CENTRAL UNIVERSITY OF PUNJAB

M.Sc. Chemical Sciences

(Medicinal Chemistry)

Batch- 2025-27

Department of Pharmaceutical Sciences and Natural Products

Graduate attributes for M. Sc. Chemical Sciences (Medicinal Chemistry) Research

Graduates will have quality-conscious service providing attribute by adopting the knowledge of spectral analysis and chromatographic techniques in manufacturing and R & D of drugs. They will be able to implement the role of Computer-Aided Drug Design (CADD) in the modern drug discovery & development process and its applicability in higher studies and at the industrial level. They will be able to apply the knowledge of medicinal chemistry for the development of synthetic methodologies, including green chemistry, peptide chemistry, retro-synthesis for making the drugs affordable to the public. They will have the ability to create, select and apply appropriate techniques, resources and modern analytical tools to identify, formulate, and solve problems of medicinal chemistry and will develop attribute to become self-reliant in Active Pharmaceutical Ingredients (APIs) by the development of scale-up of APIs and intermediates, unit operations and industrial safety guidelines. Moreover, the program will help them make their career in academic, research, and industry.

Course Structure

SEMESTER 1

S. No.	Paper Code	Course Title	Course Type	L	T	P	Cr
1.	MCMC.401	Advanced Organic Chemistry-I	DSC	4	0	0	4
2.	MCMC.402	Organic Chemistry-I (Practical)	SEC	0	0	6	3
3.	MCMC.403	Modern Spectral and Chromatography Techniques	DSC	4	0	0	4
4.	MCMC.404	Advanced Medicinal Chemistry-I	DSC	4	0	0	4
5.	XXX	Interdisciplinary Course	IDC	2	0	0	2
6.	MCMC.405	Entrepreneurship Course	EC	2	0	0	2
7.	XXX	Individualized Education Plan/ Tutorial	-	0	0	0	N. Cr
Opt any one course from following electives							
8.	MCMC.406	Chemistry of Natural Products	DSE	3	0	0	3
9.	MCMC.407	Quantum Chemistry					
10.	MCMC.408	Inorganic Chemistry-1					
11.	MCMC.409	Physical Chemistry – I					
		Total		**19**	**0**	**6**	**22**

DSC: Discipline Specific Core Course, **DSE**: Discipline Specific elective course, **SEC**: Skill Enhancement Course
L: Lectures T: Tutorial P: Practical Cr: Credits

MOOC: MOOC may be taken up 40% of the total credit (excluding dissertation credits). MOOC may be taken in lieu of any course but content of that course should match minimum 70%.

SEMESTER II

S. No.	Paper Code	Course Title	Course Type	L	T	P	Cr
1.	MCMC.421	Advanced Organic Chemistry-II	DSC	4	0	0	4
2.	MCMC.516	Organic Chemistry-II (Practical)	SEC	0	0	6	3
3.	MCMC.517	Computer Aided Drug Design	AEC	2	0	0	2
4.	MCMC.518	Advanced Spectral Analysis	DSC	4	0	0	4
5.	XXX	Value Added Course	VAC	2	0	0	2
6.	XXX	Indivisualized Education Plan/ Tutorials	-	2	0	0	N. Cr
Opt any Course from following electives							
7.	MCMC.519	Green Chemistry	DSE	3	0	0	3
8.	MCMC.520	Nuclear Chemistry					
9.	MCMC.521	Advanced Medicinal Chemistry-II					
		Total		**15**	**0**	**6**	**18**

DSC: Discipline Specific Core Course, **DSE**: Discipline Specific elective course, **SEC**: Skill Enhancement Course, **AEC**: Ability Enhancement Courses
L: Lectures T: Tutorial P: Practical Cr: Credits

MOOC: MOOC may be taken up 40% of the total credit (excluding dissertation credits). MOOC may be taken in lieu of any course but content of that course should match minimum 70%.

Multiple Entry/Exit scheme (After Second Semester)

Post-Graduate Diploma will be awarded as per NEP 2020 in multiple entry/exit scheme for students leaving the course after the end of first year (Second Semester) of M.Sc. Chemical Sciences (Medicinal Chemistry) programmes, provided students have to opt any one of the following 4 credit skill-based course.

MOOC Course							
1.	MCMC.526	Analytical Techniques	SB	4	0	0	4
2.	MCMC.527	Introduction to Computer Network and Internet Protocols	SB	4	0	0	4
3.	MCMC.528	Solid and Hazardous Waste Management	SB	4	0	0	4
4.	MCMC.529	Fundamentals of Bioinformatics	SB	4	0	0	4
Training							
5.	MCMC.530	Training at National Labs/Research Institutes/Central Instrumental Laboratory Facility of University/Industry for two months, subject to the submission of report for evaluation	SB	4	0	0	4
Lab rotation							
6.	MCMC.531	Lab rotation of two months within and the other relevant departments of the University.	SB	4	0	0	4
Publication							
7.	MCMC.532	One publication in an International repute journal indexed in Scopus/Web of Science.	SB	4	0	0	4

SEMESTER III

S. No.	Paper Code	Course Title	L	T	P	Cr
1.	MCMC. 599-1	Dissertation/Internship/Apprenticeship	0	0	40	20

SEMESTER IV

S. No.	Paper Code	Course Title	L	T	P	Cr
1.	MCMC. 599-2	Dissertation/Internship/Apprenticeship	0	0	40	20

Examination Pattern

Core, Discipline Elective, Compulsory Foundation,			**Interdisciplinary Course, Value Added, Entrepreneurship, Innovation and skill development Courses**	
	Marks	Evaluation	Marks	Evaluation
Internal Assessment	25	Various methods	-	-
Mid-semester test (MST)	25	Descriptive	50	Descriptive (70%) Objective (30%)
End-semester test (EST)	50	Descriptive (70%) Objective (30%)	50	Descriptive (70%) Objective (30%)

Objective Questions- one-word/sentence answers, fill-in the blanks, MCQs', and matching

Descriptive Questions- Short answer and essay type questions

Internal assessment- any two or more of the given methods: Surprise Tests, open book examination, assignments, term paper, etc.).

Evaluation Criteria for Practical

Item	**Practical Note book and continuous evaluation**	**Synopsis**	**Performance**	**Viva voce**
Marks	40	10	20	30

Evaluation Criteria for Dissertation

Dissertation (Fourth Semester)		
	Marks	Evaluation
Supervisor	50	Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva-voce
External expert, HoD and senior-most faculty of the department	50	Dissertation report (30), presentation (10), final viva-voce (10)

Evaluation pattern similar to fourth semester dissertation will apply for internship where supervisor will award 50% marks and external co-supervisor, HoD and senior-most faculty will award 50% marks.

Semester 1

Course Title: Advanced Organic Chemistry-I

L	T	P	Credits
4	0	0	4

Paper Code: MCMC.401
Course Hours: 60h

Learning Outcomes:

After completing this course, the learner will be able to:

CLO1: Describe and understand basic chemistry of elimination and addition reactions
CLO2: Describe disconnection approaches applied on synthetic strategies and mechanism prediction.
CLO3: Describe nomenclature and synthetic methodologies of heterocyclic systems

Course Contents

Units/Hours	Content	Mapping with course learning outcomes
Unit 1 **15 Hours**	**Basic Aspects of Organic Chemistry**: Organic intermediates: Carbocations, carbanions, free radicals, carbenes and nitrenes. Their method of formation, stability and synthetic applications. Types of reaction mechanisms and methods of determining them, Detailed knowledge regarding the reactions, mechanisms and their relative reactivity and orientations. **Learning activities:** Learner will be engaged in Molecular models to explain the stability of organic intermediates	**CLO1**
Unit 2 **15 Hours**	**Addition reactions** a) Nucleophilic uni- and bimolecular reactions (SN1 and SN2) b) Elimination reactions (E1 & E2; Hoffman & Saytzeff's rule) c) Rearrangement reaction **Learning activities:** Learner will be engaged in Molecular models to explain the stereochemistry in elimination reactions	**CLO1**

Unit 3 **15 Hours**	**Synthetic methodologies:** Synthon, Synthetic equivalent, Functional group interconversion (FGI), Functional group addition, Functional group elimination, Criteria for selection of target, Linear and convergent synthesis, Retrosynthetic analysis and synthesis involving chemoselectivity, Regioselectivity, Reversal of Polarity (Umpolung), Synthesis of cyclic molecules, Strategic bond: Criteria for disconnection of strategic bonds, Importance of the order of events in organic synthesis. One group and two group C-X disconnections in 1,2-, 1,3-, 1,4 & 1,5- difunctional compounds, One group C-C disconnections, alcohol and carbonyl compounds, regioselectiviity, alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis, Two group C-C disconnections, Diels-Alder reaction, 1,3-difunctionalised compounds, Control in carbonyl condensation, 1,5-difunctionalised compounds. **Learning activities:** Learner will be engaged in Group discussion to explain disconnection approaches in synthesis	**CLO2**
Unit 4 **15 Hours**	**Heterocyclic chemistry:** Replacement and systematic nomenclature (Hantzsch-Widman system) for monocyclic, fused and bridged heterocycles, Aromatic heterocycle, Non-aromatic heterocycle: Bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of six-membered heterocycles and their synthesis (a) Three-membered and four-membered heterocycles: synthesis and reactions of aziridines, oxiranes, thiranes, azetidines, oxetanes and thietanes. (b) Five membered heterocycles containing two heteroatoms (S,N,O): Diazoles, imidazole, pyrazole,oxazoles and thiazoles.	**CLO3**

	(c) Benzo-fused five-membered and six membered heterocycles: Synthesis and reactions of indoles, benzofurans and benzimidazoles, benzothiazoles. (d)Six-membered heterocycles with heteroatom: Synthesis and reactions of pyrylium salts and pyrones, coumarins, chromones, pyridine, pyrimidine, *etc*. **Learning activities:** Learner will be engaged in using ball and stick models and web mediated activity to explain heterocyclic Chemistry	

Suggested Readings:

