



*"Education through self-help is our motto."*

Rayat Shikshan Sanstha's

**Yashavantrao Chavan Institute of Science, Satara  
(Autonomous)**  
*Lead College of Karmaveer Bhaurao Patil University, Satara*  
**Reaccredited by NAAC with 'A+' Grade**

**Department of Chemistry**

**Syllabus for Master of Science Part - I**

**To be implemented  
from academic year 2023-24**

**(As Per NEP-2020 Guidelines)**

## Syllabus for M.Sc. I

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

### 2. Year of Implementation:

The syllabus will be implemented from June, 2023 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				
6	I	12 (3 Papers)	2	4 (1 Paper out of 2)	4	-	-	22
	II	12 (3 Papers)	2	4 (1 Paper out of 2)	-	-	4	22
6.5	III	12 (3 Papers)	2	4 (1 Paper out of 2)	-	-	6	22
	IV	12 (3 Papers)	-	4 (1 Paper out of 2)	-	4	-	22
Total		48	6	16	4	4	10	88
		70			8		10	88

### M.Sc. Part I

#### Semester I

Nature of Course	Course Code	Course Title
Theory	MICT/MOCT/MPCT/MACT 411	Inorganic Chemistry I
	MICT/MOCT/MPCT/MACT 412	Organic Chemistry I
	MICT/MOCT/MPCT/MACT 413	Physical Chemistry I
	MICT/MOCT/MPCT/MACT 414 E-I	Analytical Chemistry I
	MICT/MOCT/MPCT/MACT 414 E-II	Applied Chemistry I
	MICT/MOCT/MPCT/MACT 415	Research Methodology
Practical	MICP/MOCP/MPCP/MACP 416	Chemistry Practical I: Lab I based on (MICT/MOCT/MPCT/MACT 411, 412, 413)

#### Semester II

Nature of Course	Course Code	Course Title
Theory	MICT/MOCT/MPCT/MACT 421	Inorganic Chemistry II
	MICT/MOCT/MPCT/MACT 422	Organic Chemistry II
	MICT/MOCT/MPCT/MACT 423	Physical Chemistry II
	MICT/MOCT/MPCT/MACT 424 E-I	Analytical Chemistry II
	MICT/MOCT/MPCT/MACT 424 E-II	Applied Chemistry II
	MICP/MOCP/MPCP/MACP 425	Research Project
Practical	MICP/MOCP/MPCP/MACP 426	Chemistry Practical II: : Lab II based on (MICT/MOCT/MPCT/MACT 421, 422, 423)

**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

<b>Credits 4</b>	<b>MICT/MOCT/MPCT/MACT-411: Inorganic Chemistry I</b>	<b>No. of hours per unit / Credit</b>
<b>UNIT I</b>	<b>Chemistry of Transition Elements</b>	<b>15</b>
	1.1. Coordination chemistry of transition metal ions 1.2. Stability constants of complexes and their determination 1.3. Stereochemistry of coordination compounds 1.4. Crystal field theory, splitting of orbital's in low field environment 1.5. Crystal field stabilization energy (CFSE), Factors affecting the crystal field parameters, Examples. 1.6. Spectrochemical series 1.7. Jahn-Teller effect 1.8. Interpretation of electronic spectra including d-d and charge transfer spectra. 1.9. Magnetism and color of transition metal ions.	
<b>UNIT II</b>	<b>Organometallic Chemistry</b>	<b>15 L</b>
	2.1. Synthesis and bonding in pi-metal organometallic complex 2.2. Structure and reactivity of organometallic compounds 2.3. Classification of organometallic compounds based on hapticity and polarity of M-C bond 2.4. Nomenclature and general characters 2.5. 18 electron rule-applications and exceptions 2.6. Reactions of organometallic compounds: Oxidative addition, reductive elimination, Insertion and elimination 2.7. Organometallics in homogeneous catalysis: Hydrogenation, hydroformylation, isomerization and polymerization	
<b>UNIT III</b>	<b>A. Nuclear Chemistry</b>	<b>08 L</b>
	3.A.1. Radioactive decay and equilibrium 3.A.2. Nuclear reactions, Q value, cross sections 3.A.3. Types of reactions 3.A.4. Chemical effects of nuclear transformations 3.A.5. Fission and fusion 3.A.6. Fission products and fission yields 3.A.7. Radioactive techniques	

