Karmaveer Bhaurao Patil University,

Satara

Syllabus for

M. Sc. I Drug 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: Drug Chemistry**
2. **Year of Implementation:** June 2024.
3. **Preamble:**

This syllabus is framed to give advanced knowledge of Chemistry (Specialization-Drug Chemistry) to postgraduate students in the first year of two years of M.Sc. degree course. The goal of the syllabus is to make the study of Chemistry in particular Drug 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 the subject, industrial, and research experts. The units of the syllabus are well-defined, taking into consideration the level and capacity of the students.

4. **General objectives of the course:**

1. To educate and prepare postgraduate students will get employment on a large scale in academics, Research & Development, departments of New chemical entities synthesis, drug delivery systems, Quality control of various multinational chemical/pharmaceutical industries.
2. To provide students with a broad theoretical and applied background in Chemistry with the specialization of Drug Chemistry.
3. To provide broad common framework of syllabus to expose our graduates to the recent and applied knowledge of interdisciplinary branches of chemistry.
4. Encourage students to conduct various academic activities involves midterm tests, online tests, open book tests, tutorial, surprise test, oral, seminar, assignments and seminar presentation.

5. **Learning outcomes:**

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

6. **Duration:** Two Year
7. **Pattern:** Semester Examination
8. **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**

DSC: Discipline Specific Course; DSE: Discipline Specific Elective; RM: Research Methodology; OJT: On Job Training; RP: Research Project; T: Theory; P: Practical

Semester I

Nature of Course	Course Code	Course Title	No. of Hours per week	Credits
Theory	MDCT 411	Introduction to Microbiology	4	4
	MDCT 412	Fundamental Organic Chemistry	4	4
	MDCT 413	Coordination Chemistry	4	4
	MDCT 414 E-I	Basics of Physical Chemistry	2	2
	MDCT414 E-II	Analytical Techniques		
	MDCT 415	Research Methodology	4	4
Practical	MDCP 416	Lab I	4	2
Practical	MDCP 417	Lab II	4	2

Semester II

Nature of Course	Course Code	Course Title	No. of Hours per week	Credits
Theory	MDCT 421	Immunology and Virology	4	4
	MDCT 422	Reactive Intermediates And Rearrangements	4	4
	MDCT 423	Bioinorganic Chemistry	4	4
	MDCT 424 E-I	Physico-Chemical Theories & Equations	2	2
	MDCT 424 E-II	Advanced Analytical Techniques		
	MDCP 425	Research Project	4	4
Practical	MDCP 426	Lab III	4	2
Practical	MDCP 427	Lab IV	4	2

Credits 4	M.Sc. I Drug Chemistry Semester I Discipline Specific Course (DSE) Mandatory Paper Title: Introduction to Microbiology (MDCT- 411)	Contact Hours 60
Course objectives: Students should be able to…		
1. Learn the Structure and functions of cell organelles in microorganisms. 2. Study the organization of bacterial cells. 3. Explain the characterization of the microbe's fermentation process. 4. Understand the staining techniques of microbes.		
Unit No.	**Content**	**Contact Hours**
Unit I	**Basics of Microbiology**	**12**
	1.1. Introduction and Contributions of Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch, Alexander Fleming, Joseph Lister, Edward Jenner, Paul Ehrlich 1.2. Introduction to Microbiology, Branches of Microbiology, and Classification of Microbes. 1.3. Concept of prokaryotic and eukaryotic microorganisms 1.4. General characteristics of different groups – acellular microorganisms. (Viruses, Viroid's, Prions) and cellular microorganisms. (Bacteria, Archaebacteria, Rickettsia, Algae, Fungi and Protozoa	
Unit II	**Bacterial Cell Organization and Metabolism**	**13**
	2.1. Morphology – Size, shape, Arrangement 2.2. Cytology- Structure, chemical composition, and functions of: a) Cell wall- Gram positive & Gram negative Bacteria b) Cell membrane, Mesosomes. c) Capsule, slime layer. d) Surface appendages – flagella, pili. 2.3. Metabolism: Definition of Metabolism, catabolism, anabolism, aerobic respiration, anaerobic respiration, and fermentation 2.4. Concept of free energy, High-energy compounds. 2.5. Sugar degradation pathways (i.e. EMP, TCA cycle.) 2.6. Electron transport chain: components of respiratory chain	
Unit III	**Microbial Growth Kinetics**	**15**
	3.1 Growth curve of bacteria, Measurement of microbial growth, The influence of environmental factors in growth, Synchronous growth, Continuous growth, Extremophiles their molecular adaptations, and significance Molecular weight of a polymer (Number and mass average) 3.2 Characterization and Screening of Microbes fermentation process, 3.3 Isolation and Improvement of individual micro- organism, fermenter designing, Media Designing, antimicrobial assays 3.4 Down Stream process and effluent treatment (Microbial	

	and Chemical)	
Unit IV	**Microscopy, Staining Techniques, and Control of Microbes**	**20**
	4.1. **Introduction to microscopy and types of microscope:** **A)** Light Microscope – Parts, image formation, magnification, numerical aperture (uses of oil immersion objective) resolving power and working distance, Ray diagram and applications. **B)** Electron Microscope– Types, parts, principle of image formation, ray diagram and applications of scanning electron microscope 4.2. **Staining techniques** **a)** Definition of dye and stain **b)** Classification of stain – acidic, basic and neutral **c)** Common staining techniques- Principle, procedure, mechanism and application of simple staining, negative staining, differential staining- Gram staining 4.3. **Control of Microbes** **a)** Definitions of sterilization, disinfection & sanitization. **b)** Physical agents of control of microorganisms- temperature (Tyndallisation, dry heat, moist heat).Filtration (asbestos and membrane filter), Radiations. **c)** Chemical agents for control of microorganisms- mode of action, applications and advantages of– i) Phenol and phenolic compound. ii) Alcohol (Ethyl alcohol) iii) Halogen compounds (Chlorine and Iodine) iv) Heavy metal (Cu and Hg)	

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

1. Analyze the classification of microbes.
2. Differentiate the metabolism of bacterial cells.
3. Explain the isolation of individual micro-organisms.
4. Explore the types of microscopes.

References:

1. J. C. Pommerville, 2014, Fundamental of Microbiology, 10th edition, Jones & Bartieff publication.
2. R.Y. McMilan, McMilan, London, 2001, General Microbiology.
3. R. Ananthnarayan, C.E. Jayaram Panikar, 1996, Text book of Microbiology, 5th edition.
4. M, T, Madigan, 2017, Brock Biology of Microorganism, 14th edition, Pearson publication.
5. R, P, Singh, 2010, Immunology & Medical Microbiology, 2nd edition, Kalyani Publication.

Credits 4	M.Sc. I Drug Chemistry Semester I Discipline Specific Course (DSC) Mandatory Paper Title: Fundamental Organic Chemistry (MDCT- 412)	Contact Hours 60

Course objectives: Students should be able to…

1. Learn structure and reactivity concepts of organic chemistry.
2. Study classification & nomenclature of stereoisomers.
3. Learn the key concepts of leaving groups, nucleophiles & electrophiles.
4. Gain a comprehensive knowledge of the basic principle of addition & elimination reaction.

