction type and fabrication. | |
| **UNIT II** | **Organic light emitting material-II** | **8 L** |
| | 2.1. Organic Small Molecule Materials for Organic Light-Emitting Diodes.<br>2.2. Introductions,<br>2.3. Structure, Properties and its applications of Hole Injection | |

| | | |
|---|---|---|
| | Materials<br>2.4. Fluorocarbon Polymers and Hole Transpot Material<br>2.5. Triarylamines, | |
| **UNIT III** | **Application of Biophysical Chemistry** | **7 L** |
| | 3.1. Thermodynamics of biopolymer Solutions: Solutions of biopolymers,<br>3.2. Effect of ΔG, ΔH and ΔS on dissolution of polymer,<br>3.3. Entropy and heat of mixing of polymer solutions,<br>3.4. Osmotic pressure,<br>3.5. Membrane equilibrium. | |
| **UNIT IV** | **Statistical Data** | **8 L** |
| | 4.1. Confidence Intervals,<br>4.2. Statistical Aids to Hypothesis Testing,<br>4.3. Analysis of Variance,<br>4.4. Detection of Gross Errors,<br>4.5. Analytical Samples and Methods, Sampling,<br>4.6. Automated Sample Handling, | |

**Course outcomes:** After completion of the course students will be able to…

1) Explain fabrication, properties and applications of Metal matrix composites.
2) Evaluate the structure, properties and application of Organic Light Emitting Materials.
3) Demonstrate a core knowledge base in the theory and practice of modern Biochemistry.
4) Understand basic theoretical and applied principles of Statistical Data in Analytical samples.

**References**


[1] Mathews F. L., Rawlings R. D. 1990. *Composite Materials-Engineering & Science*. Chapman & Hall.

[2] Khanna P. 1999. *A text book of Materials Science & Metallurgy*. Dhanpat Rai pub.

[3] Li Z., Meng H. 2014. *Organic light emitting materials and devices*. CRC Publisher, United Kingdom.

[4] Nelson D. L. and Cox M. M. 2013. *Lehninger Principle of Biochemistry.* 6th edition. W. H. Freeman and Company.

| Credits 4 | MICP/MOCP/MPCP/MACP-425: Research Project (RP) | No. of hours per unit / Credit 60 |
|---|---|---|

- Working hours are same as practical of project length should be sufficient.
- Project report must be written systematically and presented in bound form: The project will consist of name page, certificate, content, summary of project (2-3 page) followed by introduction (4 to 7 pages), literature survey (4-7) pages (recently published about 30 papers must be included), experimental techniques, results, discussion, conclusions, Appendix consisting of:
  1) references, 2) standard spectra / data if any and 3) safety precautions.
- Typically, student has to present his practical work and discuss results and conclusions in details (20-30 min.) which will be followed by question-answer session (10 min).
- It is open type of examination.

## MICP/MOCP/MPCP/MACP-426: Lab-III

**Course objectives:** Students should be able to...

1) Learn about the ore and alloy for their complete compositions.
2) Understand synthesis if ferrites and nanomaterials.
3) Acquire the knowledge about separation and identification of the two component organic mixtures.
4) Study the distillation technique.

| Credits 2 | MICP/MOCP/MPCP/MACP-426: Lab-III | No. of hours per unit / Credit 60 |
|---|---|---|
| | 1) Determination of Silica and Mn from Pyrolusite ore (6 Hr)<br>2) Determination of Fe & Cr from Stainless steel alloy (6 Hr)<br>3) Preparation of ammonium trioxalatochromate (III)<br>4) Preparation of Pentamminenitrocobalt (III) chloride<br>5) Preparation of Bis(dimethylglyoximato)nickel (II)<br>6) Preparation of Nickel ferrite<br>7) Percentage purity of Pentamminenitrocobalt (III) chloride<br>8) Preparation of CuO nanoparticles<br>9) Qualitative analysis: Separation and identification of the two component mixtures using Chemical and physical methods. (9 Binary Mixtures. Each mixture requires 6 Hr)<br>10) Steam distillation techniques. | 60 |

**Course outcomes:** After completion of the course students will be able to…

1) Calculate the percentage of different elements in ore and alloys.
2) Perform the synthesis of ferrites and nanomaterials.
3) Handle two component organic mixtures for their separation and identification.
4) Apply the knowledge of different practicals from Inorganic and Organic Chemistry to their project work.