	<b>B. Transition Metal Carbonyls and Related Compounds</b>	<b>07 L</b>
	3.B.1. Introduction, Preparation, structure, physical and chemical properties of metal carbonyls, 3.B.2. Anionic and cationic carbonyl complexes, 3.B.3. Lewis base derivatives of carbonyls, 3.B.4. Carbonyl hydrides and Carbonyl halides.	
<b>UNIT IV</b>	<b>Nanoscience and Nanomaterials</b>	<b>15 L</b>
	4.1. Introduction to nanoscience and nanotechnology 4.2. Historical background 4.3. Classification of nanomaterials: 1D, 2D, 3D (with their examples) 4.4. Applications of nanotechnology & Nanomaterials 4.5. Implications of nanotechnology 4.6. Future fantasy and nanotechnology 4.7. Experimental methods for preparation of nanomaterials: Chemical and Physical techniques 4.8. Size dependent properties of nanoparticles 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*. 5<sup>th</sup> edition. John Wiley & Sons.
- [2] Shriver D. F. and Atkins P. W. 1999. *Inorganic Chemistry*. 3<sup>rd</sup> 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 Hitchman M. A. 2000. *Ligand field theory and its application*. Wiley 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
<b>UNIT I</b>	<b>Reaction Mechanism: Structure and Reactivity</b>	<b>15 L</b>
	1.1 Types of reactions, 1.2 Chemical bonding and basis of reactivity- Chemical bond, 1.3 Delocalization, conjugation, resonance, hyper conjugation, tautomerism, inductive effects. 1.4 <b>Acidity and basicity:</b> various structural effects, hard and soft acid and base concept; 1.5 <b>Aromaticity:</b> Structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. 1.6 Benzenoid and non-benzenoid compounds, Huckels rule, antiaromaticity, Application to carbocyclic and heterocyclic systems, nulenes, azulenes, tropylium cations, metallocenes, current concepts of aromaticity.; 1.7 <b>Structure and stability of reactive intermediates,</b> carbenes, nitrenes, carbocations, carbanions and free radicals.	
<b>UNIT II</b>	<b>a) Aliphatic Nucleophilic substitutions</b>	<b>07 L</b>
	2.a.1. The SN <sup>2</sup> , SN <sup>1</sup> and SN <sup>i</sup> reactions with respects to mechanism and stereochemistry. 2.a.2. Nucleophilic substitutions at an allylic, aliphatic trigonal, benzylic, aryl and vinylic carbons. 2.a.3. Reactivity effect of substrate structure, effect of attacking nucleophiles, leaving groups and reaction medium. 2.a.4. SN reactions at bridge head carbon, competition between SN <sup>1</sup> and SN <sup>2</sup> , 2.a.5. Ambident nucleophiles, Neighboring Group Participation.	
	<b>b) Aromatic Electrophilic Substitutions</b>	<b>08 L</b>
	2.b.1. Introduction, the arenium ion mechanism, orientation. 2.b.2. Reactivity in Nitration, Sulphonation, Friedel-Crafts and Halogenation in aromatic systems, energy profile diagrams. 2.b.3. The ortho/para ratio, ipso attack, concept of aromaticity, orientation in their ring systems. 2.b.4. Diazo-coupling, 2.b.5. Vilsmeier-reaction, 2.b.6. Von-Richter rearrangement.	

<b>UNIT III</b>	<b>a) Addition Reactions</b>	<b>08 L</b>
	3.a.1. Addition to C-C multiple bonds mechanism and stereo chemical aspects of addition reaction. 3.a.2. Electrophile, nucleophile and free radicals, 3.a.3. Regio and chemo selectivity, 3.a.4. Orientation and reactivity, 3.a.5. Conjugate addition.	
	<b>b) Elimination Reactions:</b>	<b>07 L</b>
	3.b.1. The E <sup>1</sup> , E <sup>2</sup> and E <sup>1</sup> CB mechanisms. 3.b.2. Orientation in Elimination reactions. 3.b.3. Hoffman Versus Saytzeff elimination, 3.b.4. competition between substitution and elimination reactions, 3.b.5. Reactivity: 3.b.5.1. effects of substrate structures, 3.b.5.2. attacking base, 3.b.5.3. the leaving group, 3.b.5.4. the nature of medium on elimination reactions. 3.b.6. Pyrolytic elimination reactions. 3.b.6.1. Chugaev reaction, 3.b.6.2. Pyrolysis of acetates.	
<b>UNIT IV</b>	<b>Stereochemistry</b>	<b>15 L</b>
	4.1. Introduction: 4.2. Molecules with two or more chiral centers: 4.3. Configurational nomenclature 4.4. Constitutionally unsymmetrical molecules: Erythro-Threo and Syn-Anti systems. Constitutionally symmetrical molecules with odd and even number of chiral centers: 4.5. Enantiomeric and meso forms, 4.6. concept of stereogenic, chirotopic and pseudo asymmetric centers. 4.7. Axial and planar chirality: Principles of axial and planar chirality. 4.8. Prochirality: Homotopic, heterotopic and diastereotopic ligands and faces. 4.9. Identification using substitution and symmetry criteria. 4.10. Nomenclature of stereoheterotopic ligands and faces. 4.11. 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 SN<sub>2</sub>, SN<sub>1</sub> and SN<sub>i</sub> 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.