Unit No.	Content	Contact Hours
Unit I	**Basics in Organic Chemistry**	**15**
	1.1 Structure and reactivity 1.1.1 Electrophile, 1.1.2 Nucleophile, 1.1.3 Delocalization, 1.1.4 Conjugation, 1.1.5 Resonance, 1.1.6 Hyper conjugation, 1.1.7 Tautomerism, 1.1.8 Inductive effects. **1.2 Acidity and basicity:** 1.2.1 Various Structural Effects 1.2.2 Hard and soft acid and base concept **1.3 Nomenclature:** IUPAC system of nomenclature for 1.3.1 Alkanes, 1.3.2 Alkenes, 1.3.3 Alkynes, 1.3.4 Cyclic compounds, 1.3.5 Aromatic compounds 1.3.6 Common names for simple organic compounds **1.4 Aromaticity** 1.4.1 Structural, thermochemical, and magnetic criteria for aromaticity, including NMR characteristics of aromatic systems. 1.4.2 Benzenoid and non-benzenoid compounds, Huckels rule, antiaromaticity, Application to carbocyclic and heterocyclic systems, nulenes, azulenes, tropylium cations, metallocenes, and current concepts of aromaticity.	
Unit II	**Stereochemistry of Alkanes & Cycloalkanes**	**15**
	2.1 Isomerism & Conformational Isomerism 2.1.1 Structural isomerism: chain, positional, and functional group isomerism Stereoisomerism: geometric (cis-trans) and optical isomerism 2.1.2 Eclipsed conformations & Staggered Conformations	

	2.1.3 Gauche conformations 2.1.4 Anti-conformations **2.2 Newman Projections** **2.3 Substituted cycloalkanes** 2.3.1 Monostustituted cycloalkanes e.g. methyl cyclohexane 2.3.2 Disubstituted cycloalkanes e.g. Dimethyl cyclohexane 2.3.4 Polysubstituted cycloalkanes e.g. 1,2,3 Trimethyl cyclohexane **2.4 Chirality in alkanes** e.g. Ethane, Butanes, Cycloalkanes **2.5 Topicity-** Homotopic, enantiotropic, and diastereotopic ligands and faces with Examples, Diastereoisomerism in Acyclic and Cyclic systems. **2.6 Axial and planar chirality**: Principles of axial and planar chirality. **2.7 Prochirality**: 2.7.1 Homotopic, heterotopic, and diastereotopic ligands and faces. 2.7.2 Identification using substitution and symmetry criteria. 2.7.3 Nomenclature of stereo heterotopic ligands and faces. 2.7.4 Symbols for stereo heterotopic ligands in molecules with one or more parochial centers, pro-pseudo asymmetric center, chiral and parochial center; prochiral axis and prochiral plane. 2.7.5 Symbols for enantiotopic and diastereotopic faces	
Unit III	**Nucleophilic & Electrophilic Substitutions**	**15**
	3.1. SN^2, SN^1 & SN_i reactions concerning mechanism and stereochemistry. 3.2. Nucleophilic substitutions at an allylic, aliphatic trigonal, benzylic, aryl, and vinyl carbons. 3.3. Reactivity effect of substrate structure, 3.4. the effect of attacking nucleophiles, 3.5. Leaving groups, and reaction medium. 3.6. SN reactions at bridgehead carbon, competition between SN^1 and SN^2, 3.7. Ambient nucleophiles, 3.8. Neighboring Group Participation. 3.9. Introduction, the arenium ion mechanism, orientation. 3.10. Reactivity in Nitration, Sulphonation, Friedel-Crafts and 3.11. Halogenation in aromatic systems, energy profile diagrams. 3.12. The ortho/para ratio, ipso attack, concept of aromaticity, and orientation in their ring systems. 3.13. Diazo-coupling, 3.14. Vilsmeier-reaction, 3.15. Von-Richter rearrangement.	
Unit IV	**Addition & Elimination Reactions**	**15**
	Addition Reaction 4.1 Recapitulation of Addition reaction 4.2 Addition of electrophiles to multiple bonds. 4.3 Nucleophilic addition to alkenes & alkynes. 4.4 Addition of carbenes.	

	4.5 Nucleophilic addition to carbonyl compounds (Aldehyde & Ketones) 4.6 Nucleophilic addition to the carbonyl carbon of a carboxylic acid derivative. 4.7 Radical additions to Alkenes. 4.8 Nucleophilic attack on Carbon Nitrogen triple bond. 4.9 Electrophile, nucleophile, and free radicals, **Elimination Reaction** 4.10 Introduction of Elimination Reactions 4.11 The Unimolecular mechanism for elimination. 4.12 The bimolecular mechanism for elimination. 4.13 Pyrolytic syn elimination -Ei-elimination internal. 4.14 Orientation in Elimination Reactions. 4.15 Hoffman Versus Saytzeff elimination, 4.16 Reactivity 4.17 Effects of substrate structures, 4.18 Attacking base, leaving group, 4.19 The nature of medium on elimination reactions. 4.20 Chugaev reaction	

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

1. Analyse the relationship between structure and reactivity of organic compounds.
2. Differentiate between configuration and conformation of molecules.
3. Explain factors influencing the mechanism of substitution reactions.
4. Explore mechanisms and pathways of addition & elimination reactions**.**

References:

1. J. Clayden, N. Greeves, S. Warren, 2002, Organic chemistry 6th edition, Oxford university, Press.
2. D. Nasipuri, 1994, Stereochemistry of organic compounds, New Delhi, New age International.
3. March. J, 2007, Advanced Organic chemistry, 6th edition, McGraw Hill.
4. Sykes. Peter, 1985, Guide book to mechanism in organic chemistry 6th edition, US orients Longmans.
5. Morrisons. R. T, & Boyd. R. N, 2002, Organic chemistry 7th edition, Prentice Hall Ashok Kghosh.
6. Eliel. E. L, 1962, Stereochemistry of carbon compounds, 1st edition, McGraw hill.

Credits 4	M.Sc. I Drug Chemistry Semester I Discipline Specific Course (DSC) Mandatory Paper Title: Coordination Chemistry (MDCT- 413)	Contact Hours 60

Course objectives: Students should be able to…

1. Study the therapeutics application & mechanism of action of coordination compound in medicine.
2. Understand the role of coordination chemistry in catalysis & enzymatic processes.
3. Learn the role of the contribution of chemistry in the development of new materials.
4. Recognize the applications of organometallic compounds.

Unit No.	Content	Contact hours
Unit I	**Introduction to Coordination Chemistry**	**15**
	1.1. Transition elements, Structure bonding theories, Spectra, Magnetic Properties, atomic radii, ionic radii, hydration energy, Ionization Energy, Electronegativity, Electrode Potential, Oxidation States; Stability of various Oxidation States for Mn, Fe, and Cu; stereochemistry of coordination compounds, 1.2. Constitution and Geometry 1.3. Isomerism and chirality 1.4. Thermodynamics of complex formation 1.5. Molecular Orbital Theory of octahedral complexes with sigma bonding 1.6. Study of Lanthanides and Actinides: Introduction, Electronic configuration, transition spectra, spin-orbital, spin multiplicity, spin-spin orbital coupling	
Unit II	**Coordination Compound I**	**15**
	2.1. Crystal Field Theory: Octahedral Complexes; Splitting of Orbitals an Octahedral Field 2.2. Spectrochemical Series, Crystal Field Stabilization Energy, Weak and Strong Field Complexes, Pairing Energies, Low Spin and High Spin Complexes 2.3. John Teller Effect; Tetrahedral and Square Planar Complexes, Magnetic Properties. Of Crystal Field Theory; Lattice Energies, Ionic Radii 2.4. Thermodynamic and Related Aspects of Crystal Fields, Heats of Ligation, Site Preference Energies 2.5. Limitation of Crystal Field Theory 2.6. Molecular Orbital Theory, Nephelauxetic Effect; Pi-Bonding and Molecular Orbital Theory, Orbital contribution of ligand complexes, ligand field theory	
Unit III	**Coordination Compound II**	**15**
	3.1 Ligand field theory of coordination complexes**:** Effect of ligand field on the energy level of transition metal ions 3.2 Energy level of transition metal ions, free ion terms, microstates,	