1. Clayden, J., Greeves, N., Warren, S., Wothers, P. (2012). *Organic chemistry Organic Chemistry* Oxford press.
2. Finar, I.L., (2012). *Organic Chemistry Vol. 1*, Pearson Education, UK.
3. Mc Murry J., (2015). *Organic Chemistry*, Asian Book Pvt. Ltd, New Delhi
4. Smith, M. B. (2013). *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*. John Wiley & Sons.
5. Ahluwalia, V. K., and Parasar R. K., (2011). *Organic Reaction Mechanism***,**Narosa Publishing House (P) Ltd., New Delhi-110002.
6. Bansal, R. K., (2010). *A text book of Organic Chemistry*, New Age Inrternational (P) Ltd., New Delhi.
7. Bansal R.K., (2010). *Organic Reaction Mechanism*, New Age International (P) Ltd., New Delhi.
8. Kalsi, P.S., (2010). *Organic Reactions and Their Mechanisms*. New Age International Pub., New Delhi.
9. Kalsi, P.S., (2010). *Stereochemistry: Conformation and Mechanism*, New Age International (p) Ltd. New Delhi.
10. Morrison, R.T., Boyd, R.N. (2011). *Organic Chemistry*, Prentice- Hall of India, New Delhi.
11. Mukherjee, S.M. Singh, S.P., (2009). *Reaction Mechanism in Organic Chemistry.* Macmillan India Ltd., New Delhi.
12. Eliel, E. L., & Wilen, S. H. (2008). *Stereochemistry of organic compounds*. John Wiley & Sons.
13. Carey, F. A., Guiliano, R. M. (2012). *Organic Chemistry.* McGraw Hill.
14. Kofie, W., Caddick, S. (2016). *Problems in Advanced Organic Chemistry*. Auris Publishing.
15. Solomons, T. W. G., Fryhle, C. B., Snyder, S. A. (2017). *Solomons' Organic Chemistry*. John Willey & Sons.
16. Acheson, R.M. (1976). *An Introduction to the Chemistry of Heterocyclic Compounds*, Wiley India Pvt. Ltd.

17. Gupta R.R., Kumar M., Gupta V. (2010). *Heterocyclic Chemistry-II Five Membered Heterocycles Vol. 1-3*, Springer Verlag, India.
18. Warren, S., (2010). *Organic Synthesis: The Synthon Approach*. John Wiley & Sons, New York,
19. Warren, S., (2010). *Designing Organic Synthesis: A Disconnection Approach*. John Wiley & Sons, New York.

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Team teaching
- Tutorial
- Self-learning

Transaction Mode

- PPT
- YouTube
- Google drive
- Google meet

Course Title: Organic Chemistry –I (Practical)

L	T	P	Credits
0	0	6	3

Paper Code: MCMC.402
Course Hours: 90h

Learning Outcomes:
After completing this course, the learner will be able to:

CLO1: Interpret stereochemistry of organic compounds
CLO2: Explain the handling, storage and disposal of hazardous chemicals and their Material safety data sheets (MSDS)
CLO3: Monitor the progress of chemical reactions by thin layer chromatography
CLO4: Purify a given organic compound through crystallization, fractional distillation or column chromatography

Course Content

Practical	**Content/Title**	**Mapping with course learning outcome**
1.	Awareness to various glassware and plasticwares used in the organic synthesis.	**CLO1**
2.	Demonstration of Stereochemical aspects of the compounds through molecular models	**CLO1**
3.	Awareness to handling, storage and disposal of hazardous chemicals and their Material safety data sheets (MSDS)	**CLO2**
4.	Thin layer chromatography: Monitoring the progress of chemical reactions, identification of unknown organic compounds by comparing the R_f values of known standards, preparative TLC for separation of mixtures	**CLO3**
5.	Purification of a given organic compound through crystallization, fractional distillation or column chromatography	**CLO4**
6.	**Organic Synthesis:** Single or multi- steps synthesis of organic compounds. Aspects such as conversion, yield, selectivity, effluent treatment, atom economy, etc. should be paid attention. TLC should be used to monitor the reaction. (attempt any five) a) Synthesis of an anticancer stilbene via Wittig reaction b) Synthesis of chalcones via Claisen-Schmidt condensation. c) Preparation of vanillyl alcohol from vanillin	**CLO4**

	d) Reduction of 3-nitroacetophone using $NaBH_4/LiAlH_4$ e) Preparation of bromohydrin from methylstyrene f) Preparation of aniline from nitrobenzene g) Synthesis of ethyl *N*-butyl acetoacetate by A.E.E. condensation h) Cannizzaro reaction: 4-chlorobenzaldehyde as substrate. i) Preparation of Iodoxybenzoic acid (IBX) and its application in oxidation. j) Preparation of pyridine chlorochromate (PCC) and its application in oxidation. k) Multistep synthesis of phenytoin.	

Suggested Readings:

1. Adams, R., Johnson, J.R., Wilcox, C.F. (1970). *Laboratory Experiments in Organic Chemistry*, The Macmillan Limited, London.
2. Mann, F. G. (2009). *Practical Organic Chemistry*. Pearson Education India.
3. Pasto, D.P., Johnson, C., Miller, M. (2010). *Experiments and Techniques in Organic Chemistry*, Prentice Hall.
4. Roberts, R.M., Gilbert, J.C., Rodewald, L.B., Wingrove, A.S. (1969). *An Introduction to Modern Experimental Organic Chemistry*, Ranehart and Winston Inc., New York.
5. Vogel, A.I. (latest edition). *Text Book of Practical Organic Chemistry*, Pearson
6. Williamson, K.L., Health, D.C. (1999). *Macroscale and Microscale Organic Experiments*, *Heath,* D. C & Co., Lexington, MA.
7. Armarego, W. L., & Chai, C. (2012). *Purification of Laboratory Chemicals*. Butterworth-Heinemann.
8. Young, J. A. (Ed.). (1991). *Improving Safety in the Cemical Laboratory: a Practical Guide*. Wiley.
9. Zercher, C. A. (2010). *Organic Syntheses*. John Wiley & Sons.
10. Leonard, J., Lygo, B., Procter, G. (2013). *Advanced Practical Organic Chemistry*. CRC Press.

The following are some of the modes of classroom transaction

- Experimentation
- Group discussion
- Demonstration
- Self-learning

Transaction Mode

- PPT
- Google classroom
- Google meet

Course Title: Modern Spectral and Chromatography Techniques

L	T	P	Credits
4	0	0	4

Paper Code: MCMC.403
Course Hours: 60h

Learning Outcomes

After completing this course, the learner will be able to:
CLO1: Conceptualize general principle and theory of UV-Vis and IR and spectroflourimetry
CLO2: Describe the concept and instrumentation of NMR and Mass techniques
CLO3: Separate different constituents of mixture by chromatographic techniques
CLO4: Explain the Principle, thermal transitions and Instrumentation of DSC, DTA and TGA

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit I **15 Hours**	**UV-Visible spectroscopy** Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy, Choice of solvents and solvent effect and Applications of UV-Visible spectroscopy, Difference/ Derivative spectroscopy. **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, Data Interpretation, Theory of NIR. **Spectroflourimetry** Theory of Fluorescence, Factors affecting fluorescence, Quenchers, Applications of fluorescence spectrophotometer, Instrumentation **Learning activities:** Learner will be provided hands on training to different instruments like UV, IR and spectroflourimetry.	**CLO1**
Unit 2 **15 Hours**	**NMR spectroscopy** Quantum numbers and their role in NMR, Principle, Instrumentation, Solvent requirement in NMR,	**CLO2**

	Relaxation process, NMR signals in various compounds, Chemical shift, Factors influencing chemical shift, Spin-Spin coupling, Coupling constant, Nuclear magnetic double resonance, Brief outline of principles of FT-NMR and ^{13}C NMR, Applications of NMR spectroscopy **Mass Spectroscopy** • Principle, Theory, Instrumentation of Mass Spectroscopy, Different types of ionization like electron impact, chemical, field, FAB and MALDI, APCI, ESI, APPI Analyzers of Quadrupole and Time of Flight, Mass fragmentation and its rules, Meta stable ions, Isotopic peaks and Applications of Mass spectroscopy. **Learning activities:** Learner will be provided NMR and mass spectra for the characterization of compounds.	
Unit 3 **15 Hours**	**Chromatography** Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution, isolation of drug from excipients, data interpretation and applications of the following: Thin Layer chromatography, High Performance Thin Layer Chromatography, Ion exchange chromatography, Column chromatography, Gas chromatography, High Performance Liquid chromatography, Ultra High-Performance Liquid chromatography, Affinity chromatography, Gel Chromatography **Learning activities:** Learner will be provided experience of chromatography by using different techniques like TLC, Column, HPLC, HPTLC and GC.	**CLO3**
Unit 4 **15 Hours**	**Thermal Techniques** Principle, thermal transitions and Instrumentation (Heat flux and power-compensation and designs), Modulated DSC, Hyper DSC, experimental parameters (sample preparation, experimental conditions, calibration, heating and cooling rates, resolution, source of errors) and their influence, advantage and disadvantages, pharmaceutical applications. Differential Thermal Analysis (DTA):	**CLO4**

	Principle, instrumentation and advantage and disadvantages, pharmaceutical applications, derivative differential thermal analysis (DDTA). TGA: Principle, instrumentation, factors affecting results, advantage and disadvantages, pharmaceutical applications **Learning activities:** Learner will be provided Web based learning to explain thermal techniques	

Suggested readings

1. Silverstein, R. M., Webster, F. X., Kiemle, D. J., & Bryce, D. L. (2014). *Spectrometric Identification of Organic Compounds.* John Wiley & Sons.
2. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). Principles of Instrumental Analysis. Singapore: Cengage Learning Asia Pte Ltd.
3. Willard, H. H. (2012). Instrumental methods of analysis. New Delhi: CBS.
4. Beckett, A. H., & Stenlake, J. B. (Eds.). (1988). *Practical Pharmaceutical Chemistry: Part II*, A&C Black.
5. Kemp, W. (1991). *Organic Spectroscopy* (pp. 42-51). London: Macmillan.
6. Sethi, P. D. (1985). *Quantitative Analysis of Drugs in Pharmaceutical Formulations*. Unique Publishers.
7. Munson, J. W. (Ed.). (1984*). Pharmaceutical Analysis: Modern Methods* (Vol. 11). CRC Press.
8. Kalsi, P. S. (2007). *Spectroscopy of Organic Compounds*. New Age International.
9. Connors, K. A. (2007). *A Textbook of Pharmaceutical Analysis*. John Wiley & Sons.
10. McHale, J. L. (2017). *Molecular Spectroscopy*. CRC Press.
11. Kromidas, S. (2017). *The HPLC Expert Possibilities and Limitations of Modern High Performance Liquid Chromatography*. John Wiley and Sons.