<b>Credits 4</b>	<b>MICT/MOCT/MPCT/MACT-413: Physical Chemistry I</b>	<b>No. of hours perunit / Credit</b>
<b>UNIT I</b>	<b>Thermodynamics</b>	<b>15 L</b>
	1.1. Introduction : revision of basic concepts: Entropy and third law of thermodynamics 1.2. Methods of determining the practical absolute entropies 1.3. Entropies of phase transition 1.4. Maxwell relations and its applications, thermodynamic equation of state 1.5. Ideal and non-ideal solutions 1.6. Thermodynamics of non-electrolyte solutions 1.7. Raoult's law 1.8. Duhem-Margules equation and its applications to vapor pressure curves (Binary liquid mixture). 1.9. Gibbs-Duhem equation and its applications to study of partial molar quantities 1.10. Chemical potential, variation of chemical potential with temperature & pressure 1.11. Henry's law 1.12. Excess and mixing thermodynamic properties 1.13. Equilibrium constants and general conditions of equilibrium in terms of thermodynamic potentials 1.14. Numerical Problems.	
<b>UNIT II</b>	<b>A] Photochemistry</b>	<b>08 L</b>
	2a.1 Absorption of light and nature of electronic spectra 2a.2 Electronic transition 2a.3 Frank Condon principle 2a.4 Selection rules 2a.5 Photo-dissociation 2a.6 Pre-dissociation 2a.7 Photo-physical phenomena: Electronic structure of molecules 2a.8 Molecular orbital 2a.9 Electronically excited singlet states 2a.10 Designation based on multiplicity rule 2a.11 Life time of electronically excited state 2a.12 Construction of Jablonski diagram 2a.13 Electronic transitions and intensity of absorption bands 2a.14 Photo-physical pathways of excited molecular system	

	(radiative and nonradiative) 2a.15 Photochemistry of environment: Green house Effect.	
	<b>B]Fluorescence Spectroscopy</b>	<b>07 L</b>
	2b.1 Introduction 2b.2 Delayed fluorescence and phosphorescence 2b.3 Fluorescence quenching: concentration quenching 2b.4 Quenching by excimer and exciplex emission, 2b.5 Fluorescence resonance energy transfer between photo-excited donor and acceptor systems. 2b.6 Stern-Volmer relation 2b.7 Critical energy transfer distances 2b.8 Energy transfer efficiency 2b.9 Examples and analytical significance 2b.10 Bimolecular collisional quenching and Stern-Volmer equation.	
<b>UNIT III</b>	<b>Macromolecules</b>	<b>15 L</b>
	3.1 Macromolecules: Mechanism of polymerization 3.2 Molecular weight of a polymer (Number and mass average) 3.3 viscosity average molecular weights 3.4 Degree of polymerization and molecular weight 3.5 Practical significance of polymer molecular weight 3.6 Methods of determining molecular weights (Osmometry, viscometer, light scattering ,diffusion and ultracentrifugation) 3.7 Chemistry of polymerization: Ceiling temperature, Free radical polymerization (Initiation, propagation and termination) 3.8 Kinetics of free radical polymerization, step growth polymerization (Poly condensation) 3.9 Molecular weight distribution, 3.10 Kinetics of step polymerization and cationic and anionic polymerization 3.11 Electronically conducting polymers 3.12 Thermodynamics of polymer solutions: Flory-Huggins Theory. 3.13 Glass transition temperature and molecular weight, factors influencing Glass transition temperature, determination of glass transition temperature 3.14 Numerical problems	
<b>UNIT IV</b>	<b>Molecular Spectroscopy</b>	<b>15 L</b>
	4.1 Recapitulation: Width and intensity of spectral transitions 4.2 Fourier transform 4.3 Signal-to-noise ratio 4.4 Microwave spectroscopy 4.5 Rotation spectra of diatomic molecules-rigid and non-rigid molecules 4.6 Stark effect. 4.7 Infra-red spectroscopy: Harmonic and anharmonic oscillator 4.8 Types of vibrational spectra of diatomic molecules, application 4.9 Electronic spectroscopy of molecules: Born – Oppenheimer	

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

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

- 1) Differentiate between classical thermodynamics and Modern thermodynamics.
- 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*. 8<sup>th</sup> 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*. 2<sup>nd</sup> edition. Prentice-Hall of India.
- [4] Nash L. K. 1974. *Elements of statistical thermodynamics*. 2<sup>nd</sup> edition. Addison Wesley.
- [5] Banewell C. N. and Cash E. Mc. 1994. *Fundamentals of molecular spectroscopy*. 4<sup>th</sup> edition. 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.