	term wave functions 3.3 Quantum numbers, spin-orbits coupling strong field effect, Orgel diagram, correlation diagrams, Tanabe Sugano diagrams, spin pairing energies. 3.4 Coordination chemistry reactions of complexes: Oxidative addition reaction, substitution reactions, Group transfer reactions, Elimination reactions	
Unit IV	**Organometallic Chemistry**	**15**
	4.1. Introduction to Sigma complexes and π complexes: Synthesis, bonding, properties and applications. 4.2. Metal-Carbon multiple bonded compounds Carbene and Carbynes: Synthesis, bonding, properties and applications 4.3. Metal Carbonyls: Isoelectric and Isolable Analogy, 4.4. Carbocyclic Polyenes: Synthesis, bonding, properties and applications. 4.5. Fluxional Behavior of organometallic compounds and study of organometallic compounds by NMR, IR. 4.6. Phosphine complexes: Synthesis, bonding, properties, and applications. 4.7. Metal-Metal Bonds: Transition metal atom clusters and cages. 4.8. Roll of transition metal organometallics in organic synthesis: As electrophiles and nucleophiles, Activating agents and protecting agents 4.9. Eighteen electron Rule applications and Exceptions. 4.10. Reactions of organometallic compounds Oxidative addition, Reductive elimination, Insertion and elimination	

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

1. Develop the ability to evaluate scientific literature and research findings in coordination chemistry critically.
2. Formulate a hypothesis and design experiments to test this hypothesis in a contest of coordination chemistry.
3. Analyse the electronic structure of coordination compounds in MOT & CFT.
4. Discuss the 18-electron rule of metal complexes.

Reference:

1. Datta. R. L, & Syamal, 2007, Elements of magneto chemistry, 2nd edition East West Press Private Limited.
2. Shriver and Atkins Inorganic chemistry, Fifth edition, Oxford, 2010.
3. Cotton. A, Wilkinson's. R. G, 2021, Advanced Inorganic chemistry, Wiley publication.
4. Inorganic chemistry by Gary L. Miessler and Paul J, Fischer.
5. Wells F. 1984, Structural Inorganic chemistry Oxford University, Press.

Credits 2	M.Sc. I Drug Chemistry Semester I Discipline Specific Elective (DSE) Elective Paper Title: Basics of Physical Chemistry (MDCT- 414 E- I)	Contact Hours 30

Course objectives: Students should be able to…

1. Understand the kinetics behind chemical reactions.
2. Study the thermodynamics.
3. Learn the different types of catalysts.
4. Acquire knowledge of thermodynamic properties.

Unit No.	Content	Contact hours
Unit I	**Chemical Kinetics I**	**7**
	1.1. Introduction to Chemical kinetics, Experimental methods of following kinetics of a reaction, chemical and physical (measurement of pressure, volume, EMF, conductance, diffusion current, and absorbance) methods and examples. 1.2. Elementary reaction kinetics-Rate laws for elementary reactions, rate-determining steps, collision theory and transition state theory 1.3. Steady-state approximation and study of the reaction between NO_2 and F_2, decomposition of ozone, and nitrogen pentoxide.	
Unit II	**Chemical Kinetics II**	**8**
	2.1. Ionic reaction: Primary and secondary salt effect 2.2. Homogeneous catalysis: acid and base catalyzed reactions Michaelis–Menten enzyme catalysis 2.3. Heterogeneous catalysis: Adsorption of gas on a surface and its kinetics. 2.4. Catalyzed hydrogen-deuterium exchange reaction.	
Unit III	**Thermal Reactions I**	**7**
	3.1. Introduction: revision of basic concepts: Entropy and third law of thermodynamics 3.2. Methods of determining the practical absolute entropies, Entropies of phase transition, Maxwell relations and its applications. 3.3. Thermodynamic equation of state, Ideal and non-ideal solutions. 3.4. Thermodynamics of non-electrolyte solutions.	
Unit IV	**Thermal Reactions II**	**8**
	4.1 Raoult's law 4.2 Duhem-Margules equation and its applications to vapor pressure curves (Binary liquid mixture) 4.3 Gibbs-Duhem equation and its applications to the study of partial molar quantities 4.4 Chemical potential, variation of chemical potential with	

	temperature & pressure in terms of thermodynamic potentials 4.5 Numerical Problem 4.6 Henry's law 4.7 Excess and mixing thermodynamic properties 4.8 Equilibrium constants and general conditions of equilibrium	

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

1. Find the rate-determining step.
2. Explain the Gibbs-Duheme equation and its applications in thermal reactions.
3. Solve Numerical problems of thermodynamics.
4. Apply Gibbs- Duhem equation for partial molar quantities.

References:

1. P. W. Atkins, 2002 Physical Chemistry 7th edition –, Oxford University Press.
2. S. Glasstone. And Nostrand D. Van. 1965, Textbook of Physical Chemistry
3. Srivastava R. C., Saha S. K. and Jain A. K 2004 Thermodynamics, A Core Course. 2nd edition Prentice-Hall of India
4. K. J. Laidler, Pearson 2004 Chemical Kinetics
5. G. L. Agarwal, Tata-McGraw Hill Basic Chemical Kinetics.

Credits 2	M.Sc. I Drug Chemistry Semester I Discipline Specific Elective (DSE) Elective Paper Title: Analytical Techniques (MDCT- 415 E-II)	Contact Hours 30

Course Objective: Students should be able to…

1. Understand different spectroscopic techniques.
2. Study ^{13}C NMR spectroscopy.
3. Acquire knowledge about mass fragmentation & its rules.
4. Learn factors affecting on separations.

Unit No.	Content	Contact hours
Unit I	**Spectroscopic Techniques I**	**6**
	1.1. UV-Visible spectroscopy: Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy, Choice of solvents and solvent effect, and Applications of UV-Visible spectroscopy. 1.2. IR spectroscopy: Theory, Modes of Molecular vibrations, Sample handling, Instrumentation of Dispersive and Fourier - Transform IR Spectrometer, Factors affecting vibrational frequencies, and Applications of IR spectroscopy.	
Unit II	**Spectroscopic Techniques II**	**6**
	2.1. Spectrofluorometric techniques: Theory of Fluorescence, Factors affecting fluorescence, Quenchers, Instrumentation and Applications of Fluorescence Spectrophotometer. 2.2. Flame emission spectroscopy: Principle, Instrumentation, Interferences and Applications. 2.3. Atomic absorption spectroscopy: Principle, Instrumentation, Interferences and Applications.	
Unit III	**NMR Spectroscopy**	**9**
	3.1. NMR spectroscopy: Quantum numbers and their role in NMR, Principle, Instrumentation, Solvent requirement in NMR, Relaxation process, 3.2. NMR signals in various compounds, Chemical shift, Factors influencing chemical shift, 3.3. Spin-Spin coupling, Coupling constant, Nuclear magnetic double resonance, 3.4. A brief outline of principles of FT-NMR and ^{13}C NMR. Applications of NMR spectroscopy	
Unit IV	**Mass Spectroscopy**	**9**
	4.1 Mass Spectroscopy: Principle, Theory, Instrumentation of Mass Spectroscopy. 4.2 Different types of ionization include electron impact, chemical, field, FAB and MALDI, APCI, ESI, APPI Analyzers of Quadrupole, and Time of Flight. 4.3 Mass fragmentation and its rules, Meta stable ions, Isotopic	

	peaks. 4.4 Applications of Mass spectroscopy	

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

1. Analyze applications of IR spectroscopy in spectroscopic techniques.
2. Explain the instrumentation of nuclear magnetic resonance spectroscopy.
3. Classify different types of ionization like electron impact.
4. Acquire the knowledge of application FT NMR.