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Tutorial
- Self-learning

Transaction Mode

- PPT
- YouTube
- Google drive
- Google mee

Course Title: Advanced Medicinal Chemistry-I
Paper Code: MCMC.404
Course Hours: 60h

L	T	P	Credits
4	0	0	4

Learning Outcomes

After completing this course, the learner will be able to:

CLO1: Interpret basics concepts of drugs, their effects and screening.

CLO2: Describe drugs interaction with various types of enzymes and receptors

CLO3: Conceptualize the process of drug discovery and its progress

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 **15 Hours**	**History of drug discovery** Introduction, Drug discoveries, Recent trends in drug discovery, Enzymes as drug targets, Membrane transporters as drug targets, Voltage-gated ion channels as drug targets **Learning activities:** Learner will be engaged in group discussion to explain history of drug discovery	**CLO1**
Unit 2 **15 Hours**	**Drug discovery:** Stages of drug discovery, lead discovery; identification, validation and diversity of drug targets **Biological drug targets** Receptors, types, binding and activation, theories of drug receptor interaction, drug receptor interactions, agonist vs antagonists, artificial enzymes. **Measurement and expression of drug effects** Introduction, *In-vitro* experiments, *Ex-vivo* experiments, *In-vivo* experiments. **Learning activities:** Learner will be explained about drug interaction and target through molecular modeling studies	**CLO2**
Unit 3 **15 Hours**	**Prodrug Design and Analog design** **Prodrug design**	**CLO3**

	Basic concept, Carrier linked prodrugs/ Bioprecursors, Prodrugs of functional group, Prodrugs to improve patient acceptability, Drug solubility, Drug absorption and distribution, site specific drug delivery and sustained drug action. Rationale of prodrug design and practical consideration of prodrug design. **Combating drug resistance** Causes for drug resistance, strategies to combat drug resistance in antibiotics and anticancer therapy, Genetic principles of drug resistance. **Analog Design** Introduction, Classical & Non classical, Bioisosteric replacement strategies, rigid analogs, alteration of chain branching, changes in ring size, ring position isomers, design of stereo isomers and geometric isomers, fragments of a lead molecule, variation in inter atomic distance. **Learning activities:** Learner will be engaged in Web based training to familiarize with prodrug and analog design	
Unit 4 **15 Hours**	Medicinal chemistry aspects of the following class of drugs, Systematic study, SAR, Mechanism of action and synthesis of new generation molecules of following class of drugs: a). Anti-hypertensive drugs, Psychoactive drugs, H1 & H2 receptor antagonist, COX1 & COX2 inhibitors, Antineoplastic and Antiviral agents. b). Stereochemistry and Drug action: Realization that stereo selectivity is a pre-requisite for evolution. Role of chirality in selective and specific therapeutic agents. Case studies, enantioselectivity in drug adsorption, metabolism, distribution and elimination. **Learning activities:** Learner will be engaged in Group discussion to explain SAR, Mechanism of action and synthesis of drugs	**CLO3**

Suggested Readings:

1. Foye, W. C. (2019). *Principles of Medicinal Chemistry*, Publisher: Wolters Kluwer.
2. King, F. D. (2006). *Medicinal Chemistry Principles and Practice*, Royal Society of Chemistry.
3. Nogardy, T. and Weaver D F (2005). *Medicinal Chemistry: A Molecular and Biochemical Approach*, Oxford University Press.
4. Patrick, G.L. (2017). *An Introduction to Medicinal Chemistry*, Publisher: Oxford university Press, UK.
5. Singh, H., Kapoor, V.K. (1996). *Medicinal and Pharmaceutical Chemistry* Vallabh Prakashan, Delhi.
6. Smith, H.J. (2006). *Introduction to the Principles of Drug Design and Action*, Taylor and Francis.
7. Wermuth, C.G. (2009). *The Practice of Medicinal Chemistry*, Academic Press (Elsevier).
8. Wolff, M E, Ed., (Latest Edition). *Burger's Medicinal Chemistry and Drug Discovery* John Wiley and Sons, New York.
9. Ferrant, E., (2011). *New Synthetic Technologies In Medicinal Chemistry*. Royal Chemical Society.
10. Medicinal Chemistry by Burger, Vol I –VI.
11. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, 12th Edition, (2004). Lppincott Williams & Wilkins, Woltess Kluwer (India) Pvt. Ltd, New Delhi.
12. Comprehensive Medicinal Chemistry – Corwin and Hansch.
13. Computational and structural approaches to drug design edited by Robert M Stroud and Janet. F Moore

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Team teaching

Transaction Mode

- Molecular Models
- PPT
- YouTube
- Software for *In silico* study
- Google meet

Course Title: Entrepreneurship Course

L	T	P	Credits
2	0	0	2

Paper Code: MCMC. 405
Course Hours: 30h

Learning Outcomes: After completing this course, the learner will be able to:

CLO1: Understand the basic concepts of skill entrepreneur, entrepreneurship and its importance.

CLO2: Aware of the issues, challenges and opportunities in skill entrepreneurship.

CLO3: Develop capabilities of preparing proposals for starting small Pharmaceutical businesses.

CLO4: Know the availability of various institutional supports for making a new start-up for Drug Discovery.

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 **6 Hours**	Introduction to entrepreneur and entrepreneurship; Characteristics of an entrepreneur; Characteristics of entrepreneurship; entrepreneurial traits and skills; innovation and entrepreneurship; Types of entrepreneurial ventures; enterprise and society in Indian context; Importance of women entrepreneurship **Learning activities:** Learner will be engaged in Group discussion to explain the concept of entrepreneurship	**CLO1**
Unit 2 **8 Hours**	Promotion of a venture – Why to start a small business; How to start a small business; opportunity analysis, external environmental analysis, legal requirements for establishing a new unit, raising of funds, and establishing the venture - Project report preparation – format for a preliminary project report, format for a detailed/final project report.	**CLO2**

	Learning activities: Learner will interact with Entrepreneurs to understand how to start small business	
Unit 3 **10 Hours**	Launching and Organising an Enterprise in Medicinal and Process Chemistry: Environment scanning – Information, sources, schemes of assistance, problems. Enterprise selection, market assessment, enterprise feasibility study, Resource mobilisation - finance, technology, raw material, site and manpower. Costing and marketing management and quality control. Feedback, monitoring and evaluation. **Learning activities:** Learner will be engaged in Group discussion to explain about resource mobilization, costing and marketing management	**CLO1, CLO2**
Unit 4 **6 Hours**	Introduction to Intellectual Property Rights: Importance of IPR, Patentable and non-patentable, Trade Secrets, Know-how agreements, Types of inventions protected by a patent, Need for a patent, Preparing Project Proposal to Start On New Enterprise Project work in Drug Design development – Feasibility report; Planning, resource mobilisation and implementation. **Learning activities:** Learner will be engaged to prepare project proposal to start new enterprise	**CLO3, CLO4**

Suggested Readings:

1. Arora, Renu (2008). *Entrepreneurship and Small Business*, Dhanpat Rai & Sons Publications.
2. Chandra, Prasaaan (2018). *Project Preparation, Appraisal, Implementation*, Tata Mc-Graw Hills.
3. Desai, Vasant (2019). *Management of a Small-Scale Industry*, Himalaya Publishing House.
4. Jain, P. C. (2015). *Handbook of New Entrepreneurs*, Oxford University Press.
5. Srivastava, S. B. (2009). *A Practical Guide to Industrial Entrepreneurs*, Sultan Chand & Sons.
6. Akhauri, M.M.P. (1990): Entrepreneurship for Women in India, NIESBUD, New Delhi.

7. Hisrich, R.D & Brush, C.G. (1996) The Women Entrepreneurs, D.C. Health & Co., Toranto.
8. Hisrich, R.D. and Peters, M.P. (1995): Entrepreneurship – Starting, Developing and Managing a New Enterprise, Richard D., Inwin, INC, USA.
9. Meredith, G.G. etal (1982): Practice of Entrepreneurship, ILO, Geneva.
10. Patel, V.C. (1987): Women Entrepreneurship – Developing New Entrepreneurs, Ahmedabad EDII.
11. Douglas, F.S. etal (2010). The case for entrepreneurship in R&D In the Pharmaceutical industry. Nature Reviews Drug Discovery, 6, 683-689
12. Shorr, R.R.G. (2008). Entrepreneurship in Pharmaceutical and Biological Drug Discovery and Development. In: Madhavan, G., Oakley, B., Kun, L. (eds) Career Development in Bioengineering and Biotechnology. Series in Biomedical Engineering. Springer, New York, NY.

