

**Dolphin (PG) Institute of Biomedical & Natural Sciences
Dehradun, Uttarakhand-248007**

(An Autonomous Institute)

NAAC Accredited A⁺ (2nd cycle)



(Affiliated with H.N.B. Garhwal University, Srinagar, Srinagar Garhwal)

Ordinance & Syllabus

of

M.Sc. Pharmaceutical Chemistry

Two Year (4 Semester Programme)

**Based upon NEP-2020 and Curriculum frame work for
Post Graduate Programme-2024**

Effective from

Academic Session

2024-2025

Department of Pharmaceutical Chemistry & Chemistry

Acknowledgement

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We would like to acknowledge the contributions of our Board of Studies (BOS) members, whose expertise and guidance have been instrumental in shaping the curriculum. Our sincere appreciation goes to the students and alumni for their feedback and suggestions, which have been incorporated to make this syllabus more relevant and effective.

Dr. Deepak Kumar

**(Chairperson, Board of Studies in
Pharmaceutical Chemistry & Chemistry)**

Board of Studies in Pharmaceutical Chemistry & Chemistry

	Name	Designation	Institute/Industry
Head of the Department			
1	Dr. Deepak Kumar	Chairperson	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
All Faculty Members of the Department			
1	Dr. Versha Parcha	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
2	Dr. Raju	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
3	Dr. Ritu Singh	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
Subject Expert nominated by Vice-Chancellor			
1	Prof. Anjana Srivastava	NominatedMember	Department of Chemistry, G. B. Pant University of Agriculture & Technology, Pantnagar
Subject experts			
1	Prof. V. K. Varshney	Nominated Member	HOD, Department of Chemistry, Forest Research Institute, Dehradun
2	Dr. Rakesh Joshi	Nominated Member	Department of Chemistry, Sri Dev Suman University, Rishikesh.
Representative from Industry/corporate sectors			
1	Dr. Vinod Tiwari	Nominated Member	Plant Head, Planet Herb Life Sciences Ltd. Dehradun
Alumnus			
1	Mrs. Kavita	Nominated Member	Ms. PGT, Doon Haritage School, Dehradun

Vision, Mission and Core Values of the Institute

Vision

Lead the youth on a journey of knowledge and innovation, along with cultivating a sense of responsibility, perseverance, integrity and fellowship to fortify society on a global scale.

Mission

1. Steadfastly delivering holistic and ethical development of students with education.
2. Focusing on learning inside the classroom, and beyond, by nurturing qualities of leadership, teamwork, self-agency and ingenuity in all the lives we touch.

Core Values

With encouragement and enthusiasm in each tireless, dedicated step into a future that embodies the institute's novel motto of "**Honours Beyond Education**".

Vision and Mission of the Department

Our vision is to strengthen our standing as an outstanding centre for interdisciplinary research and teaching that draws the brightest students with its quality teaching and creative research to foster the development of new talents

Our mission is to equip our students to take on the challenges of both the academic and industrial sectors; we provide unique and pertinent graduate and postgraduate education in the chemical and pharmaceutical sciences. We conduct scholarly research and academic work related to the current problems facing society and industry

About the Programme

Pharmaceutical Chemistry is an interdisciplinary field that combines knowledge of chemistry and pharmacology to design, develop, and analyze drugs. This master's programme aims to provide students with a deep understanding of the principles of drug discovery, design, synthesis, and development, equipping them with the skills needed to contribute to the pharmaceutical industry and research.

Objectives of the Programme are as follows

1. Advanced Knowledge in Pharmaceutical Chemistry

To provide advanced knowledge in pharmaceutical chemistry, including drug design, synthesis, and analysis.

2. Practical Laboratory Skills

To develop practical skills in modern laboratory techniques and instrumentation used in pharmaceutical research.

3. Critical Thinking and Problem-Solving

To foster critical thinking and problem-solving skills in the context of pharmaceutical industry & research areas.

4. Career Preparation

To prepare students for careers in the pharmaceutical industry, regulatory agencies, and academic research.

5. Understanding Ethical, Legal, and Regulatory Aspects

To promote an understanding of the ethical, legal, and regulatory aspects of drug development and use.