References:

1. Robert M. Silverstein; 2005, Spectrometric identification of organic compounds; 6th edition John Wiley & sons, Inc.
2. Jag Mohan; 2004, Organic spectroscopy principles & applications 2nd edn, Norosa publishing houses.
3. P.S. Kalsi; 2004, Spectroscopy of organic compounds; 5th Edn, New age international Publishers.
4. William Kemp; 2004, Organic Spectroscopy, 3rd edition, Palgrave.
5. Donald L. Pavia; Garry M. Lampman; George S. Kirz: 2004, Introduction to spectroscopy, 3rd edition, Harcourt College Publishers.

Credits 4	M.Sc. Drug Chemistry Semester I MDCT-415: Research Methodology (RM)	Contact Hours 60

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.

Unit No.	Content	Contact hours
Unit I	**Research Design**	**15**
	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.	
Unit II	**Design of Sample Surveys**	**15**
	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.	
Unit III	**Data Preparation and Process**	**15**
	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	
Unit IV	**Research Report and Ethics**	**15**
	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. 3rd edition, London, UK: TJ International Ltd, Padstow, Corwall.
8. Chemical safety matters – IUPAC – IPCS, 1992. Cambridge University Press.

Credits 2	M.Sc. I Drug Chemistry Semester I MDCP-416: Lab I	Contact Hours 60
	Part A	
	1. Preparation of cotton plugs for test tubes and flasks, wrapping of plates and pipettes. 2. Use, care and study of compound microscope. 3. Microscopic Examination of Bacteria by Monochrome staining method 4. Microscopic Examination of Bacteria by Negative staining method 5. Microscopic Examination of Bacteria by Gram staining 6. Study of growth phases and growth curve of bacteria 7. Demonstration of working of industrial fermenters by visiting the fermentation industry	
	Part B	
	1. Organic qualitative analysis of binary Mixture (Any 4) 2. To perform Assay of aspirin 3. To carry out the Assay of furosemide tablets. 4. To carry out the Assay of Chlorpromazine. 5. To carry out the assay of atropine. 6. One stage preparation of 5, 5 - Diphenyl hydentoine. 7. One stage preparation of 7-Hydroxy 4-methyl coumarin. 8. Aromatic Electrophilic substitutions: Synthesis of p Nitroaniline and p-Bromoaniline. 9. To determine the acid value of given oil. 10. Beginlli reaction: Micorwave-assisted synthesis of Dihydropyrimidone. 11. Estimation of Amino acids.	

Reference:

1. Loudon, Gregory M., and Josephine I. Davies. 2016, Organic Chemistry Principles and Mechanisms. 2nd ed. W.H. Freeman and Company.
2. Zubrick, James W. 2019, The Organic Chem lab survival Manual: a Students Guides to Techniques.10th ed. Wiley.
3. Wade, Leroy G. 2017, Organic Chemistry a Laboratory Manual. 8th ed. Pearson.
4. Noble, David R., and Michael B. Smith. 2014, Organic Chemistry a Laboratory Manual 3rd ed. University Science Books.
5. Harris, Daniel C. 2016, Quantitative Chemical Analysis. 9th ed. New York: W.H. Freeman and Company.
6. Benson, Harold J. 2018, Microbiological Applications: Laboratory Manual in General Microbiology. 11th ed. McGraw-Hill Education.
7. Baron, Elliot J., and Patricia A. D. Stalons. 2020, Bailey & Scott's Diagnostic Microbiology. 14th ed. Elsevier.
8. Murray, Patrick R., Ken S. Rosenthal, and Michael A. Pfaller. 2020, Medical Microbiology. 9th ed. Elsevier.
9. Pommerville, Jeffrey C. 2019, Alcamo's fundamentals of Microbiology: A Laboratory Manual. 11th ed. Jones & Bartlett Learning.
10. Cappuccino, James G., and Natalie Sherman 2022, Microbiology: A Laboratory Manual. 11th ed. Pearson.

Credits 2	**M.Sc. I Drug Chemistry** **Semester I** **MDCP-417: Lab II**	Contact Hours 60
	Part A	
	1. Preparations and purity (any four) i)Potassium trioxalatochromate (III) trihydrate ii) cis-potassium dioxalatodiaqua chromate(III) iii) Potassium hexathiocyanatochromate(III) iv) Bis (dimethyl glyoxylate)nickel(II) v)Carbonatotetramminocobalt(III)nitrate vi)Hexamminocobaltic(III) chloride 2. Determination of concentration of phosphates in water samples colorimetrically 3. Determination of sodium from the fertilizer sample using cation exchange chromatographically. 4. Determination of calcium from the given drug sample. 5. Determination of hardness, alkalinity, and salinity of water sample 6. Separation and estimation of chloride and bromide on anion exchanger. 7. Study of adsorption of phosphate ion on alfa-Fe_2O_3 8. Removal and kinetics of photo catalytic dyes, degradation (methylene blue) by ZnO or TiO_2 photo catalysis. 9. Synthesis and photochemistry of $K_3[Fe(C_2O_4)3].3H_2O$ 10. Synthesis and Purity of Chloropenta-ammine cobalt (III) chloride. 11. Synthesis and Purity of Nitro penta-ammine-cobalt (III) chloride. 12. Synthesis and Purity of Bis [Tris Cu (I)thiourea].	
	Part B	
	1. To determine relative strength of chloroacetic acid and acetic acid by conductivity measurement. 2. Polarimetry: Kinetics of inversion of cane sugar in the presence of strong acid. 3. Chemical Kinetics: Kinetics of reaction between bromate and iodide. 4. to determine molar extension coefficient and unknown concentration of given sample colourimetricaly. 5. To determine the normality and strength of each acid in the given mixture of strong acid and weak acid conductometrically 6. Chemical Kinetics: To determine the relative strengths of 1N hydrochloric acid and N/2 hydrochloric acid. 7. Determination of ΔG, ΔH, and ΔS of $BaSO_4$ by conductometry.	