The following are some of the modes of classroom transaction

- Group discussion
- Lecture
- Demonstration
- Team teaching

Transaction Mode

- PPT
- YouTube
- Google drive
- Google meet

Discipline Specific Elective courses

Course Title: Chemistry of Natural Products

L	T	P	Credits
3	0	0	3

Paper Code: MCMC.406
Course Hours: 45h

Learning Outcomes
After completing this course, the learner will be able to:

CLO1: Describe categories, synthesis and biosynthesis of terpenoids
CLO2: Conceptualize the nomenclature, synthesis and structure of alkaloids
CLO3: Explain the occurrence, nomenclature and structural investigation of steroids
CLO4: Describe the isolation, purification and structural investigation of flavonoids

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 **10 Hours**	**Terpenoids and carotenoids:** Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Geraniol, Menthol and β-Carotene **Learning activities:** Learner will be engaged in molecular models to explain the structure and stereochemistry of terpenoids.	**CLO1**
Unit 2 **10 Hours**	**Alkaloids:** Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, stereochemistry, synthesis and biosynthesis of the following: Ephedrine, Nicotine and Morphine **Learning activities:** Learner will be able to explain chemical tests for the identification of plant alkaloids	**CLO2**
Unit3 **10 Hours**	**Steroids:** Occurrence, nomenclature, basic skeleton and stereochemistry, Structure	**CLO3**

	determination and synthesis of cholesterol, partial synthesis of Testosterone and Progesterone, Chemical tests for steroids **Learning activities:** Learner will be engaged in molecular models to explain the structure and stereochemistry of steroids.	
Unit 4 **15 Hours**	**Flavonoids:** Introduction, isolation and purification of flavonoids, General methods of structural determination of flavonoids; Structural elucidation of quercetin **Chemistry of Carbohydrates** Introduction, classification, configuration and conformation, reactions of monosaccharides; oxidation, reduction, osazone formation, chain shortening and chain lengthening, mutarotation, Structure elucidation and chemistry of Glucose **Learning activities:** Learner will be provided spectral data for the identification of above-mentioned natural compounds.	**CLO4**

Suggested Readings

1. Bhat, S.V., Nagasampagi, B.A., Meenakshi, S. (2013). *Natural Product Chemistry & Applications*, Narosa Publishing House, New Delhi.
2. Bhat, S.V., Nagasampagi, B.A., Sivakumar, M. (2005), *Chemistry of Natural Products.* Narosa Publishing House, New Delhi.
3. Brahamchari, G. (2009). *Natural Product: Chemistry, Biochemistry and Pharmacology*. . Narosa Publishing House, New Delhi.
4. Cseke, L.J. (2009). *Natural Products from plants*. CRC Press, Taylor and Francis, US.
5. Dewick, P.M. (2009). *Medicinal Natural Products: A Biosynthetic Approach*. Willey & Sons, UK.
6. Finar, I.L. (2006). *Organic Chemistry: Stereochemistry and the Chemistry of Natural Products.* Dorling Kindersley Pvt. Ltd., India.
7. Peterson, F., Amstutz, R. (2008). *Natural Compounds as drugs.* Birkhauser Verlay.
8. Thomson, R.H. (2008). *The Chemistry of Natural Products*, Springer.
9. Singh, J., Ali, S. M., Singh, J. (2010) *Natural Products Chemistry*. Pragati Books.
10. Xu, R., Ye, Y., Zhao, W., (2011). *Introduction to Natural Products Chemistry.* CRC Press.
11. Rehman, A., (2015). *Studies in Natural Products Chemistry,* Elsevier Books.

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Tutorial

Transaction Mode

- PPT
- YouTube
- Google meet

Course Title: Quantum Chemistry

L	T	P	Credits
3	0	0	3

Paper Code: MCMC.407
Course Hours: 45 h

Learning Outcomes
After completing this course, the learner will be able to:

CLO1: Describe quantum chemical description of chemical bonding, reactivity and their applications in molecular spectroscopy and inorganic chemistry
CLO2: Explain Electronic and Hamiltonian operators for molecules.
CLO3: Utilize Quantum chemical description of angular momentum and term symbols for a one and many-electron systems.
CLO4: Conceptualize Born-Oppenheimer approximation, the Pauli principle, Hund's rules, Hückel theory and the variation principle

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 **10 Hours**	**Fundamental Background:** Postulates of quantum mechanics, Eigen values and Eigen functions, operators, hermitian and unitary operators, some important theorems. Schrodinger equation-particle in a box (1D, 3D) and its application, potential energy barrier and tunneling effect, one-dimensional harmonic oscillator and rigid rotor, Particle in a Ring, Hydrogen Atom. **Learning activities:** Learner will apply Schrodinger equation for particle in 1D and 3D	**CLO1, CLO2**
Unit 2 **10 Hours**	**Approximate Methods:** Perturbation theory for non-degenerate and degenerate states and its applications, Variation theorem and its application. **Learning activities:** Web based approach will be used to explain perturbation and variation theory	**CLO1**
Unit 3 **10 Hours**	**Angular Momentum:** Ordinary angular momentum, Eigen functions and Eigen values for angular momentum, Addition of angular momenta, Spin, Anti-symmetry and Pauli exclusion principle. **Electronic Structure of Atoms:** Electronic configuration, Russell-Saunders terms and	**CLO3**

	Coupling Schemes, Magnetic Effects: Spin-orbit Coupling and Zeeman Splitting, the self-consistent field method, Hartree-Fock SCF method for molecules. **Learning activities:** Learner will apply Angular momentum and Pauli exclusion principle to solve numerical problems	
Unit 4 **15 Hours**	**Born-Oppenheimer Approximation:** LCAO-MO and VB treatments of the H_2^+ and H_2, Hybridization and valence MOs of H_2O and NH_3. Huckel Theory of acyclic and cyclic conjugated systems, Bond Order and Charge Density Calculations. **Learning activities:** Learner will be engaged in web-based learning to explain Born-Oppenhelmer approximation concept	**CLO4**

Suggested Readings:

1. Levine, I.N. *Quantum Chemistry*, 2016, Pearson Educ., Inc. New Delhi.
2. Chandra, A.K. 1994, *Introductory Quantum Chemistry*, Tata McGraw Hill.
3. Prasad, R.K., 2009, *Quantum Chemistry*, New Age Science.
4. Mc Quarrie, D. A. (2011). *Quantum Chemistry*. Viva Publishers.
5. Murrell, J.N. Kettle S.F.A. and Tedder, J. M. Valence Theory, 1965, John Wiley.
6. Lowe, J. P. and Peterson, K. 2006, *Quantum Chemistry*, Academic Press.

The following are some of the modes of classroom transaction

- Demonstration
- Group discussion
- Lecture
- Self-learning

Transaction Mode

- Google meet
- PPT

Course Title: Inorganic Chemistry - I
Paper Code: MCMC.408
Total Contact Hours: 45 h

L	T	P	Credits
3	0	0	3

Learning Outcome:
On completion of this course the student's will able to:

CLO1: Reaction mechanism, formation constant and stability of the coordination complexes.
CLO2: Interpret the electronic properties.
CLO3: Interpret the magnetic properties.

Course Content

Units/ hours	Content	Mapping with course learning outcome
Unit-1 10 Hours	**Metal-Ligand Equilibria in Solution:** Stepwise and overall formation constant and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of formation constants by spectrophotometry and potentiometric (pH) methods. *Group Discussion among the students on the stability of metal complex formation*	**CLO1**
Unit-2 10 Hours	**Reaction Mechanisms of Transition Metal Complexes:** Introduction, potential energy diagram and reactivity of metal complexes, ligand substitution reactions, labile and inert metal complexes, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, anation reaction, substitution reactions in square planar complexes, trans effect, mechanism of the substitution reaction reactions without metal ligand bond cleavage, electron transfer processes outer and inner sphere. *Demonstration of reactions mechanism of metal complexes.*	**CLO1**

Unit-3 **15 Hours**	**Electronic Absorption spectra of Metal Complexes:** Ligand field theory, nephelauxetic effect, Jahn-Teller effects, spin orbital (LS) coupling, LS and J-J coupling schemes, determination of all the spectroscopic terms of p^n, d^n, f^n ions, determination of total degeneracy of terms, order of interelectronic repulsions and crystal field strength in various fields, spin orbit coupling parameters ( ) energy separation between different j states, the effect of octahedral and tetrahedral fields on S, P, D and F terms. selection rules of electronic transitions, relaxation of the selection rule in centrosymmetric and non-centrosymmetric molecules, Orgel diagrams, Tanabe Sugano diagrams, spectrochemical series, band intensities, factors influencing band widths. *Classroom discussion on interpretation of LS coupling and various energy level diagrams through brainstorming*	**CLO2**
Unit-4 **10 Hours**	**Magnetic properties**: magnetic properties of transition metal complexes, effects of L-S coupling on magnetic properties, quenching of orbital angular momentum by crystal fields in complexes in terms of splitting, temperature independent paramagnetism (TIP). *Hands-on experience of metal complexes for magnetic properties by using Gouy`s Balance.*	**CLO3**

Mode of Transactions: Lecture, Demonstration, Lecture cum demonstration, Problem solving, Brainstorming, Tutorial

Suggested Readings

1. Cotton, F. A., and Wilkinson, G., Murillo, C. A., Bochmann, M.(1999). *Advanced Inorganic Chemistry* (6th Edition). New York: Wiley.
2. Huheey, J. E., Keiter, E. A., Keiter, R. L., andMedhi, O. K. (2006). *Inorganic Chemistry: Principles of Structure and Reactivity*. Pearson Education India.
3. Greenwood, N. N., and Earnshaw, A. (2012). *Chemistry of the Elements*. Elsevier.
4. Miessler, G. L. and Tarr, D. A. (2011) *Inorganic Chemistry*, Pearson Education.
5. Atkins, P. (2010). *Shriver and Atkins' Inorganic Chemistry*. Oxford University Press, USA.

6. Dutta, R. L., and Syamal, A. (1993). *Elements of Magnetochemistry*. Affiliated East- West Press.
7. Drago, R. S. (1992) *Physical Methods for Chemists*. Saunders College Publishing.
8. Lee, J. D. Concise Inorganic Chemistry: Fifth Edition (2012). Elsevier.
9. Kent, B. Inorganic Chemistry: Reactions, Structures and Mechanisms (12 June 2019), NY Research Press.
10. Close, D. Principles of Inorganic Chemistry (19 June 2019), Larsen and Keller Education

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Team teaching

Transaction Mode

- PPT
- Google meet
- YouTube

Course Title: Physical Chemistry-I
Paper Code: MCMC. 409
Total Contact Hours: 45

L	T	P	Credits
3	0	0	3

Learning Outcome: After the completion of the course students will be able to:

CLO1: Interpret and solve the Schrodinger equation for various systems, particle in a boundary model, Electronic and Hamiltonian operators for molecules.

CLO2: Explain the quantum chemical description of angular momentum and term symbols for a one and many-electron systems.