Possible career pathways

Graduates of the Master's in Pharmaceutical Chemistry programme can pursue various career paths, including:

Pharmaceutical Research and Development Scientist in Industry & research organizations

Involved in discovering and developing new drugs. They work in laboratories to conduct experiments, analyze data, and develop new drug formulations. Focuses on the design, synthesis, and testing of new pharmaceutical compounds. They collaborate with biologists and pharmacologists to optimize the effectiveness and safety of new drugs.

Quality Control and Quality Assurance Analyst

Ensures that pharmaceutical products meet required standards. They conduct tests and inspections of raw materials, in-process samples, and finished products to ensure compliance with regulatory standards.

Regulatory Affairs Specialist

Manages the regulatory approval process for new drugs. They ensure that products meet all legal and regulatory requirements and prepare the necessary documentation for submission to regulatory agencies.

Clinical Research Associate

Oversees clinical trials to test new drugs. They ensure that trials are conducted ethically and in compliance with regulatory standards, collect data, and monitor the progress of studies.

Academic Researcher and Lecturer

Conducts research in pharmaceutical chemistry and teaches at universities or colleges. They contribute to the advancement of knowledge in the field and mentor the next generation of scientists.

Drug Safety and Pharmacovigilance Officer

Monitors the safety of pharmaceutical products post-marketing. They collect and analyze data on adverse effects and ensure that any risks associated with a drug are identified and managed.

Formulation Scientist

Develops and optimizes the formulation of pharmaceutical products. They work on creating stable, effective, and safe drug formulations, considering factors like dosage form, delivery system, and patient compliance.

PROGRAMME OUTCOMES

PO-1 Complex Problem Solving:

Students will develop the ability to think critically and solve complex problems by applying foundational knowledge and advanced concepts of pharmaceutical chemistry. This includes the capability to tackle numerical problems and case studies relevant to the Drug related issues.

PO-2 Critical Thinking

Graduates will develop strong critical thinking skills, enabling them to evaluate scientific literature, identify gaps in knowledge, and formulate hypotheses and theories based on empirical evidence.

PO-3 Creativity:

The curriculum fosters creativity by encouraging students to apply both practical skills and theoretical knowledge in innovative ways, enhancing their ability to devise novel solutions and approaches in pharmaceutical industries & innovations.

PO-4 Communication Skills:

Graduates will possess strong communication skills, enabling them to effectively read, understand, and convey chemical information from various sources to diverse audiences, both orally and in writing. This will help them to secure good positions in industries & R& D organizations.

PO-5 Analytical Reasoning and Thinking:

Students will develop the ability to draw logical conclusions based on observations, facts, and established rules, thereby enhancing their analytical reasoning skills.

PO-6 Research-Related Skills:

The programme equips students with the skills necessary to design scientific experiments and conduct research, including statistical hypothesis testing and data analysis.

PO- 7 Coordination and Collaboration:

Graduates will be proficient in collaborating effectively with peers, colleagues, and interdisciplinary teams to achieve common goals, demonstrating strong teamwork and coordination skills.

PO- 8 Leadership Readiness and Qualities:

The programme cultivates leadership qualities in graduates, preparing them to take on leadership roles within organizations and to inspire and motivate others to achieve shared objectives.

PO-9 Learning How to Learn:

Students will adopt a curiosity-driven and self-directed approach to learning, developing the ability to ask insightful questions and explore new areas of knowledge independently.

PO- 10 Digital and Technological Skills:

Graduates will be proficient in using digital tools and information and communication technologies (ICT), including programming languages, simulation software, and data analysis tools, essential for modern pharmaceutical industries & research.

PO-11 Multicultural Competence and Inclusive Spirit:

The programme instills an understanding of the values and beliefs of multiple cultures, fostering a global perspective and an inclusive spirit that respects and honors diversity.

PO-12 Value Inculcation:

Students will be aware of global and national issues related to science and technology, understanding their roles and responsibilities as both Indian and global citizens.

PO-13 Autonomy, Responsibility, and Accountability:

Student will demonstrate the ability to work autonomously, taking responsibility for their own learning and research, and being accountable for their professional conduct and contributions to the field

PO-14 Environmental Awareness and Action:

The curriculum emphasizes the importance of environmental stewardship, equipping students with the knowledge, skills, attitudes, and values necessary to take action against environmental degradation, climate change, and pollution. This includes effective waste management, conservation of biodiversity, and promotion of sustainable development.