<b>Credits 4</b>	<b>MICT/MOCT/MPCT/MACT-414 E-I: Analytical Chemistry I</b>	<b>No. of hours per unit / Credit</b>
<b>UNIT I</b>	<b>Errors and Treatment in Analytical Chemistry</b>	<b>15 L</b>
	1.1 Errors, Determinant, constant and indeterminate. 1.2 Accuracy and precision, Distribution of random errors. 1.3 Average deviation and standard deviation, variance and confidence limit. 1.4 Significance figures and computation rules. 1.5 Least square method. 1.6 Methods of sampling: samples size. 1.7 Techniques of sampling of gases, fluid, solids, and particulates.	
<b>UNIT II</b>	<b>Chromatographic Methods</b>	<b>15 L</b>
	2.1 General principle, classification of chromatographic methods. 2.2 Nature of partition forces. 2.3 Chromatographic behavior of solutes. 2.4 Column efficiency and resolution. 2.5 Gas Chromatography: detector, optimization of experimental conditions. 2.6 Ion exchanges chromatography. 2.7 Thin layer chromatography: coating of materials, preparative TLC. 2.8 Nature of column materials. 2.9 Preparation of the column.	
<b>UNIT III</b>	<b>Luminescence Spectrometry</b>	<b>15 L</b>
	3.1 Introduction of Luminescence Spectrometry 3.2 Comparison of absorption and fluorescence methods 3.3 Theory of Luminescence Spectrometry, fluorimetry. 3.4 Instrumentation, applications of fluorimetry 3.5 Applications of Phosphometry 3.6 Comparison of Fluorimetry and Phosphometry.	
<b>UNIT IV</b>	<b>Thermal Analysis</b>	<b>15 L</b>
	4.1 Introduction to thermal analysis, types of thermal analysis, significance of thermal analysis in Analytical Chemistry, effect of heat on materials, chemical decomposition, phase	

	<p>transformation etc.</p> <p>4.2 General thermal analysis applications, advantages and disadvantages.</p> <p><b>A) Thermogravimetry Analysis(TGA),</b>  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 implications of TGA.</p> <p><b>B) Differential Thermal Analysis (DTA),</b>  4.b.1. Instrumentation, methodology, application and research implications. Thermometric titrations method and applications  Problems: Simple problems based on TGA, DTA and DSC.</p> <p><b>C) Differential Scanning Calorimetry (DSC)</b>  4.c.1 Instrumentation, methodology, application and research implications. Thermometric titrations method and applications  Problems: Simple problems based on TGA, DTA and DSC.</p>	
--	--	--

**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 4	MICT/MOCT/MPCT/MACT-414 E-II: Applied Chemistry I	No. of hours perunit / Credit
<b>UNIT I</b>	<b>Thin Film Materials</b>	<b>15 L</b>
	1.1. Introduction, Definition of thin films, 1.2. Preparation of Thin Film Materials, 1.3. Methods: Spray Pyrolysis, Physical Vapor Deposition (PVD), Sputtering, DC Glow discharge and Low-pressure sputtering 1.4. Chemical Vapor Deposition (CVD) and Chemical Bath Deposition (CBD) 1.5. Methods of preparing device grade films 1.6. Thickness measurement techniques- electrical, and mechanical methods 1.7. Optical measurements and Band gap	
<b>UNIT II</b>	<b>Organic Light Emitting Material-I</b>	<b>15 L</b>
	2.1. Introduction, Poly (p-Phenylene Vinylenes), 2.2. Synthetic Routes to Poly (p-Phenylene Vinylenes), 2.3. Substituted Poly (p-Phenylene Vinylene) Homopolymers, 2.4. Alkoxy-Substituted Poly (p-Phenylene Vinylenes), 2.5. Alkyl-Substituted Poly (p-Phenylene Vinylenes) and their applications.	
<b>UNIT III</b>	<b>Biophysical Chemistry</b>	<b>15 L</b>
	3.1. Introduction to biophysical chemistry: amino acids, peptides, proteins, enzymes, nucleic acids. 3.2. Introduction to primary, secondary, tertiary and quaternary structures, acid-base properties. 3.3. Intermolecular forces: H-bonding, Vander Waals forces, Lenard -Jones potential, 3.4. Columbic interactions, 1-4 interactions, hydrophobic hydration and interaction. 3.5. Protein folding/Defolding phenomena, 3.6. Use of spectroscopic acid, 3.7. Thermodynamic tools for protein-ligand binding equilibrium, 3.8. Thermodynamic methods for determination of molar mass of biological macromolecules.	
<b>UNIT IV</b>	<b>Spreadsheets and Calculations Used in Analytical Chemistry</b>	<b>15 L</b>
	4.1. Keeping Records and Making Calculations,	