Reference:

1. Mann, F. G., and B. C. Saunders. 1960, Practical Organic Chemistry**.** 4th ed. London: Longmans, Green and Co.
2. Clarke, H. T.A 1956, Handbook of Qualitative Analysis and Quantitive Analysis. 6th ed. London: Edward Arnold.
3. Blatt, A. Organic Synthesis: Collective Volumes. New York: Wiley, various volumes.
4. Kitchener, J. A., 1971, Findlay's Practical Chemistry. 9th ed. London: Macmillan.
5. Vogel, A. I. 1961, Textbook of Inorganic Qualitative Analysis. 3rd ed. London: Longmans, Green and Co.
6. Das, R. C., and B. Behera. 2002, Experimental Physical Chemistry**.** 2nd ed. New Delhi: Tata McGraw-Hill.
7. Viswanathan, B., and P. S. Raghavan. 2006, Practical Physical Chemistry. 3rd ed. Chennai: New Age International.
8. Athawale, V. D., and Parul Mathur. 2004, Experimental Physical Chemistry. 1st ed. Mumbai: Himalaya Publishing House.
9. Rajbhoj, S. W., and T. K. Chondhekar. 2008, Systematic Experimental Physical Chemistry**.** 1st ed. Pune: Vidyarthi Prakashan.
10. Palmer, W. G. 1969, Experimental Inorganic Chemistry**.** 2nd ed. London: Chapman and Hall.
11. Schoeller, W. R., and A. R. Powell. 1958, The Analysis of Minerals and ores of the Rarer Elements. London: Charles Griffin and Company Limited.
12. Tokushige, M. 1971, Allosteric Regulation: Selected papers in Biochemistry. Vol. 8. Tokyo: University of Tokyo Press.
13. Patel, A. H. 1985, Industrial Microbiology. 2nd ed. Madras: Macmillan India Ltd.

Credits 4	M.Sc. I Drug Chemistry Semester II Discipline Specific Course (DSC) Mandatory Paper Title: Virology and Immunology (MDCT-421)	Contact Hours 60
Course objectives: Students should be able to...		
1. Study the structural properties of viruses. 2. Identify types of infections. 3. Acquire the knowledge about immunology. 4. Learn the concept of modern vaccines & their types.		
Unit No.	**Content**	**Contact hours**
Unit I	**Virology**	**17**
	1.1. Biquitous nature of viruses, Discovery of viruses, the Beneficial and harmful nature of viruses. 1.2. General properties of viruses. 1.3. The Structural properties of viruses: Capsids, Nucleic acids, and envelope. 1.4. Structure of T4 bacteriophages, HIV, Viroid, and prions. f) Cultivation of viruses. A) Animal virus - Tissue culture, chick embryo, and live animals g) Purification of viruses based on physicochemical properties: i] Density gradient centrifugation. ii] Precipitation 1.5. Replication of viruses: DNA (ds) - Poxvirus , RNA(ss+ve)- Poliovirus, RNA (ss -ve) – Influenza virus and RNA with RT- HIV 1.6. Antiviral: Mode of Action of various antiviral drugs	
Unit II	**Host-Pathogen Interaction**	**16**
	2.1. Definitions: Host, Parasite, Commensal, etiological agent, Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Signs of disease, symptoms, syndrome, sequelae infections, fomite 2.2. Types of Infection: Opportunistic infections, Nosocomial infections, Primary, Reinfection, secondary, Cross, Iatrogenic, In apparent, Latent, Inherited, Congenital, Pyogenic 2.3. Disease Process: Portal of Entry and Exit of Organisms Virulence: Adherence, Attachment, colonization, Invasiveness, Enzymes and Toxin produced, Cell structures Viz. Cell wall, Capsule	
Unit III	**Immunology**	**15**
	3.1. Definition i) Immunity ii) Innate Immunity- Types, factors influencing innate immunity iii) Acquired Immunity – Active & passive 3.2. Non-Specific defense mechanisms of the vertebrate body i) First line of defense ii) Second line of defense iii) Third	

	line defense mechanism 3.3. Cells of the immune system- Monocytes & macrophages, granulocytes, mast cells, dendritic cells, NK cells, lymphocytes- B & T cells. 3.4. Antigen (Chemical nature, types of antigens, factors affecting antigenicity), Adjuvants. 3.5. Antibody: Nature of antibodies, Types of antibodies – Structure, properties and functions	
Unit IV	**Vaccines**	**12**
	4.1 Concept and principal requirements of the vaccine. 4.2 Active and passive immunization 4.3 Types of Vaccines a) Conventional Vaccine and their Types 4.4 Live Vaccine, ii) Killed Vaccine with examples. 4.5 Modern Vaccines and their Types: i) Peptide Vaccine, ii) Genetically Engineered Vaccine with examples.	

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

1. Explore the general properties of viruses.
2. Gain comprehensive knowledge about disease processes.
3. Differentiate non-specific defense mechanisms of the vertebrate body.
4. Apply the concept and principal requirements of the vaccine.

Reference:

1. Pelczar, M.J.Jr., Chan E.C.S., Krieq, N.R, 1986, Microbiology, 5th edition,McGraw Hills Publication.
2. C. V. Mosby & Co. London, 1983, Text Book of Immunology, Barret James D 4th edition.
3. S. K. Gupta, Essentials of Immunology
4. S. Gangal, S. Sontakke, Textbook of Basic and Clinical Immunology- University Press.
5. John Wiley and Sons, 1978, General Virology- Luria.
6. John, 2013, Virology Principles and Applications, 2nd Edition Wiley publications.

Credits 4	M.Sc. I Drug Chemistry Semester II Discipline Specific Course (DSC) Mandatory Paper Title: Reactive Intermediates in Reaction Mechanism (MDCT-422)	Contac t Hours 60

Course objectives: Students should be able to…

1. Identify the reactive intermediate.
2. Learn about common oxidizing & reducing agents.
3. Study the regioselectivity & stereo selectivity of involved in hydroboration.
4. Gain comprehensive knowledge of organometallic compounds & their unique reactivity.

Unit No.	Content	Contact hours
Unit I	**Reactive Intermediates & Rearrangements**	**10**
	1.1 Structure and stability of reactive intermediates, 1.1.1 Carbocations, 1.1.2 Carbanions, 1.1.3 Free radicals, 1.1.4 Carbenes, 1.1.5 Nitrenes, 1.1.6 Benzyne. **1.2 Rearrangements** -General mechanistic considerations- nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements: 1.2.1 Beckmann rearrangement,, 1.2.2 Hofmann rearrangement, 1.2.3 Pinacol Pinacolone 1.2.4 Wolf rearrangement, 1.2.5 Baeyer Villager rearrangement, 1.2.6 Semipinacole rearrangment 1.2.7 Favorskii rearrangement, 1.2.8 Benzil-Benzillic acid rearmaments, 1.2.9 Claisen rearrangements, 1.2.10 Cope Rearrangements, 1.2.11 Curtius rearrangement 1.2.12 Wagner Meerwein rearrangement **1.3 Reactions**: 1.3.1 Chichibabin, 1.3.2 Simon-Smith, 1.3.3 Mc-Murry, 1.3.4 Suzuki coupling reaction. 1.3.5 Wolf Kirshner rduction 1.3.6 Appel reaction 1.3.7 Houben-Hoesch reaction 1.3.8 Sommelet reaction, 1.3.9 Witting reaction 1.3.10 Michael addition reaction	