**References**


[1] Vogel A. I. 1980. *A text book of Quantitative Inorganic Analysis including elementary instrumental analysis*, Longman Sc & Tech.

[2] Palmer W. G. 1948. *Experimental Inorganic Chemistry.* Cambridge University Press.

[3] Vogel. 1948. *A text book of practical organic chemistry*, Thetford: Lowe And Brydone Printers.

[4] Mann and Saunders 1960. *Practical organic chemistry.* United states of America: Longman Inc.

[5] Kitchner J. A. 1954. *Findlay's Practical Chemistry*. V$^{th}$ edition. Longmans, Green and Co,

[6] Viswanathan B. and Raghavan P. S. 1983. *A. I. Vogel Chemistry*. London. McGraw-Hill.

[7] Athawale A. D. and Parul Mathur, 2001. *Vogelical C Chemistry*. New Age International Private limited.
[8] Rajbhoj S. W. and Chondhekar T. K. 2013. III$^{rd}$ edition Anjali Publication.

## MICP/MOCP/MPCP/MACP-427: Lab-IV

**Course objectives:** Students should be able to...

1) Acquire the knowledge about rate of reactions and kinetics of reactions.
2) Learn about potentiometric and conductometric determinations.
3) Understand the solubility of different salts.
4) Study the ion exchangers for separation of cations and anions.

| **Credits 2** | **MICP/MOCP/MPCP/MACP-427: Lab-IV** | **No. of hours per unit / Credit 60** |
|---|---|---|
| | 1) To investigate kinetics of iodination of acetone .<br>2) To determine formal redox potential of $Fe^{3+}/Fe^{2+}$ system.<br>3) To determine the partial molar volume of ethyl alcohol in a mixture of ethyl alcohol and water.<br>4) To determine the amount of each halide in the given mixture of KBr &KCl potentiometrically.<br>5) Titration of a mixture trichloroacetic acid, monochloroacetic acid & acetic acid by NaOH conductometrically.<br>6) To study inversion of cane sugar polarimetrically.<br>7) To draw polar plots of atomic orbital like 1s, 2pz, $3dz^2$ by using angular part of hydrogen atom wave function.<br>8) To determine thermodynamic parameter for the copper silver system.<br>9) Determination of stability constant of silver ammonia complex.<br>10) Verification of Onsagar Equation for 1:1 type strong electrolyte.<br>11) To determine the amount of iron in given soap sample by colorimetrically.<br>12) Determination of alkalinity and salinity of water sample.<br>13) To Estimate the sulphadimine in the pharmaceutical sample.<br>14) To verify the Beer-Lamberts Law and determine the concentration of given organic dye solution colorimetrically.<br>15) To determine the solubility of PbI2 in presence of different concentration of KNO3.<br>16) To determine the solubility of PbI2 in presence of different concentration of KCl<br>17) Determination of standard deviation from the results obtained by redox titration of iron solution against standard potassium dichromate solution.<br>18) Application of excel spreadsheet for determination of Mean, | 60 |

| | | |
|---|---|---|
| | median, standard deviation and graph plot.<br>19) Determination of capacity of cation exchanger<br>20) Determination of capacity of anion exchanger | |

**Course outcomes:** After completion of the course students will be able to…

1) Calculate the rate of reactions and kinetics of reactions.
2) Perform the potentiometric and conductometric estimations.
3) Handle variety of instrumentation techniques.
4) Apply the knowledge of ion exchangers for separation of cations and anions.

**References**


[1] Vogel A. I. 1980. *A text book of Quantitative Inorganic Analysis including elementary instrumental analysis*, Longman Sc & Tech.

[2] Palmer W. G. 1948. *Experimental Inorganic Chemistry.* Cambridge University Press.

[3] Vogel. 1948. *A text book of practical organic chemistry*, Thetford: Lowe And Brydone Printers.

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[5] Kitchner J. A. 1954. *Findlay's Practical Chemistry*. V$^{th}$ edition. Longmans, Green and Co,

[6] Viswanathan B. and Raghavan P. S. 1983. *A. I. Vogel Chemistry*. London. McGraw-Hill.

[7] Athawale A. D. and Parul Mathur, 2001. *Vogelical C Chemistry*. New Age International Private limited.

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