	4.2. More Complex Examples, 4.3. Some Important Units of Measurement, 4.4. Unified Atomic Mass Units and the Mole, 4.5. The Factor - Label Approach to Example solutions and Their Concentrations, 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*. 9<sup>th</sup> 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	<b>MICT/MOCT/MPCT/MACT-415: Research Methodology (RM)</b>	No. of hours perunit / Credit
<b>UNIT I</b>	<b>Research Design</b>	<b>15 L</b>
	1.1. Meaning of Research Design, 1.2. Need of Research Design, 1.3. Features of Good Design, 1.4. Important Concept Relating to Research Design, 1.5. Different Research Design, 1.6. Basic principles of Experimental Designs, 1.7. Important Experimental Designs.	
<b>UNIT II</b>	<b>Design of Sample Surveys</b>	<b>15 L</b>
	2.1. Introduction, Sample Design, 2.2. Sampling and Non-Sampling Errors, 2.3. Sample Survey and Census Survey, 2.4. Types of Sampling Designs, 2.5. Non-probability Sampling and Probability Sampling 2.6. Complex Random sampling designs.	
<b>UNIT III</b>	<b>Data Preparation and process</b>	<b>15 L</b>
	3.1. Data Preparation Process. 3.2. Questionnaire Checking 3.3. Editing, Coding, Classification, 3.4. Tabulation, Graphical Representation, 3.5. Data Cleaning, 3.6. Data Adjusting, 3.7. Some Problems in Analysis 3.8. Measure of Central Tendency, 3.9. Measure of Dispersion, 3.10. Measure of Skewness, 3.11. Kurtosis	
<b>UNIT IV</b>	<b>Research Report and Ethics</b>	<b>15 L</b>
	4.1. Research report and its structure, 4.2. Components of journal article. 4.3. Explanation of various components. 4.4. Structure of components and its importance. 4.5. Components of thesis and dissertations.	



	4.6. Referencing styles and bibliography. 4.7. Plagiarism Definition, different forms, 4.8. Consequences, unintentional plagiarism, 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*. 3<sup>rd</sup> edition, London, UK: TJ International Ltd, Padstow, Cornwall.
- [8] Chemical safety matters – IUPAC – IPCS, 1992. Cambridge University Press.

**MICP/MOCP/MPCP/MACP-416: Chemistry Practical-I (Lab-I)**  
**(Based on MICT/MOCT/MPCT/MACT-411, 412, 413)**

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

- 1) Learn about ore and its complete analysis.
- 2) Understand about single stage preparation of important organic products
- 3) Acquire the knowledge about rate of reactions and kinetics of reactions
- 4) Study the estimation of Ca, Na, chloride, bromide ions.

Credits 2	MICP/MOCP/MPCP/MACP-416: Chemistry Practical-I (LAB-I)	No. of hours perunit / Credit 60
	<ol style="list-style-type: none"> <li>1) Determination of iron from hematite ore.</li> <li>2) Preparation of Ammonium trioxalatochromate (III)</li> <li>3) Preparation of Hexathiourealead (II) nitrate</li> <li>4) Percentage purity of chromium from Ammonium trioxalatochromate(III)</li> <li>5) Percentage purity of Lead form Hexathiourealead (II) nitrate</li> <li>6) Determination of calcium from given drug sample.</li> <li>7) Determination of hardness, alkalinity and salinity of water sample</li> <li>8) One stage preparation of 5, 5 - Diphenyl hydantoine.</li> <li>9) One stage preparation of 7-Hydroxy 4-methyl coumarin.</li> <li>10) Beginlli reaction: Microwave assisted synthesis of Dihydropyrimidone.</li> <li>11) Aromatic Electrophilic substitutions: Synthesis of p-Nitroaniline and p-Bromoaniline.</li> <li>12) Estimation of Amino acids.</li> <li>13) To verify the Beer-Lamberts Law and determine the concentration of given dye solution colorimetrically.</li> <li>14) To determine the acid value of given oil.</li> <li>15) Determination of mixture of acids and relative strength of weak acids.</li> <li>16) Determination of <math>\Delta G</math>, <math>\Delta H</math>, and <math>\Delta S</math> of <math>BaSO_4</math> by conductometry.</li> <li>17) Determination of molecular radius of molecule of organic compound.</li> <li>18) Kinetics of reaction between bromate and iodide.</li> <li>19) To determine the molar extinction coefficient and unknown concentration of given sample colorimetrically.</li> <li>20) To Study the kinetics of iodination of acetone spectrophotometrically</li> </ol>	

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

- 1) Conduct different ore analysis having different metal compositions.
- 2) Perform the estimations and preparations of organic compounds.
- 3) Handle variety of instrumentations.

- 4) Apply the knowledge of different practicals from Inorganic, Organic and Physical 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<sup>th</sup> 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<sup>rd</sup> 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
<b>UNIT I</b>	<b>Chemistry of Non-transition Elements and their compounds</b>	<b>15 L</b>
	1.1. General discussion on the properties of the non-transition elements 1.2. Polymorphism in carbon, phosphorous and Sulphur 1.3. Synthesis, properties and structure of boranes 1.4. Carboranes 1.5. Silicates 1.6. Sulphur-nitrogen compounds 1.7. Structure and bonding in oxyacid of nitrogen, Sulphur, phosphorous, and halogens 1.8. Interhalogens 1.9. Pseudohalides	
<b>UNIT II</b>	<b>A) Stereochemistry and bonding in Main group compounds</b>	<b>08 L</b>
	2.A.1. Hybridization and structure of molecules 2.A.2. VSEPR Theory 2.A.3. $p\pi-p\pi$ and $p\pi-d\pi$ bonds 2.A.4. Bent rule 2.A.5. Walsh Diagram 2.A.6. Back bonding 2.A.7. Some simple reactions of covalently bonded molecules (atomic inversion, Berry Pseudorotation, Nucleophilic displacement, free radical reaction)	
	<b>B) Bioinorganic Chemistry</b>	<b>07</b>
	2.B.1. Mineral origin of life 2.B.2. Transition metal ions in biology 2.B.1. Structure and properties of metalloproteins 2.B.2. Porphyrines 2.B.3. Cytochromes 2.B.4. Ferredoxins and iron Sulphur proteins 2.B.5. Ion transport across membranes 2.B.6. Nitrogen fixation nitrogenase.	