CLO3: Relate the Born- Oppenheimer approximation, the Pauli principle, Hund's rules, Hückel theory and the variation principle with the atomic and molecular phenomena.

CLO4: Explain the statistical aspects of system and relate the classical thermodynamics to quantum mechanics.

CLO5: Apprehend and apply partition function in the deduction of thermodynamic properties of chemical systems.

Course Content

Units/ hours	Content	Mapping with CLOs
Unit 1 **11 Hours**	**Fundamental Background:** Review of essential mathematical concepts required for quantum chemistry, Postulates of quantum mechanics, Eigen values and Eigen functions, operators, Schrodinger equation. **Translational, Rotational and Vibrational Motions:** - Free particle and particle in a box and its application, one-dimensional harmonic oscillator and rigid rotor, particle in a ring, particle on a sphere. *Problem solving approach to determine Eigen values and Eigen function using corresponding operator and Schrodinger equation. Brainstorming on defining and solving Schrodinger equation for different systems like particle in a box, rigid rotator, simple harmonic oscillator.*	**CLO1**

Unit 2 **11 Hours**	**Angular Momentum:** Ordinary angular momentum, generalized angular momentum, Eigen functions and Eigen values for angular momentum, Ladder operator, addition of angular momenta, spin, antisymmetry and Pauli exclusion principle, Slatter determinantal wave functions. **Electronic Structure of Atoms:** Electronic configuration, term symbols and spectroscopic states, Russell-Saunders terms and J-J coupling schemes, Magnetic effects: spin-orbit coupling and Zeeman splitting. *Understanding multi-electron atom quantum evaluation through peer discussion and brainstorming sessions.*	**CLO2, CLO3**
Unit 3 **12 Hours**	**Variation Methods:** The variation theorem and its application, linear variation principle. **Born-Oppenheimer Approximation:** LCAO-MO and VB treatments of the H2+ and H2, Shape of molecules, Hybridization and valence MOs of H2O and NH3. Determination of bond angle in sp^3, sp^2 and sp, Huckel Theory of acyclic and cyclic conjugated systems, Bond order and charge density *Application of Variation method and its uses in pi-HMO theory for acyclic and cyclic conjugated organic systems through peer learning. Application of MOT and VBT for H2 and H2+ system through demonstration.*	**CLO4**
Unit 4 **11 Hours**	**Classical Thermodynamics and Phase Transitions: Partial Molar Properties,** Gibbs- Duhem equation, Chemical potential of liquids, Phase transition: Clausius-Clapeyron equation. **Statistical Thermodynamics:** Statistical concepts and examples, Thermodynamic probability and entropy, Partition function, molar partition function, thermodynamic properties in terms of the molecular partition function for monoatomic gases, rotational, translational, vibrational, and electronic partition functions for diatomic molecules, calculation of equilibrium constants in terms of the partition function.	**CLO5**

	Partition function and its correlation to classical thermodynamic evaluation through brainstorming session and peer learning	

Mode of Transactions: Lecture, Demonstration, Presentation, Group Discussion, Lecture cum demonstration, Problem solving, Brainstorming

Suggested Readings

1. Levine, I.N. (2014) *Quantum Chemistry*. 7th ed. Pearson Education Inc.
2. Chandra, A.K. (2017) *Introductory Quantum Chemistry*. 4th ed. Tata Mcgraw-Hill.
3. McQuarrie, D. A. and Simon, J. D. (1998) *Physical Chemistry: A Molecular Approach.* Viva Books.
4. Prasad, R.K., (2009) *Quantum Chemistry*. 4th Ed. New Age Science.
5. Murrell, J.N., Kettle S.F.A. and Tedder, J. M. (1965) *Valence Theory*. John Wiley Publishers.
6. Lowe, J. P. and Peterson, K., (2006).*Quantum Chemistry*. Academic Press.
7. Atkins, P., and Friedman, R. (2011). *Molecular Quantum Mechanics*, 5th edition, Oxford university press.
8. Drennan, C., Taylor, E. V., (2008) https://ocw.mit.edu/courses/chemistry/5-111- principles-of-chemical-science-fall-2008/index.htm
9. Griffin, R. G., Voorhis, T. V. (2007) https://ocw.mit.edu/courses/chemistry/5-111- principles-of-chemical-science-fall-2008/index.htm
10. Atkins, P., De Paula, J. and Keeler, J. (2018) Oxford University Press. *Atkins' Physical Chemistry*, 11th ed.
11. McQuarrie, D. A. and Simon, J. D. (2019) *Physical Chemistry: A Molecular Approach.* Viva Books
12. Silbey, R. J. Alberty, R. A. and Bawendi, M. G. (2004) *Physical Chemistry*. Wiley- Interscience Publication.
13. Engel, T., Reid, P. and Hehre, W. (2012) *Physical Chemistry*. Pearson Education
14. Puri, B.R., Sharma L.R. and Pathania, M.S. (2013) *Principles of Physical Chemistry.* Vishal Publishing Company Nash, L. K. (2012) *Elements of Statistical Thermodynamics. Dover Publication Inc.*
15. Laurendeau*, N. M. (2005) Statistical Thermodynamics: Fundamentals and Applications. Cambridge University Press.*
16. *Hi*ll, T. L. (1986) *An Introduction to Statistical Thermodynamics*. Dover Publications Inc.
17. Yu, T. H. (2020) Teaching Thermodynamics with the Quantum Volume J. Chem. Educ., *97* (3), 736-740 DOI: 10.1021/acs.jchemed.9b00742
18. Nelson, K. A., Bawendi, M. (2008) https://ocw.mit.edu/courses /chemistry/5-60- thermodynamics-kinetics-spring-2008/video-lectures.

19. Bhattacharyya, D. and Dawlaty, J. M. (2019) Teaching Entropy from Phase Space Perspective: Connecting the Statistical and Thermodynamic Views Using a Simple One-Dimensional Model *J. Chem. Educ.,* 96 (10), 2208-2216. DOI: 10.1021/acs.jchemed.9b00134
20. Halpern A. M. and Marzzacco, C. J. (2018) Using the Principles of Classical and Statistical Thermodynamics to Calculate the Melting and Boiling Points, Enthalpies and Entropies of Fusion and Vaporization of Water, and the Freezing Point Depression and Boiling Point Elevation of Ideal and Nonideal Aqueous Solutions*, J. Chem. Educ.,95*(12), 2205-2211. DOI: 10.1021/acs.jchemed.8b00561
21. Halpern A. M. and Marzzacco, C. J. (2018) Constructing the Phase Diagram of a Single-Component System Using Fundamental Principles of Thermodynamics and Statistical Mechanics: A Spreadsheet-Based Learning Experience for Students. *J. Chem. Educ., 95* (12), 2197-2204. DOI: 10.1021/acs.jchemed.8b00560

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Team teaching

Transaction Mode

- PPT
- Google meet
- YouTube

Semester –II

Course Title: Advanced Organic Chemistry-II
Paper Code: MCMC.421
Course Hours: 60h

L	T	P	Credits
4	0	0	4

Learning Outcomes

After completing this course, the learner will be able to:

CLO1: Interpret the stereochemistry, spatial arrangement of atoms/groups and apply it on the course of reactions and mechanism prediction.

CLO2: Explain the chemical reactions in peptides

CLO3: Apply principle of photochemistry in various chemical transformations

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 **15 Hours**	**Stereochemistry:** IUPAC nomenclature of organic molecules, Elements of symmetry, Chirality, Projection formulae [Fly wedge, Fischer, Newman and Saw horse], Configurational and conformational isomerism in acyclic and cyclic compounds; Stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity, racemic mixture and their resolution, Configurational notations of simple molecules, D/L, R/S, *E*/*Z* and *cis*/*trans* configurational notations, Threo and erythro isomers, Methods of resolution, Optical purity, Enantiotopic and diastereotopic atoms, groups and faces, Stereospecific and stereoselective synthesis, Asymmetric synthesis, Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), Chirality due to helical shape, Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus, Conformational analysis of cyclic compounds such as cyclopentane, cyclohexane, cyclohexanone derivatives, decalins, 1,2-; 1,3-, 1,4-disubstituted cyclohexane derivatives and D-Glucose, Effect of conformation on the course of rate of reactions, Effect of	**CLO1**

	conformation on reactivity, Conformation of sugars, strain due to unavoidable crowding. **Learning activities:** Learner will be engaged in Molecular models and online modeling tools to explain the stereochemistry of compounds	
Unit 2 **15 Hours**	**Chemistry of peptides:** a) Coupling reactions in peptide synthesis b) Principles of solid phase peptides synthesis, t-BOC and FMOC protocols, various solid supports and linkers: Activation procedures, peptide and bond formation, deprotection and cleavage from resin, low and high HF cleavage protocols, formation of free peptides and peptide amides, purification and case studies, site-specific chemical modifications of peptides. c) Segment and sequential strategies for solution phase peptide synthesis with any two case studies d) Side reactions in peptide synthesis: Deletion peptides, side reactions initiated by proton abstraction, protonation, over- activation and side reactions of individual amino acids ide reactions in peptide synthesis: Deletion peptides, side reactions initiated by proton abstraction, protonation, over- activation and side reactions of individual amino acids. **Learning activities:** Learner will be engaged in practical's involving coupling, protection/deprotection and coupling reactions for peptide synthesis.	**CLO2**
Unit 3 **15 Hours**	**Photochemistry:** Franck-Condon principle, Jablonski diagram, Singlet and triplet states, Photosensitization, Quantum efficiency, Photochemistry of carbonyl compounds, Norrish type-I and type-II cleavages, Paterno-Buchi reaction, Photoreduction, Di π – methane rearrangement. Photochemistry of aromatic compounds, Photo-Fries reactions of anilides, Photo-Fries rearrangement, Barton reaction Singlet molecular oxygen reactions	**CLO3**