Unit II	Chemistry of Oxidative and Reductive Reagents	10
	2.1 Oxidizing agents: 2.1.1 TEMPO, 2.1.2 CAN, Ceric Ammonium Nitrate 2.1.3 PCC, Pyridinium chlorochromate 2.1.4 $KMnO_4$ Potassium per magnet 2.1.5 O_3, Ozone 2.1.6 Swern oxidation, 2.1.7 SeO_2, Selenium Dioxide 2.1.8 Pb $(Ac)_4$,Lead tetra acetate 2.1.9 Pd-C, Palladium catalyst 2.1.10 RuO_4, Ruthenium tetroxide 2.1.11 OsO_4, Osmium tetra oxide 2.1.12 m-CPBA,m- chloro per benzoic acid 2.1.13 MnO_2, Manganese dioxide 2.1.14 $NaIO_4$, Sodium per iodate 2.1.15 CrO_3- Chromium trioxide, 2.1.16 DDQ, 2.3 dichloro- 5,6 dicyano- 1,4 Benzoquinone 2.1.17 PDC, Pyridinium Dichloro chromate **2.2 Reducing agents:** 2.2.1 Boranes and hydroboration reactions, 2.2.2 MPV reduction 2.2.3 Reduction with H_2/Pd-C, 2.2.4 Raney-Ni, 2.2.5 $NaBH_3CN$, 2.2.6 Wilkinson's catalyst, 2.2.7 DIBAL 2.2.8 Wolff-Kishner reduction, 2.2.9 Birch reduction, 2.2.10 Clemenson's condensation reaction	
Unit III	**Importance of Hydroboration, and Enamines Reactions**	**15**
	3.1 Hydroboration: 3.1.1 Importance of hydroboration reaction 3.1.2 Various hydro borating agents their Mechanism 3.1.3 Synthetic Applications i) 9- BBN, ii)Thexyl borane, iii)Diisamyl borane 3.1.4 Application of hydroboration reactions **3.2 Enamines** 3.2.1 Importance of Enamines reaction 3.2.2 Formation of enamines. 3.2.3 Reactivity of enamines. 3.2.4 Application of Enamines reactions	
Unit IV	**Reactions of Organometallics and Ylides**	**15**
	4.1 Addition of 4.1.1 Grignard Reagent, 4.1.2 Organo lithium,	

	4.1.3 Organo Zinc, 4.1.4 Organo Copper reagents to Carbonyl unsaturated Carbonyl compounds. **4.2 Reactions of** 4.2.1 Phosphorous, 4.2.2 Nitrogen 4.2.3 Sulphur Ylids.	

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

1. Assemble reactive intermediate with their reactivities.
2. Investigate the use of oxidizing and reducing agents in organic synthesis.
3. Illustrate the use of hydroboration in synthesis of complexes.
4. Explore the types of organometallic reagents, including Grignard's reagents, organo lithium etc.

References:

1. J. Clayden, N. Greeves, S. Warren, Organic chemistry 6th edition, Oxford University, Press.
2. D. Nasipuri, 1994, Stereochemistry of organic compounds, New Delhi, New Age International.
3. March. J, 2007, Advanced Organic chemistry, 6th edition, McGraw Hill.
4. Sykes. Peter, 1985, Guide book to mechanism in organic chemistry 6th edition, US orients Longmans.
5. Morrisons. R. T, & Boyd. R. N, 2002, Organic chemistry 7th edition, Prentice Hall Ashok Kghosh.
6. Eliel. E. L, 1962, Stereochemistry of carbon compounds,1st edition, McGraw Hill.

Credits 4	M.Sc. I Drug Chemistry Semester II Discipline Specific Course (DSC) Mandatory Paper Title: Bioinorganic Chemistry	Contact Hours 60

Course objectives: Students should be able to…

1. Explore the roles & functions of metal ions in various biological processes.
2. Understand the fundamental principles of inorganic chemistry relevant to drug delivery
3. Gain compressive knowledge of the structural features of metalloenzymes
4. Study the biochemical & physiological mechanism through which inorganic compounds exerts therapeutic effects.

Unit No.	Content	Contact hours
Unit I	**Introduction to Bioinorganic Chemistry**	**15**
	1.1. Introduction of bioinorganic chemistry, 1.2. Role of metals, metalloproteins and metalloenzymes in living system. 1.3. Principles of coordination chemistry related to bioinorganic chemistry research and protein, Nucleic acid and other metal-bonding biomolecules. 1.4. Thermodynamic aspects - HSAB concept, chelate effect and Irving-William series, pKa values of coordinated ligands, Tuning of redox potential, Biopolymer effects. 1.5. Kinetic aspects- Electron transfer reaction, Electronic substitution reaction. 1.6. Reactions of coordinated ligands and Template effect, concept of spontaneous self-assembly model compounds. 1.7. Biochemistry of Na, K and Ca with respect to Na/K pumps, Distribution of Cationic and anionic electrolytes in blood plasma and intracellular fluid, Calmodulin, Ionophores natural and synthetic application of Ionophores and Ca in blood Coagulation. 1.8. Biochemistry of following elements: a) Iron: Ferritin, Transferrin, Ferredoxin, Rubredoxin, Porphyrin-based system b) Magnesium: Photosystem I c) Manganese: Photosystem II	
Unit II	**Inorganic Chemistry in Drug Delivery**	**15**
	2.1. Importance of inorganic chemistry in pharmaceuticals, 2.2. Traditional drug delivery methods, 2.3. Metal-based drugs: Platinum base anticancer drug e.g. cisplatin, gold compounds in rheumatoid arthritis treatment, other metal-based therapeutics 2.4. Inorganic nanoparticles in Drug delivery: types of nanoparticles e.g. gold, silver, Iron oxides. 2.5. Synthesis & functionalization of nanoparticles 2.6. Mechanism of drug loading and release. 2.7. Targeted drug delivery using inorganic nanoparticles: active vs passive targeting, surface modification for	

	targeted delivery 2.8. Toxicological consideration, Biocompatibility of metal based drugs and nanoparticles. 2.9. Imaging and diagnostics applications**.**	
Unit III	**Metalloenzymes**	**15**
	Introduction to Metalloenzymes: 3.1. Definition and classification of metalloenzymes. 3.2. Importance of metal ions in biological systems. 3.3. Historical perspective and key discoveries. **Metal Cofactors in Enzymes**: 3.4. Types of metal ions commonly found in metalloenzymes (e.g., transition metals, alkali, and alkaline earth metals). 3.5. Roles of metal ions in enzyme structure, stability, and function. 3.6. Examples of metalloenzyme families (e.g., metalloproteases, metallohydrolases, metallooxidases). **Metal Binding Sites**: 3.7. Coordination chemistry of metal ions in enzymes. 3.8. Ligands and coordination geometries around metal ions. 3.9. Structural determination techniques (e.g., X-ray crystallography, NMR spectroscopy) for metalloenzyme complexes. **Catalytic Mechanisms**: 3.10. Roles of metal ions in enzyme catalysis 3.11. Proton transfer, substrate binding, and activation mechanisms. 3.12. Specific examples of metalloenzyme reactions (e.g., redox reactions, hydrolysis reactions). 3.13. **Regulation and Inhibition**: 3.14. Regulation of metalloenzyme activity by endogenous and exogenous factors (e.g., pH, temperature, allosteric effectors). 3.15. Mechanisms of enzyme inhibition (competitive, non-competitive, mixed inhibition) and their implications for the drug. 3.16. Biological Significance	
Unit IV	**Inorganic Compounds in Medicinal Chemistry**	**15**
	4.1 Importance of inorganic compounds in medicinal chemistry 4.2 solubility, nature, pharmacodynamics, mode of actions, metabolism and side effects of following compounds: 4.2.1 Lithium carbonate 4.2.2 Calcium gluconate 4.2.3 Sodium Benzoate 4.2.4 Sodium bicarbonate	

	4.2.5 magnesium hydroxide 4.2.6 Cis-platin 4.2.7 Boric acid 4.2.8 Potash Alum 4.2.9 Ferrous Sulphate 4.2.10 Zinc Sulphate	

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

1. Analyse case studies of clinical approved metal-based drugs.
2. Examine the interaction between inorganic compounds and biological systems.
3. Apply principles learn to the development of new therapeutic agents targeting metalloenzymes.
4. Evaluate relationship between chemical structures of inorganic compounds and their pharmacological activities.