<b>UNIT III</b>	<b>Chemistry of f-block elements (Lanthanides and Actinides)</b>	<b>15 L</b>
	3.1. Occurrence, properties of the f-block elements 3.2. Colour, oxidation state, Spectral and magnetic properties of lanthanides and actinides 3.3. Lanthanide contraction 3.4. Use of lanthanide compounds as shift reagents 3.5. Compounds of lanthanides 3.6. Photoluminescence properties of lanthanide compounds 3.7. Modern methods of separation of lanthanides and actinides, 3.8. Applications of lanthanide and actinide compounds in Industries	
<b>UNIT IV</b>	<b>Group Theory and Molecular Symmetry</b>	<b>15 L</b>
	4.1. Symmetry operations 4.2. Symmetry elements 4.3. Point group and its classification (C <sub>n</sub> -type, D <sub>n</sub> -type, Special-type) 4.4. Schoenflies symbol for point groups 4.5. Determination of point group for AB <sub>2</sub> (Bent), AB <sub>3</sub> (Trigonal pyramid), AB <sub>3</sub> (Trigonal Planar), AB <sub>4</sub> (Square planar), AB <sub>5</sub> (Trigonal bipyramidal), AB <sub>6</sub> (Octahedral), CO <sub>2</sub> , HCl, CO. 4.6. Symmetry and dipole moment of molecule 4.7. Symmetry and optical active Group and its Properties 4.8. Group multiplication table 4.9. Reducible and Irreducible representations 4.10. Great orthogonally theorem (without proof) and its importance 4.11. Construction of character table for C <sub>2v</sub> & C <sub>3v</sub> point groups 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*, 5<sup>th</sup> 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 ylides.
- 4) Learn importance of organometallic compounds.

Credits 4	MICT/MOCT/MPCT/MACT-422: Organic Chemistry II	No. of hours perunit / Credit
<b>UNIT I</b>	<b>Study of Organic reactions:</b> Mechanism of condensation reaction involving enolates 1.a.1. Benzoin 1.a.2. Stobbe 1.a.3. Demjanov reaction 1.a.4. Robinson annulation 1.a.5. Chichibabin 1.a.6. Simon-Smith 1.a.7. Uhlmann 1.a.8. Mc-Murry 1.a.9. Dakin, 1.a.10. Curtius 1.a.11. Lossen 1.a.12. Suzuki coupling reactionn.	<b>15 L</b>
<b>UNIT II</b>	<b>Oxidation and Reduction :</b> <b>a) Oxidation</b> 2.a.1. CrO <sub>3</sub> , 2.a.2. PDC, 2.a.3. PCC, 2.a.4. KMnO <sub>4</sub> , 2.a.5. MnO <sub>2</sub> , 2.a.6. Swern, 2.a.7 H <sub>2</sub> O <sub>2</sub> 2.a.8. Pb(OAc) <sub>4</sub> , NaIO <sub>4</sub> and HIO <sub>4</sub> , 2.a.9. Pd-C, 2.a.10. m-CPBA, 2.a.11. O <sub>3</sub> 2.a.12. Etard oxidation,	<b>15 L</b>  <b>08 L</b>
	<b>b) Reduction</b> 2.b.1. General mechanism and selectivity, 2.b.2. important applications of the following reducing reagents: 2.b.3. Metal hydride reduction: Boron reagents (NaBH <sub>4</sub> , NaCNBH <sub>3</sub> , Na(OAc) <sub>3</sub> BH), 2.b.4 Aluminium reagents (LiAlH <sub>4</sub> , DIBAL-H, RedAl),	<b>07 L</b>

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

**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. 2<sup>nd</sup> 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.

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



<b>UNIT III</b>	<b>Electrochemistry</b>	<b>15 L</b>
	3.1 Debye - Huckel theory of inter-ionic attraction 3.2 ionic atmosphere 3.3 time of relaxation 3.4 relaxation and electro-phoretic effects, 3.5 Debye-Huckel-Onsagar equation and its validity for dilute solutions and at appreciably concentrated solutions 3.6 Abnormal ionic conductance of hydroxyl and hydrogen ions 3.7 Activity coefficients: forms of activity coefficients and their interrelationship 3.8 Debye-Huckel limiting law for osmotic and activity coefficients of dilute electrolytic solutions and its applications to concentrated solutions 3.9 Debye-Huckel-Bronsted equations 3.10 Quantitative and qualitative verification of Debye-Huckel limiting law 3.11 Bjerrum theory of ion-ion association 3.12 Types of electrode 3.13 Determination of activity coefficients of an electrolyte using concentration cells 3.14 degree of dissociation of mono basic weak acid (approximate and accurate), instability constant of silver ammonia complex 3.15 Acid and alkaline storage batteries.	
<b>UNIT IV</b>	<b>Chemical Kinetics</b>	<b>15 L</b>
	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 4.2. Steady state approximation and study of reaction between NO <sub>2</sub> and F <sub>2</sub> 4.3. decomposition of ozone, and nitrogen pentoxide. 4.4. Ionic reaction: Primary and secondary salt effect, 4.5. Homogeneous catalysis: acid and base catalyzed reactions, 4.6. Michaelis-Menten enzyme catalysis 4.7. Heterogeneous catalysis: Adsorption of gas on a surface and its kinetics 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*. 6<sup>th</sup> 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*. Chapman and 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.