PO-15 Community Engagement and Service:

Graduates will demonstrate the capability to engage in community service activities, promoting the well-being of society and contributing to community development.

PO-16 Empathy:

The Pharmaceutical Chemistry graduates will be able to demonstrate the ability to give regard to points of view of another individual or group, and to identify and understand other people's emotions.

Eligibility: B. Sc (any stream of science) or B. Pharma

Structure of PG programme

Minimum credits requirement =80

M. Sc. Pharmaceutical Chemistry

M. Sc Pharmaceutical Chemistry 1st Semester

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
PCC101	Core	Quantitative Chemical Analysis	4	-	-	4
PCC102	Core	Analytical Techniques	4	-	-	4
PCC103	Core	Pharmacology	4	-	-	4
PCC104	Core	Stereochemistry and Reaction Mechanisms	4	-	-	4
PCC105	Core	Lab-I [Quantitative Chemical Analysis]	-	-	4	2
PCC106	Core	Lab-II [Pharmaceutical Chemistry]	-	-	4	2
Total Credits						20

M. Sc Pharmaceutical Chemistry 2nd Semester

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
PCC201	Core	Drug Dosage & Delivery System	4	-	-	4
PCC202	Core	Advance Analytical Techniques	4	-	-	4
PCC203	Core	Medicinal Chemistry -I	4	-	-	4
PCC204	Core	Chemistry of Natural Products	4	-	-	4
PCC205	Core	Lab-I [Pharmaceutical Formulations]	-	-	4	2
PCC206	Core	Lab-II [Chemistry of Natural Products]	-	-	4	2
PCC207	Core	Internship	4	-	-	4
Total Credits						24

M. Sc Pharmaceutical Chemistry 3rd Semester

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
PCC301	Core	Drug Discovery Development	4	-	-	4
PCC302	Core	Medicinal Chemistry-II	4	-	-	4
PCE ---	Elective	Choose from Pool	4	-	-	4
PCE ---	Elective	Choose from Pool	4	-	-	4
PCC303	Core	Lab-I [Medicinal Chemistry & Drug Design]	-	-	4	2
PCC304	Core	Lab-II [Pharmaceutical Technology]	-	-	4	2
Total Credits						20

M. Sc Pharmaceutical Chemistry 4th Semester

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
PCC401	Core	Herbal Drug Technology	4	-	-	4
PCE ---	Elective	Choose from Pool	4	-	-	4
PCC402	Core	Lab-I [Herbal Drug Technology]	-	-	4	2
PCC403	Core	Project (Viva-voce)	12	-	-	12
Total Credits						22

Note:

- ❖ Atleast two additional courses from SWAYAM/NPTEL/MOOCs of 10 credits to be qualify under the supervision of advisor of the department during the entire program is mandatory.
- ❖ Elective pool courses emphasises the connection between chemistry & entrepreneur skills highlighting how students can apply their scientific knowledge to create and develop Pharmaceutical based businesses and start-ups.

M. Sc Pharmaceutical Chemistry 1st Semester

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
PCC101	Core	Quantitative Chemical Analysis	4	-	-	4
PCC102	Core	Analytical Techniques	4	-	-	4
PCC103	Core	Pharmacology	4	-	-	4
PCC104	Core	Stereochemistry and Reaction Mechanisms	4	-	-	4
PCC105	Core	Lab-I [Quantitative Chemical Analysis]	-	-	4	2
PCC106	Core	Lab-II [Pharmaceutical Chemistry]	-	-	4	2
Total Credits						20

Course Name	Quantitative Chemical Analysis	L	T	P	C
Course Code	PCC101	4	0	0	4

Quantitative Chemical Analysis

Course objective:

The course provides the concept of volumetric analysis and methods of expressing concentration, estimation of various compounds.

Course Outcome:

On completion of this course, the students will be able to

CO1. Define the concept of errors, accuracy and precision.

CO2. Understand chemical equilibrium, law of mass action, common ion effect and methods of expressing concentration.

CO3. Explains the types of acid base & the methods for detection of end point of Acid base titration.

CO4. Describes redox and precipitation titration & the methods for detection of end point in redox and precipitation titration.

CO5. Estimate various compounds quantitatively along with standardization of titrant in complexometric titration and steps involved in gravimetry.