	Learning activities: Learner will be engaged in web-based learning to explain photochemical reactions	
Unit 4 **15 Hours**	**Pericyclic Chemistry:** Main features of pericyclic reactions, Classification of pericyclic reactions, Thermal and photochemical pericyclic reactions. Electrocyclic reactions: Conrotation and disrotation, Electrocyclic closure and opening in 4n and 4n+2 systems. Woodward-Hoffmann selection rules for electrocyclic reactions. Explanation for the mechanism of electrocyclic reactions by (i) symmetry properties of HOMO of open chain partner (ii) Conservation of orbital symmetry and orbital symmetry correlation diagrams and (iii) Huckel-Mobius aromatic and antiaromatic transition state method. Examples of electrocyclic reactions. Cycloaddition reactions: Suprafacial and antarafacial interactions. $\pi^2 + \pi^2$ and $\pi^4 + \pi^2$ cycloadditions. Cycloreversions. Stereochemical aspects in supra-supra, supra-antara, antara-supra and antara-antara $\pi^2 + \pi^2$ and $\pi^4 + \pi^2$ cycloadditions. Diels-Alder reaction. Woodward-Hoffmann Selection rules for cycloaddition reactions. Sigmatropic reactions: [1,j] and [i,j] shifts; Suprafacial and antarafacial shifts; Selection rules for [lj} shifts; Cope and Claisen rearrangements **Learning activities:** Learner will be engaged in web-based learning to explain cycloaddition, electrocyclic and sigmatropic reactions.	**CLO3**

Suggested Readings

1. Morrin Acheson, R. (2008) *An Introduction to the Chemistry of heterocyclic compounds.* Wiley India Pvt. Ltd.
2. Clayden, J., Greeves, N., Warren, S., Wothers, P. (2012). *Organic Chemistry.* Oxford press.
3. Ahluwalia, V. K., and Parasar R. K., (2011). *Organic Reaction Mechanism*, Narosa Publishing House (P) Ltd., India.

4. Bansal, R. K., (2012). *Organic Reaction Mechanism*, New Age International (P) Ltd., New Delhi.
5. Bansal, R. K., (2007). *A Text Book of Organic Chemistry*, New Age International (P) Ltd., New Delhi.
6. Bansal, R.K. (2010). *Heterocyclic Chemistry*, New Age International (P) Ltd., New Delhi.
7. Carey B. F. A., Sundberg R.J., (2007). *Advanced Organic Chemistry Part A and Part B, Springer*.
8. Finar, I. L., (2012). *Organic Chemistry Vol. 1*, Pearson Education, UK.
9. Gilchrist, T.L. (1997). *Heterocyclic Chemistry*, Longman, Prentice Hall, US.
10. Gupta R.R., Kumar M., Gupta V. (2010). *Heterocyclic Chemistry-II Five Membered Heterocycles*, Springer Verlag, India.
11. Joule, J.A., Mills, K. (2010). *Heterocyc1ic Chemistry*, Blackwell Publishers, New York.
12. Kalsi P. S., (2010). *Organic Reactions and Their Mechanisms*, New Age International Publication, New Delhi.
13. Lowry, T. H., Richardson K. S., (1998). *Mechanism and Theory in Organic Chemistry*, Addison-Wesley Longman Inc, US.
14. Morrison, R.T., Boyd R.N., (2011). *Organic Chemistry*, Prentice- Hall of India, New Delhi.
15. Mukherjee S. M., Singh S. P., (2009). *Reaction Mechanism in Organic Chemistry*, Macmillan India Ltd., New Delhi.
16. R. Katritzky, (2010). *Handbook of Heterocyclic Chemistry* Elsevier, UK.
17. Smith, M. B. (2013). *March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure*. John Wiley & Sons.
18. Sykes, P., (1997). *A Guide Book to Mechanism in Organic Chemistry*, Prentice Hall, US.
19. Norman, R.O.C.; Coxon, J.M. (1995). *Principles of Organic Synthesis*, Blackie Academic & Professional.
20. Warren, S., (2010). *Organic Synthesis: The Synthon Approach*. John Wiley & Sons, New York,
21. Warren, S., (2010). *Designing Organic Synthesis: A Disconnection Approach*. John Wiley & Sons, New York.
22. Corey E.J., Cheng Xue-Min, (1989) *The Logic of Chemical Synthesis*, Pubs: John Wiley & Sons,
23. Carey, F. A., Guiliano, R. M. (2012). *Organic Chemistry*. McGraw Hill.
24. Kofie, W., Caddick, S. (2016). *Problems in Advanced Organic Chemistry*. Auris Publishing.
25. Solomons, T. W. G., Fryhle, C. B., Snyder, S. A. (2017). *Solomons' Organic Chemistry*. John Willey & Sons.
26. Fleming (1999). *Pericyclic Reactions***,** Oxford University Press, Oxford.

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Team teaching

Transaction Mode

- PPT
- Google meet
- YouTube

Course Title: Organic Chemistry-II (Practical)

L	T	P	Credits
0	0	6	3

Paper Code: MCMC.516
Course Hours: 90h

Learning Outcomes

After completing this course, the learner will be able to:

CLO1: Differentiate mixture of *ortho* and *para* as well as cis/trans mixture by column chromatography

CLO2: Describe Multi-Step Synthesis of Organic Compounds

CLO3: Identify compounds *via* combined spectral interpretation of ^{1}H, ^{13}C NMR, IR, UV and Mass along with 2-D NMR spectra.

Course content

Practical	**Content/Title**	**Mapping with course learning outcome**
1.	Separation and purification of organic compounds by column chromatography: Separation of mixture of *ortho* and *para* mixture and cis/trans mixture. The column chromatography should be monitored by TLC.	**CLO1**
2.	**Multi-Step Synthesis of Organic Compounds:** The Learning activities should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques. (Any five) a) Synthesis of isoxazole derivatives via 1,3-dipolar cycloaddition. b) Synthesis of pyrazole derivatives from chalcones. c) Synthesis of an antihypertensive drug-propranolol via epoxide ring opening reaction. d) Synthesis of Diltiazem (a calcium channel blocker) via Darzen condensation, a key step in its synthesis. e) Protection and deprotection of alcohols and amines. f) Preparation of Triphenyl Carbinol from Bromobenzene (Grignard's reaction) g) Preparation of allylic alcohols via Baylis-Hillman reaction using DABCO as a catalyst under neat condition and their characterization through various spectroscopic techniques. h) Preparation of homoallyl alcohols via Barbier type reaction under aqueous condition using Indium as a catalyst.	**CLO2**

	i) Suzuki reaction of 3,4-dimethoxy phenyl boronic acid with aryl halides using $Pd(PPh_3)_4$ as a catalyst.	
3.	Exercises on identification of compounds *via* combined spectral interpretation of ^{1}H, ^{13}C NMR, IR, UV and Mass along with 2-D NMR spectra.	**CLO3**

Suggested Readings

1. Adams, R.; Johnson, J.R.; Wilcox, C.F. (1970). *Laboratory Experiments in Organic Chemistry*, The Macmilan Limited, London.
2. Mann and Saunders. (2009). *Practical organic chemistry*, Pearson.
3. Pasto, D.P., Johnson, C., Miller, M. (2010). *Experiments and Techniques in Organic Chemistry*, Prentice Hall.
4. Roberts, R.M.; Gilbert, J.C.; Rodewald, L.B.; Wingrove, A.S. (1969). *An introduction to Modern Experimental Organic Chemistry*, Ranehart and Winston Inc., New York.
5. Vogel, A.I. (Latest edition). (1989). *Text book of practical organic chemistry*, Pearson
6. Williamson, K.L., Health, D.C. (1999). *Macroscale and Microscale Organic Experiments*, *Heath, D. C*and Co.,Lexington, MA.
7. Findeisen, M., (2013). *50 And More Essential NMR Experiments: A Detailed Guide.* John Willey & Sons.

The following are some of the modes of classroom transaction

- Experimentation
- Group discussion
- Demonstration
- Self-learning

Transaction Mode

- PPT
- YouTube
- Google drive
- Google meet

Course Title: Computer Aided Drug Design

L	T	P	Credits
2	0	0	2

Paper Code: MCMC.517
Course Hours: 30h

Learning outcome:
After completing this course, the learner will be able to:

CLO1: Describe the role of CADD in drug discovery
CLO2: Work with molecular modelling software's to design new drug molecules
CLO3: Design and develop new drug like molecules

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 **8 Hours**	**Introduction to Computer Aided Drug Design (CADD)**: History, different techniques and applications. Quantitative Structure Activity Relationships: Basics. History and development of QSAR: Physiochemical parameters and methods to calculate physiochemical parameters: Hammett equation and electronic parameters (sigma), lipoiphilicity effects and parameters (log P, pi-substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physiochemical parameters. Hansch analysis, Free Wilson analysis and relationship between them, Advantages and disadvantages: Deriving 2D-QSAR equations. 3D- QSAR approaches and contour map analysis. Statistical methods used in QSAR analysis and importance of statistical parameters. **Learning activities:** Learner will be engaged in group discussion to explain 2D-QSAR, 3D-QSAR and importance of statistical parameters	**CLO1**
Unit 2 **8 Hours**	**Molecular Modeling and Docking:** a) Molecular and Quantum Mechanics in drug design.	**CLO2**

	b) Energy Minimization Methods: comparison between global minimum conformation and bioactive conformation. c) Molecular docking and drug receptor interactions: rigid docking, flexible docking and extra-precision docking. Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AchE & BchE) **Learning activities:** Learner will be engaged in molecular modeling of compounds	
Unit 3 **7 Hours**	**Molecular Properties and Drug Design:** a) Prediction and analysis of ADMET properties of new molecules and its importance in drug design. b) De novo drug design: Receptor/enzyme-interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design. c) Homology modelling and generation of 3D-structure of protein. **Learning activities:** Learner will study Molecular model to explain interactions between ligand and drug target	**CLO3**
Unit 4 **7 Hours**	**Pharmacophore Mapping and Virtual Screening:** Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophore's modelling; Conformational search used in pharmacophore mapping. In-silico Drug Design and Virtual Screening Techniques. Similarity based methods and Pharmacophore based screening, structure based In-silico virtual screening protocols. **Learning activities:** Learner will be engaged in Pharmacophore band structure based *In-silico* virtual screening protocols	**CLO2, CLO3**