<b>Credits 4</b>	<b>MICT/MOCT/MPCT/MACT-424 E-I: Analytical Chemistry II</b>	<b>No. of hours perunit / Credit</b>
<b>UNIT I</b>	<b>A] Nuclear Magnetic Resonance (NMR):</b>	<b>15 L</b>
	1a.1 Recapitulations of NMR, 1a.2 Elementary ideas of NMR Integration 1a.3, Larmor frequency, 1a.4 Absorption of radio frequency. 1a.5 Instrumentation (FT-NMR). Sample preparation, chemical shift, 1a.6 Factor affecting chemical effect, spin-spin coupling, coupling constant, Cosy, Nosal, DEPT, <sup>19</sup> F, <sup>1</sup> H, <sup>13</sup> C, <sup>31</sup> P, and <sup>14</sup> NNMR. 1a.7 First order coupling, applications to simple structural problems.	
	<b>B] Mass spectroscopy (MS):</b>	
	1b.1 Instrumentation, working of mass spectrometer (double beam). 1b.2 Formation of different types of ions, McLafferty rearrangements 1b.3 Nitrogen rule, C-13 rule, fragmentation of alkanes, alkyl aromatics, alcohols and ketones, simple applications, 1b.4 simple structural problems based on IR, UV, NMR and MS.	
<b>UNIT II</b>	<b>A] Infrared Spectroscopy (IR)</b>	<b>15L</b>
	2a.1 Introduction, instrumentation of Infrared Spectroscopy 2a.2 Fundamental modes of vibrations, 2a.3 Fundamental group region, 2a.4 sampling technique, 2a.5 selection rules, 2a.6 types of bonds, 2a.7 absorption of common functional groups. 2a.8 Factors affecting frequencies, applications.	
	<b>B] Electron Spin Resonance Spectroscopy (ESR)</b>	
	2b.1 Introduction, 2b.2 Factors affecting on g value 2b.3 Instrumentation 2b.3 Electron nucleus interaction 2b.4 Hyperfine Interaction-Isotropic and anisotropic coupling (Splitting)	

	2b.5 ESR of $d^1$ and $d^9$ transition metal ions in cubic and tetragonal ligand fields. 2b.6 Applications of ESR	
<b>UNIT III</b>	<b>Mossbauer Spectroscopy</b>	<b>15L</b>
	3.1 Introduction 3.2 Principle Mossbauer Spectroscopy 3.3 Mossbauer effect 3.4 Apparatus for Mossbauer Spectroscopy 3.5 Lamb Mossbauer factor 3.6 Mossbauer nuclides 3.7 Formation of Mossbauer nuclides 3.8 Standard reference absorber 3.9 Application of studies of bonding structures of $Fe^{+2}$ and $Fe^{+3}$ compounds including those of intermediate, spin and $Sn^{+2}$ and $Sn^{+4}$ compounds	
<b>UNIT IV</b>	<b>Flame Atomic Absorption and Emission Spectrometry</b>	<b>15 L</b>
	<b>A) Absorption Spectrometry</b> 4a.1 Introduction and Principle 4a.2 Instrumentation, Single and double beam AAS, 4a.3 Preparation of samples 4a.4 Measurement of atomic absorption 4a.5 Calibrating solution and methods of Calibration 4a.6 Advantages of atomic absorption 4a.7 Disadvantage and limitation of atomic absorption.	
	<b>B) Emission Spectrometry</b>	
	4b.1 Introduction and Principle 4b.2 Flame and Flame Spectra 4b.3 Variation of emission intensity within the flame 4b.4 Chemical reaction and temperature in Flames 4b.5 Instrumentation of single beam and double beam flame spectrophotometer. 4b.6 Applications	