References:

1. Inorganic chemistry by Gary L. Miessler and Paul J, Fischer.
2. Shrivar and Atkins Inorganic chemistry, Fifth edition, Oxford, 2010.
3. Wells F. 1984, Structural Inorganic chemistry Oxford University, Press.
4. Datta. R. L, & Syamal, 2007, Elements of magneto chemistry, 2nd edition east west press private limited.
5. Cotton. A, Wilkinson's. R. G, 2021, Advanced Inorganic chemistry, Wiley publication.

Credits 2	M.Sc. I Drug Chemistry Semester II Discipline Specific Elective (DSE) Elective Paper Title: Physicochemical Theories and Equations (MDCT- 424 E I)	Contact Hours 30

Course objectives: Students should be able to…

1. Explain Pauli's Exclusion Principle.
2. Learn Maxwell-Boltzmann (MB) distribution law.
3. Understand colloidal Systems.
4. Study of different electrodes.

Unit No.	Content	Contact hours
Unit I	**Quantum Chemistry**	**8**
	1.1. Introduction: Wave-particle duality of matter 1.2. De Broglie's hypothesis, Uncertainty principle, Schrodinger equation 1.3. Operators: algebra of operators, linear operator, commutator, angular momentum operator, ladder operator and operator-related theory 1.4. Solutions of the wave equation for a free particle and particle in a box problem 1.5. Transition dipole moment integral and selection rule 1.6. Pauli Exclusion Principle 1.7. Spectroscopic term symbols.	
Unit II	**Statistical Thermodynamics**	**7**
	2.1. Ensembles, ensemble average and time average of property. 2.2. Statistical equilibrium, thermodynamic probability 2.3. Maxwell-Boltzmann (MB) distribution law. 2.4. Partition function and its significance. 2.5. Rotational, translational, vibrational and electronic partition functions. 2.6. Thermodynamic probability and entropy: Boltzmann–Planck equation 2.7. Relationship between partition function and thermodynamic properties.	
Unit III	**Colloids and surface phenomena**	**8**
	3.1. Colloidal Systems-Sols, Lyophilic and lyophobic sols, properties of sols, coagulation. 3.2. Sols of surface-active reagents, surface tension and surfactants 3.3. Electrical phenomena at interfaces including electro-kinetic effects, micelles, reverse micelles, solubilization. 3.4. Thermodynamics of micellization, critical micelle concentration, factors affecting critical micelle concentration (cmc), experimental methods of cmc	

	determination 3.5. Micellar catalysis. 3.6. Adsorption, adsorption isotherms, methods for determining surface structure and composition 3.7. BET equation, surface area determination 3.8. Gibbs adsorption equation and its verification. 3.9. Application of photoelectron spectroscopy, ESCA, and Auger spectroscopy to the study of surfaces. 3.10. Numerical Problems.	
Unit IV	**Electrochemistry**	**07`**
	4.1 Activity and Activity coefficients: forms of activity coefficients and their interrelationship 4.2 Types of electrodes, Determination of activity coefficients of an electrolyte using concentration cells, instability constant of silver ammonia complex. 4.3 Acid and alkaline storage batteries, abnormal ionic conductance of hydroxyl and hydrogen ions. 4.4 Electro kinetic phenomena: Electrical double lever, theories of double layer-Helmholtz-Perrin theory, Gouy and Chapman theory, Stern theory. 4.5 Electro-capillary phenomena, electro- capillary curve. 4.6 Electro-osmosis, electrophoreses.	

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

1. Explain conditions for acceptable wave functions and its interpretation.
2. Differentiate partition function and thermodynamic properties.
3. Explore Micellar catalysis.
4. Classify the Streaming and Sedimentation potentials.

References:

1. P. W. Atkins, 2002 Physical Chemistry 7 th edition,xford University Press.
2. S. Glasstone and Nostrand D. Van. 1965, Textbook of Physical Chemistry
3. A. K. Chandra. Tata McGraw-Hill 1988 Introductory Quantum Chemistry
4. W. Kauzmann Quantum Chemistry, Academic Press.
5. Gurdeep Raj Advanced Physical Chemistry, Goel Publishing House
6. S. Glasstone, D. Van Nostrand 1965 Electrochemistry,

Credits 2	M.Sc. I Drug Chemistry Semester II Discipline Specific Elective (DSE) Elective Paper Title: Advanced Analytical Techniques (MDCT-424 E-II)	Contac t Hours 30

Course objectives: Students should be able to…

1. Understand the concepts of preparative HPLC.
2. Learn different techniques of chromatography.
3. Study the capillary electrophoresis.
4. Classify the instrumentation of mass spectrometry.

Unit I	**High-Performance Liquid Chromatography**	**8**
	1.1. Principle, instrumentation, pharmaceutical applications, 1.2. Peak shapes, capacity factor, selectivity, plate number, plate height, resolution, band broadening, pumps, injector, detectors, columns, column problems, gradient HPLC, 1.3. HPLC solvents, troubleshooting, sample preparation, method development, 1.4. New developments in HPLC-role and principles of ultra, nano liquid chromatography in pharmaceutical analysis. Immobilized polysaccharide 1.5. CSP‟s: Advancement in enantiomeric separations, revised phase chiral method development and HILIC approaches. 1.6. HPLC in Chiral analysis of pharmaceuticals. 1.7. Preparative HPLC, practical aspects of preparative HPLC.	
Unit II	**Bio-Chromatography**	**07**
	2.1. Size exclusion chromatography 2.2. Ion-exchange chromatography 2.3. Ion pair chromatography 2.4. Affinity chromatography general principles, stationary phases, and mobile phases. 2.5. Gas chromatography: Principles, instrumentation, derivatization, headspace sampling, columns for GC, detectors, quantification.	
Unit III	**Super Critical Fluid Chromatography**	**07**
	3.1. Supercritical fluid chromatography: Principles, instrumentation, pharmaceutical applications. 3.2. Capillary electrophoresis: Overview of CE in pharmaceutical analysis, basic configuration, CE characteristics, principles of CE, methods and modes of CE. 3.3. General considerations and method development in CE, Crown ethers as buffer additives in capillary electrophoresis. CE-MS hyphenation.	
Unit IV	**Mass Spectrometry**	**08**
	4.1 Mass spectrometry: Principle, theory, instrumentation of mass spectrometry. 4.2 Different types of ionization like electron impact,chemical,	

	field, FAB and MALD, APCI, ESI, APPI mass fragmentation and its rules, metastable ions, isotopic peaks and applications of mass spectrometry. 4.3 LC-MS hyphenation and DART MS analysis. 4.4 Mass analyzers (Quadrupole, Time of flight, FT-ICR, ion trap and Orbitrap) instruments.	

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

1. Explain the principle of HPLC.
2. Acquire the knowledge about chromatography.
3. Discovered method development in CE.
4. Predict the application of mass spectrometry.