Suggested Readings

1. Ellis, G.P., West, G. B. (1983). *Progress in Medicinal Chemistry Series*. Elsevier Science.

2. Foye, W.O., Lemke, T. L., Williams, D. A. (2019). *Principles of Medicinal Chemistry*, Indian Ed. Waverly, Pvt. Ltd. New Delhi.
3. Ganellin, C.R.; Roberts S. M., (1993). *Medicinal Chemistry: The Role of Organic Chemistry in Drug Research*. Publisher: Academics Press Inc.
4. Kadam, Mahadik, Bothara (2010). *Principle of Medicinal Chemistry (Volume I & II)*, Nirali publication
5. Kulkarni, V. M., Bothra, K.G., (2008). *Drug Design*, Nirali Publication.
6. Lawton, G., Witty, D.R. (2011). *Progress in Medicinal Chemistry Series. Volume 50*.
7. Lednicer D., Laster A. M. (1998). *The Organic Chemistry of Drug Synthesis(3 Volumes)* John Wiley & Sons.
8. Lednicer, D. (2008). *Strategies for Organic Drug Synthesis and Design. (7 volume)* Publisher: John Wiley & Sons.
9. Lemke, T.L., Williams, D.A. (2012). *Foye's Principles of Medicinal Chemistry*.
10. Silverman R.B., (2014). *Organic Chemistry of Drug Design and Drug Action*, Publisher: Elsevier.
11. Wilson, C.O.; Block, J.H.; Gisvold, O.; Beale,J. M. Wilson and Gisvold's (2003) *Textbook of Organic Medicinal and Pharmaceutical Chemistry*. Lippincott Willaiams & Wikins.
12. Gore, M., & Jagtap, U. (2018). *Computational Drug Discovery and Design*. Springer Publishers.

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Team teaching
- Tutorial
- Self-learning

Transaction Mode

- PPT
- YouTube
- Molecular modeling software
- Google drive
- Google meet

Course Title: Advanced Spectral Analysis
Paper Code: MCMC.518
Course Hours: 60h

L	T	P	Credits
4	0	0	4

Learning outcome:
After completing this course, the learner will be able to:

CLO1: Describe the applications of UV, IR and Raman spectroscopy
CLO2: Explain the 1D and 2D NMR analysis of different compounds
CLO3: Conceptualize the different rules of mass fragmentation
CLO4: Describe chromatographic techniques for separation and quantification of drugs

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 **15 Hours**	**UV and IR spectroscopy:** Wood ward – Fisher rule for 1,3- butadienes, cyclic dienes and carbonyl compounds and interpretation compounds of enones. **Infrared spectroscopy**: IR Interpretation of organic compounds, NIR Applications. **Raman Spectroscopy:** Introduction, Principle, Instrumentation and Applications. • Learner will calculate λmax for conjugated diene and enone derivatives	**CLO1**
Unit 2 **15 Hours**	**NMR spectroscopy:** 1-D and 2-D NMR, NOESY and COSY, HECTOR, INADEQUATE techniques, Interpretation of organic compounds. **Learning activities:** Learner will be provided spectra for the identification of compounds	**CLO2**
Unit 3 **15 Hours**	**a. Mass Spectroscopy:** Mass fragmentation and its rules, Fragmentation of important functional groups like alcohols, amines, carbonyl groups and alkanes, Meta stable ions, Mc Lafferty rearrangement, Ring rule, Isotopic peaks, Interpretation of organic compounds.	**CLO1, CLO2, CLO3**

	b. Spectral Characterization of the following compounds by spectroscopic techniques: UV, IR, MS, NMR (1H, 13C) a) Carvone, Citral, Menthol b) Luteolin, Kaempferol c) Nicotine, Caffeine d) Glycyrrhizin **Learning activities:** Students will develop advanced skills in data interpretation and problem-solving through the rigorous analysis of spectral data acquired from UV, IR, MS, and NMR experiments conducted on natural products.	
Unit 4 **15 Hours**	**Chromatography:** Principle, Instrumentation and Applications of the following: a) GC-MS b) GC-AAS c) LC-MS d) LC-FTIR e) LC-NMR f) CE-MS g) High Performance Thin Layer chromatography h) Super critical fluid chromatography i) Ion Chromatography j) I-EC (Ion-Exclusion Chromatography) k) Flash chromatography **Learning activities:** Learner will be engaged in Learning experience of chromatography by using different techniques like TLC, Column, HPLC, HPTLC and GC	**CLO4**

Suggested Readings:

1. Silverstein, R. M., Webster, F. X., Kiemle, D. J., & Bryce, D. L. (2014). *Spectrometric Identification of Organic Compounds*. John wiley & sons.
2. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). *Principles of Instrumental Analysis*. Cengage learning.
3. Willard, H. H., Merritt Jr, L. L., Dean, J. A., & Settle Jr, F. A. (1988). *Instrumental Methods and Analysis*.
4. Kemp, W. (1991). *Organic Spectroscopy* (pp. 42-51). London: Macmillan.
5. Sethi, P. D. (1996). *HPTLC: High Performance Thin-layer Chromatography; Quantitative Analysis of Pharmaceutical Formulations*. CBS Publishers & Distributors.
6. Sethi, P. D. (1985). *Quantitative Analysis of Drugs in Pharmaceutical Formulations*. CBS Publishers, New Delhi, 1997.
7. Munson, J. W. (Ed.). (1984). *Pharmaceutical Analysis: Modern Methods* (Vol. 11). CRC Press.
8. Findeisen, M., (2013). *50 And More Essential Nmr Experiments: A Detailed Guide*. John Willey & Sons.
9. Kromidas, S. (2017). *The Hplc Expert Possibilities and Limitations of Modern High Performance Liquid Chromatography*. John Wiley and Sons

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Problem solving

Transaction Mode

- PPT
- YouTube
- Google meet

Discipline Specific Elective Course

Course Title: Green Chemistry
Paper Code: MCMC.519
Course Hours: 45h

L	T	P	Credits
3	0	0	3

Learning outcome

After completing this course, the learner will be able to:

CLO1: Describe various aspects of green chemistry for sustainable development
CLO2: Utilize ionic liquids and solid supported reaction conditions to reduce or eliminate use of volatile organic solvents
CLO3: Utilize MW and sonicator in organic synthesis
CLO4: Solid state and aqueous reactions

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 **12 Hours**	**Introduction to green chemistry**: History, need and goals. Green chemistry and sustainability, dimensions of sustainability, limitations/obstacles in pursuit of the goals of green chemistry. Opportunities for the next generation of materials designers to create a safer future. Basic principles of green chemistry: Atom economy and scope, Prevention/Minimization of hazardous/toxic products, designing safer chemicals, Selection of appropriate auxiliary substances (solvents, separation agents etc.), use of renewable starting materials, Avoidance of unnecessary derivatization-careful use of blocking/protection groups. Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents, designing biodegradable products, Prevention of chemical accidents, Strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes. **Learning activities:** Learner will be engaged in Group discussion to explain Green Chemistry Principles	**CLO1**

Unit 2 **12 Hours**	**Approaches to green synthesis:** Basic principles of green synthesis. Different approaches to green synthesis, Use of green reagents in green synthesis: polymer supported reagents, polymer supported peptide coupling reagents. Green catalysts, Phase-transfer catalysts in green synthesis. Advantages of PTC, Reactions to green synthesis, Application of PTCs in C-alkylation, N-alkylation, S-alkylation. Darzens reaction, Williamson's synthesis, Wittig reaction, Click Chemistry. Use of Crown ethers in esterification, saponification, anhydride formation, aromatic substitution and elimination reactions. Water and ionic liquids as green solvents. **Learning activities:** Learner will be engaged in Group discussion to explain the use of PTC and crown ethers	**CLO2**
Unit 3 **12 Hours**	**Microwave induced and ultrasound assisted green synthesis:** Introduction to synthetic organic transformation under microwave (i) Microwave assisted reactions in water (ii) Microwave assisted reactions in organic solvents. (iii) Microwave solvent free reactions Ultrasound assisted reactions: Introduction, substitution reactions, addition, oxidation, reduction reactions. Biocatalysts in organic synthesis: Introduction, Biochemical oxidation and reductions. **Learning activities:** Learner will be engaged in Web based learning to Perform Microwave induced and ultrasound assisted reactions	**CLO3**
Unit 4 **9 Hours**	**Organic synthesis in aqueous phase and in solid state:** Aqueous reactions. Solid state reactions (i) Solid phase synthesis without using any solvent (ii) Solid supported synthesis	**CLO4**

Suggested Readings:

1. Ahulwalia, V.K.; Kidwai M. (2004). *New Trends in Green Chemistry*, Springer
2. Anastas, P.T.; Warner J. C. (2000). *Green Chemistry, Theory and Practical*. Oxford University Press.
3. Grieco, P.A. (1997). *Organic Synthesis in Water*. Publisher: Kluwer Academic.
4. Matlack, A. (2010). *Introduction to green chemistry*. CRC Press.