**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 Bassler, 2014 *Spectrometric Identification of Organic Compounds*. 8<sup>th</sup> 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 4	MICT/MOCT/MPCT/MACT-424 E-II: Applied Chemistry II	No. of hours perunit / Credit
<b>UNIT I</b>	<b>Metal matrix composites</b>	<b>15 L</b>
	1.1. Fabrication, interface, 1.2. Properties and applications, 1.3. Dispersion strengthened, 1.4. Particle reinforced, 1.5. Fiber and laminate reinforced composites, 1.6. Fiber reinforced super alloy composites, 1.7. Superconducting composites Introduction type and fabrication. 1.8. Ceramic matrix composites - Fabrication, interface, properties and applications, 1.9. Carbon fiber composites- Fabrication, interface, properties and applications, 1.10. Advanced C-C composites.	
<b>UNIT II</b>	<b>Organic light emitting material-II</b>	<b>15 L</b>
	2.1. Organic Small Molecule Materials for Organic Light-Emitting Diodes. 2.2. Introductions, 2.3. Structure, Properties and its applications of Hole Injection Materials 2.4. Fluorocarbon Polymers and Hole Transpot Material 2.5. Triarylaminines, 2.6. Triphenylmethanes, 2.7. Phenylazomethines.	
<b>UNIT III</b>	<b>Application of Biophysical Chemistry</b>	<b>15 L</b>
	3.1. Thermodynamics of biopolymer Solutions: Solutions of	

	biopolymers, 3.2. Effect of $\Delta G$ , $\Delta H$ and $\Delta S$ on dissolution of polymer, 3.3. Entropy and heat of mixing of polymer solutions, 3.4. Osmotic pressure, 3.5. Membrane equilibrium. 3.6. Fluorescence spectroscopy using labelled peptides for determination of binding and stoichiometry, 3.7. Structural studies of peptides interacted with bacterial cell by NMR, to study the biophysical properties/ interactions by using UV-Visible spectroscopy.	
<b>UNIT IV</b>	<b>Statistical Data</b>	<b>15 L</b>
	4.1. Confidence Intervals, 4.2. Statistical Aids to Hypothesis Testing, 4.3. Analysis of Variance, 4.4. Detection of Gross Errors, 4.5. Analytical Samples and Methods, Sampling, 4.6. Automated Sample Handling, 4.7. Standardization and Calibration, 4.8. Lab-On-a-Chip, 4.9. A Comparison method for aflatoxins, 4.10. Multivariate calibration, 4.11. Figures of merit .	

**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*. 6<sup>th</sup> edition. W. H. Freeman and Company.

Credits 4	MICT/MOCT/MPCT/MACT-425: Research Project (RP)	No. of hours perunit / Credit 60
<ul style="list-style-type: none"> <li>• Working hours are same as practical of project length should be sufficient.</li> <li>• 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.</li> <li>• 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).</li> <li>• It is open type of examination.</li> </ul>		

**MICP/MOCP/MPCP/MACP-426: Chemistry Practical II (LAB-II)**  
**(Based on MICT/MOCT/MPCT/MACT-421,422,423 courses)**

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

- 1) Learn about alloy and its complete analysis.
- 2) Understand single stage Quantitative analysis of important organic products.
- 3) Acquire the knowledge about rate of reactions and kinetics of reactions.
- 4) Study the experiments of Inorganic, Organic and Physical Chemistry.

Credits 2	MICP/MOCP/MPCP/MACP-426: Chemistry Practical II (LAB-II)	No. of hours perunit / Credit
	<ol style="list-style-type: none"> <li>1) Determination of iron &amp; chromium from steel.</li> <li>2) Preparation of Hexathiourea-plumbous(II)nitrate</li> <li>3) Preparation of Potassium hexathiocyanatochromate (III) tetrahydrate</li> <li>4) Preparation of Pentamminechlorocobalt (III) chloride</li> <li>5) Preparation of Penta-aqua-chlorochromium(II)chloride</li> <li>6) Preparation of Copper ferrite</li> <li>7) To determine the amount of iron in given soap sample by colorimetrically.</li> <li>8) Qualitative analysis: Separation and identification of the two component mixtures using Chemical and physical methods.</li> <li>9) Steam distillation techniques.</li> <li>10) Estimation of pesticide</li> <li>11) Analysis of pharmaceutical tablets: Ibrufen / INAH</li> <li>12) Colorimetric estimation of drugs/dyes</li> <li>13) Column and thin layer chromatography</li> <li>14) Interpretation of IR spectra.</li> <li>15) Determination of binary mixture of halides using Potentiometry.</li> <li>16) Verification of Onsager Equation for 1:1 type strong electrolyte.</li> <li>17) Kinetics of iodination of acetone in presence of strong acid.</li> <li>18) To draw polar plots of atomic orbitals like <math>1s, 2p_z, 3d_{z^2}</math> by using angular part of hydrogen atom wave function.</li> <li>19) Determination of atomic refractions of H, C and Cl atoms.</li> <li>20) To determine formula of complex ion by Job's method by colorimetry.</li> </ol>	

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

- 1) Calculate the percentage of different elements in alloys having different metal compositions.
- 2) Perform the estimations and preparations of organic compounds.
- 3) Handle variety of instrumentation techniques.
- 4) Apply the knowledge of different practical's from Inorganic, Organic and Physical



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<sup>th</sup> 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<sup>rd</sup> edition Anjali Publication.