References:

1. Robert M. Silverstein; 2005, Spectrometric identification of organic compounds; 6th edition John Wiley & sons, Inc.
2. Jag Mohan; 2004, Organic spectroscopy principles & applications 2nd edn, Norosa publishing houses,
3. P.S. Kalsi; 2004, Spectroscopy of organic compounds; 5th Edn, New age international Publishers
4. William Kemp; 2004, Organic Spectroscopy, 3rd edition, Palgrave.
5. Donald L. Pavia; Garry M. Lampman; George S. Kirz: 2004, Introduction to spectroscopy, 3rd edition, Harcourt College Publishers.

Credits 4	**M.Sc. Drug Chemistry** **Semester II** **MDCT-425: Research Project (RP)**	**Contact Hours 60**

1. Working hours are same as practical of project length should be sufficient.

2. 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.

3. 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).

4. It is open type of examination.

Credits 2	M.Sc. I Drug Chemistry Semester II MDCP-426: Lab III	Contact Hours 60
	Part A	
	1. To study Gram nature of bacterial cells in given suspensions. 2. To observe morphology of given bacterial by negative staining method. 3. To prepare a smear of given bacterial suspension and observe the morphology of bacterial cell by monochrome staining method. 4. To observe antibiotic activity of given antibiotics. (any 4) 5. Preparation of antifungal ointment. 6. Preparation of antifungal cream. 7. Synthesis of quinolene 8. Synthesis of 1,3 pyrazole 9. Synthesis of 2,3 biphenyl qunoxiline 10. Synthesis 1,3 Azoles	
	Part B	
	1. Organic qualitative analysis of a ternary mixture (Any 4) 2. Two-stage preparation of benzylic acid. 3. Synthesis of Ag (silver) NPs and its potential application towards reduction of 4-nitrophenol 4. Synthesis of 1,2,3,4-Tetrahydrocarbazole 5. Preparation of Cyclohexanone oxime from Cyclohexanone 6. Preparation of Caprolactam from Oxime by Beckmann Rearrangement. 7. Preparation of Pyridinium chlorochromate (PCC): 8. Preparation of Benzaldehyde from Benzyl alcohol using PCC. 9. Synthesis of 4-nitrotriphenylamine (NTPA). 10. Base catalyzed aldol condensation using $LiOH.H_2O$ as a Catalyst. 11. Bromination of trans-stilbene using sodium bromide and sodium bromate. 12. Benzil-benzilic acid rearrangement under solvent-free condition 13. Solid-state synthesis of 7-hydroxy-4-methyl coumarin. 14. Bromination of acetanilide using ceric ammonium nitrate in aqueous medium. 15. Green approach for preparation of benzopinacolone from bezopinacol.	
References:		
1. Loudon, Gregory M., and Josephine I. Davies. 2016 Organic Chemistry Principles		

and Mechanisms. 2nd ed. W.H. Freeman and Company.
2. Zubrick, James W. 2019, The Organic Chem lab survival Manual: a Students Guides to Techniques.10th ed. Wiley.
3. Wade, Leroy G. 2017, Organic Chemistry a Laboratory Manual. 8th ed. Pearson.
4. Noble, David R., and Michael B. Smith. 2014, Organic Chemistry a Laboratory Manual 3rd ed. University Science Books.
5. Harris, Daniel C. 2016, Quantitative Chemical Analysis. 9th ed. New York: W.H. Freeman and Company.
6. Benson, Harold J. 2018, Microbiological Applications: Laboratory Manual in General Microbiology. 11th ed. McGraw-Hill Education.
7. Baron, Elliot J., and Patricia A. D. Stalons. Bailey & Scott's, 2020, Diagnostic Microbiology. 14th ed. Elsevier.
8. Murray, Patrick R., Ken S. Rosenthal, and Michael A. Pfaller. 2020, Medical Microbiology. 9th ed. Elsevier.
9. Pommerville, Jeffrey C. Alcamo's, 2019, fundamentals of Microbiology: A Laboratory Manual. 11th ed. Jones & Bartlett Learning.
10. Cappuccino, James G., and Natalie Sherman 2022, Microbiology: A Laboratory Manual. 11th ed. Pearson.

Credits 2	M.Sc. I Drug Chemistry Semester II MDCP-427: Lab IV	Contact Hours 60
	Part A	
	1. Separation and identification of amino acid mixture by 2D paper chromatography. 2. Separation and identification of amino acid mixture by TLC. 3. Preparation of immobilized cells of yeast cells and determination of invertase activity. 4. Study of effect of gel concentration on immobilized enzyme activity. 5. Isolation of cellulase producers from soil. 6. Titration curve of glycine. 7. Determination of the blood group of a given sample 8. To Asses temperature stability of the enzyme. 9. To Asses effect of substrate conc. (Vmax and Km) on enzyme activity 10. To Asses effect of activator/ inhibitor on enzyme activity. 11. Analysis of iron tablet for its iron content calorimetrically by 1-10 phenanthroline method. 12. Synthesis of inorganic compounds (Any 4) i) Calcium gluconate ii) Sodium Benzoate iii) Magnesium hydroxide iv) Boric acid v) Potash Alum vi) Zinc Sulphate	
	Part B	
	1. Determination of critical micellar concentration (CMC) and ΔG of micellization of sodium Lauryl Sulphate / Detergent. 2. To estimate the amount of NH_4Cl colorimetrically using Nesseler's Reagent. 3. Determine the solubility of lead iodide in the presence of varying concentration of salt KCl. 4. Determine the solubility of lead iodide in the presence of varying concentration of salt KNO_3 5. To determine instability constant & stoichiometry of silver ammonia complex potentiometrically. 6. Hydrolysis of NH_4Cl or CH_3COONa or aniline hydrochloride. 7. Study of conductometric titration of a mixture of strong acid (HCl) and weak acid (CH3COOH) against a strong base (NaOH)	

	8. Determination of dissociation constants (Ka) of a dibasic acid (oxalic acid) by pH-metry 9. Study of potentiometric titration of a strong acid (HCl) against a strong base (NaOH) 10. Study of potentiometric titration of ferrous ammonium sulphate (FAS) against potassium dichromate ($K_2Cr_2O_7$)	

References:

1. Mann, F. G., and B. C. Saunders. 1960, Practical Organic Chemistry**.** 4th ed. London: Longmans, Green and Co.
2. Clarke, H. T. A 1956, Handbook of Qualitative Analysis and Quantitive Analysis. 6th ed. London: Edward Arnold.
3. Blatt, A. Organic Synthesis: Collective Volumes. New York: Wiley, various volumes.
4. Kitchener, J. A. 1971, Findlay's Practical Chemistry. 9th ed. London: Macmillan.
5. Vogel, A. I. Textbook of Inorganic Qualitative Analysis. 3rd ed. London: Longmans, Green and Co.
6. Das, R. C., and B. Behera. 2002, Experimental Physical Chemistry**.** 2nd ed. New Delhi: Tata McGraw-Hill.
7. Viswanathan, B., and P. S. Raghavan. 2006, Practical Physical Chemistry. 3rd ed. Chennai: New Age International.
8. Athawale, V. D., and Parul Mathur. 2004, Experimental Physical Chemistry. 1st ed. Mumbai: Himalaya Publishing House.
9. Rajbhoj, S. W., and T. K. Chondhekar. 2008, Systematic Experimental Physical Chemistry**.** 1st ed. Pune: Vidyarthi Prakashan.
10. Palmer, W. G. 1969 Experimental Inorganic Chemistry**.** 2nd ed. London: Chapman and Hall.
11. Schoeller, W. R., and A. R. Powell. 1958 The Analysis of Minerals and ores of the Rarer Elements. London: Charles Griffin and Company Limited.