5. Ahluwalia, V. K. (2011). *Green Chemistry: Greener Alternatives to Synthetic Organic Transformations*. Alpha Science International.
6. Torok, B.; Dransfield, T. (2018). *Green Chemistry: An Inclusice Approach*, Elsevier

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Self-learning

Transaction Mode

- PPT
- YouTube
- Google drive
- Google meet

Course Title: Nuclear Chemistry

L	T	P	Credits
3	0	0	3

Paper Code: MCMC.520
Course Hours: 45h

Learning outcome:
After completing this course, the learner will be able to

CLO1: Explain the nuclear structure and its stability
CLO2: Describe nuclear reactions and different fission model
CLO3: Explain reactor theory along with nuclear resources
CLO4: Describe interaction of gamma radiation

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 **11 Hours**	**Nuclear Structure and Stability** Binding energy, empirical mass equation, nuclear models, the liquid drop model, the shell model, the Fermi gas model & collective nuclear model, nuclear spin, parity & magnetic moments of odd mass numbers nuclei. **Learning activities:** Learner will be provided models to explain structure and stability of nucleus	**CLO1**
Unit 2 **11 Hours**	**Nuclear reaction** Introduction, Production of projectiles, nuclear cross section, nuclear dynamics, threshold energy of nuclear reaction, Coulomb scattering, potential barrier, potential well, formation of a compound nucleus, Nuclear reactions, direct Nuclear reactions, heavy ion induced nuclear reactions, photonuclear reactions. **Nuclear fission** Liquid drop model of fission, fission barrier and threshold, fission cross section, mass energy and charge distribution of fission products, symmetric and Asymmetric fission, decay chains and delayed neutrons.	**CLO2**

	Learning activities: Learner will be provided Web based learning to understand nuclear fission reactions	
Unit 3 **11 Hours**	**Reactor Theory** Nuclear fission as a source of energy, Nuclear chain reacting systems, critical size of a reaction, research reactors, graphite moderated, heterogeneous, enriched uranium reactors, light water moderated, heterogeneous, enriched uranium reactors, water boilers enriched aq. Homogeneous reactors, Thermonuclear reactors, gamma interactions, shielding and health protection. Reactors in India. **Nuclear Resources in India** Uranium and Thorium resources in India and their extractions, Heavy water manufacturing in India. **Learning activities:** Learner will be engaged in group discussion to understand reactor theory and natural resources in India	**CLO3**
Unit 4 **12 Hours**	**Elements of Radiation Chemistry** Radiation Chemistry, Interaction of radiation with matter, Passage of neutrons through matter, Interaction of gamma radiation with matter, Units for measuring radiation absorption, Radiolysis of water, Free radicals in water radiolysis, Radiolysis of some aqueous solutions **Learning activities:** Learner will be provided Web based learning to understand radiation chemistry and interaction of gamma radiation	**CLO4**

Suggested readings:

1. Friedlander, G., Kennedy, J. W., & Macias, E. S. (1981). *Nuclear and radiochemistry*. John Wiley & Sons.
2. Harvey, B. G. (1962). *Introduction to Nuclear Physics and Chemistry*. Soil Science, 94(4), 274.
3. Haissinsky, M. (1964). *Nuclear chemistry and its applications*. Addison-Wesley Pub. Co.
5. Choppin, G. R., Liljenzin, J. O., & Rydberg, J. (2002). *Radiochemistry and Nuclear Chemistry*. Butterworth-Heinemann.
6. Friedlander, G., Kennedy, J. W., & Macias, E. S. (1981). *Nuclear and Radiochemistry*. John Wiley & Sons.

7. Kanne, W. R. (1961). *Basic Principles of Nuclear Science and Reactors*. Journal of the American Chemical Society, 83(2), 508-508.
8. Darmstadter, J., Landsberg, H. H., & Morton, H. C. (1983). *Energy, today and tomorrow: living with uncertainty*. Prentice Hall.
9. Kenneth: Nuclear Power Today, Tomorrow: ELBS
10. Arnikar, H. J. (1995). *Essentials of nuclear chemistry* (No. 1653). New Age International.
11. Cottingham, W. N., Greenwood, D. A., & Greenwood, D. A. (2001). *An Introduction to Nuclear Physics*. Cambridge University Press.

The following are some of the modes of classroom transaction

- Lecture
- Demonstration
- Tutorial
- Self-learning

Transaction Mode

- PPT
- YouTube

Course Title: Advanced Medicinal Chemistry-II
Paper Code: MCMC.521
Course Hours: 45h

L	T	P	Credits
3	0	0	3

Learning outcome:
After completing this course, the learner will be able to:

CLO1: Interpret basics concepts of drugs, their effects and screening.

CLO2: Describe drugs interaction with various types of enzymes and receptors

CLO3: Conceptualize the mechanism of action and SAR studies of drug molecules.

Course Content

Units/Hours	Content	Mapping with course learning outcome
Unit 1 **10 Hours**	Physicochemical and stereochemical aspects: In relation to biological activity, Drug receptor interaction, Adrenergic hormones and Drugs including biosynthesis, storage, release and metabolism of catecholamines (Adrenaline, Isoprenaline, Salbutamol, Amphetamine, Naphazoline), Cholinergics and Anticholinesterases including biosynthesis, storage and metabolism of acetylcholine (Methacholine Chloride, Neostigmine Bromide), Antiparkinsonism Drugs (Apomorphine). **Learning activities:** Learner will be engaged in Web based learning to study Physicochemical and Stereochemical aspect of drugs	**CLO1**
Unit 2 **10 Hours**	Neuromuscular blocking agents: Gallamine Triethiodide, Succinylcholine chloride, Hypoglycaemic drugs (Tolbutamide), Thyroid hormones and Antithyroid drugs (L- Thyroxine, Propylthiouracil) Pancuronium, vecuronium, rocuronium, rapacuronium, dacuronium, malouètine, duador, dipyrandium, pipecuronium, chandonium. Anticoagulants and haemostatic agents: Warfarin, Phenindione, Oxytocics (includes discussion on Ergot alkaloids) (Ergometrine). Antihistamines including discussion on Sodium cromoglycate (Mepyramine, Diphenhydramine, Chlorpheniramine, Promethazine). Non-steroidal anti-inflammatory drugs and anti–gout drugs:	**CLO2**

	Indomethacin, Phenylbutazone, Allopurinol, Probenecid. **Learning activities:** Learner will be engaged in Molecular modeling study to understand neuromuscular blocking reagent	
Unit 3 **10 Hours**	General Anaesthetic Agents: Introduction, medicinal aspects of anaesthetics, mode of action, gases and volatile liquid anaesthetics, intravenous anaesthetics or fixed anaesthetics, toxicity of general anaesthetics (Divinyl ether, Ethyl chloride, Cyclopropane, Thiopentone Sodium). Local Anaesthetic Agents: Introduction, Structure-activity relationships, benzoic acid derivatives, aminobenzoic acid derivatives, lidocaine derivatives, miscellaneous, toxicity, mode of action (Benzocaine, Procaine Hydrochloride, Lidocaine Hydrochloride). **Learning activities:** Learner will be engaged in web-based study to understand aesthetic reagent	**CLO2**
Unit 4 **15 Hours**	Sedatives-Hypnotics: Introduction, classification of sedative-hypnotics, structure-activity relationships, barbiturates, amides and imides, alcohols and their carbamate derivatives, aldehydes and their derivatives, mode of action, pharmacological properties and side effects (Barbitone, Phenobarbitone, Cyclobarbitone, Pentobarbitone Sodium, Thiopentone Sodium), non-barbiturates (Official drugs). Anticonvulsants: Introduction, epilepsy and its types, SAR, barbiturates (official products), hydantoins, Oxazolidinediones, Succinamides; miscellaneous drugs, (Phenytoin Sodium, Troxidone), Antipsychotic agents: introduction, SAR and drugs like chlorpromazine, prochlorperazine, *etc.* **Learning activities:** Learner will be engaged in group discussion to understand the structures of different sedatives and hypnotics and anticonvulsants.	**CLO3**

Suggested Readings

1. Delgado, J. N. and Remers W A, Ed. (2010). *Wilson & Gisvold's Textbook of Organic and Pharmaceutical Chemistry*, J. Lippincott Co., Philadelphia.
2. Foye, W. C. (2019). *Principles of Medicinal Chemistry*, Publisher: Wolter Kluwer.
3. King, F. D. (2006). *Medicinal Chemistry Principles and Practice*, Royale Society of Chemistry, London.
4. Nogardy, T. and Weaver D F (2005). *Medicinal Chemistry: A Molecular and Biochemical Approach*, Oxford University Press, UK.
5. Patrick, G.L. (2017). *An Introduction to Medicinal Chemistry*, Oxford University PressUS.
6. Singh, H., Kapoor, V.K. (1996). *Medicinal and Pharmaceutical Chemistry* Vallabh Prakashan, Delhi.
7. Smith, H.J. (2006). *Introduction to the Principles of Drug Design and Action*, Taylor and Francis.
8. Wermuth, C.G. (2009). *The Practice of Medicinal Chemistry*, Academic Press (Elsevier).
9. Wolff, M E, Ed., (2010). *Burger's Medicinal Chemistry and Drug Discovery* John Wiley & Sons, New York.
10. Ferrant, E., (2011). *New Synthetic Technologies In Medicinal Chemistry*. Royal Chemical Society.

The following are some of the modes of classroom transaction

- Lecture
- Group discussion
- Demonstration
- Self-learning

Transaction Mode

- PPT
- YouTube
- Google drive
- Google meet

Semester III

Course Title: Dissertation Part
Paper Code: MCMC. 599-1

L	T	P	Credits
0	0	40	20

Learning outcome:
After completing this course, the learner will be able to:

CLO1: Designing of research problem and prepare synopsis
CLO2: Preparation of synopsis for Project
CLO3: Planning of experiments

Evaluation criteria:

- Literature survey/background information
- Organization of content
- Physical presentation
- Questions and answers
- Report evaluation

Mapping with course learning outcome: CLO1, CLO2, CLO3

The following are some of the **modes of classroom transaction**

- Lecture cum demonstration
- Project Method
- Seminar
- Group discussion

The following **tools** can be used in **different transactional modes**:

PPT
Video
Multimedia packages
TED Talks
google drive

Software tools

- Tracker
- ChemBioDraw
- Schrodingermaestro/AutoDck
- ppt
- BLAST
- Endnote

Semester IV

Course Title: Dissertation Part
Paper Code: MCMC. 599-2

L	T	P	Credits
0	0	40	20

Learning outcome:
After completing this course, the learner will be able to:

CLO1: Designing of research problem and prepare synopsis
CLO2: Preparation of synopsis for Project
CLO3: Planning of experiments

Evaluation criteria:

- Literature survey/background information
- Organization of content
- Physical presentation
- Questions and answers
- Report evaluation

Mapping with course learning outcome: CLO1, CLO2, CLO3

The following are some of the **modes of classroom transaction**

- Lecture cum demonstration
- Project Method
- Seminar
- Group discussion

The following **tools** can be used in **different transactional modes**:

PPT
Video
Multimedia packages
TED Talks
google drive

Software tools

- Tracker
- ChemBioDraw
- Schrodingermaestro/AutoDck
- ppt
- BLAST
- Endnote