Course Content

Unit I: Statistical Analysis:

8 Hrs

Limitations of analytical methods. Errors, Classification of errors, Accuracy, Precision, Minimisation of errors, Significant figures, Mean and standard deviations, Correlation and Regression, Linear regression.

Unit II: Fundamental Theoretical Principles of Reaction in Solution:

10 Hrs

Chemical equilibrium, The Law of Mass Action, Factor affecting chemical reaction in solution. Solubility Product, Acid Base equilibria in water, Strength of acid and base, Common ion-effect, Buffer Solutions, Methods of expressing concentrations, pH.

Titrimetric analysis, Classification of reactions in titrimetric analysis, Standard solutions, primary and secondary standard solutions,

Unit III: Neutralisation Titrations: Introduction, Theory of Neutralisation titration. neutralizations indicators. Choice of indicators in neutralization reaction.

Nonaqueous Titrations: Titrations in non-aqueous solvents, Solvents for non-aqueous titrations, aprotic, protophilic, protogenic and amphiprotic solvents, Indicators for non-

aqueous titrations, Titrations with perchloric acid, potassium methoxide and tetrabutyl ammonium hydroxide.

12 Hrs

Unit IV: Oxidation-reduction Titrations: Principle & theory of oxidation reduction titrations, Change in electrode potential during oxidation reduction titration, iodometric and iodimetric titration, redox indicators, Application of redox titration in pharmaceuticals.

Precipitation Titration: Introduction and Theory of Precipitation reactions, methods of end point detection in precipitation titrations, Application of precipitation titrations. 12 Hrs

Unit V: Complexometric Titrations: Introduction, principle and theory of complexometric titrations, titrations with disodium edetate. Methods of end point detection in complexometric titration. Application of complexometric titrations.

Gravimetric analysis: Introduction, Precipitation method of gravimetric analysis, purity of precipitate, condition of precipitation. Application of gravimetric analysis. 10 Hrs

Books Suggested

S. No.	Unit	Books Suggested
1	I	1. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K., 1989
2	II	1. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K., 1989. 2. A. Keneth & A. Connors, A Text Book of Pharmaceutical Analysis, 3 rd ed., Wiley Interscience Singapore, 1982.
3	III	1. A. H. Becket and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I, 4 th ed., CBS Publishers & Distributors, New Delhi, 1997. 2. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K., 1989. 3. A. Keneth & A. Connors, A Text Book of Pharmaceutical Analysis, 3 rd ed., Wiley Interscience Singapore, 1982.
4	IV	1. A. H. Becket and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I, 4 th ed., CBS Publishers & Distributors, New Delhi, 1997. 2. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K., 1989. 3. A. Keneth & A. Connors, A Text Book of Pharmaceutical Analysis, 3 rd ed., Wiley Interscience Singapore, 1982.
5	V	1. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K., 1989.

Course Name	Analytical Techniques	L	T	P	C
Course Code	PCC102	4	0	0	4

Analytical Techniques

Course objective:

This course provides comprehensive study of the instrumental techniques viz. chromatography, Calorimetry, Fluorimetry, AAS, FES, ORD and CD.

Course Outcome:

On completion of this course, the students will be able to

CO1. Explains the basic theoretical knowledge of the instrumentation techniques available.

CO2. Deals with different analytical data from different principle instrument.

CO3. Learn theoretical principle, instrumentation and applications of chromatographic techniques like adsorption, partition, paper, TLC, Ion exchange, column, GC, HPLC and Gel electrophoresis.

CO4. Understand theoretical principle, instrumentation and applications of Spectroscopic techniques like Calorimetry, Fluorimetry, AAS, FES, ORD and CD.

CO5. Interpret the structure of the chemical compounds.

Course Content

Unit I: Introduction to chromatography Adsorption and partition chromatography, definition of terms, techniques and chemical concept of column, paper, TLC and HPTLC. 8 Hrs

Unit II: GC Theory of gas chromatography, principle of gas chromatography, instrumentation and application of gas chromatography. 10 Hrs

Unit III: HPLC: High performance liquid chromatography – principles, theories, stationary phases, Instrumentation for HPLC. Factors affecting resolution, tailing, selectivity, gradient elution, reversed phase chromatography. Preparative HPLC, separation of enantiomers – chiral mobile phases – chiral solid stationary phases – Indirect separation of enantiomers. Special techniques in HPLC – Micro and capillary HPLC, High speed and super speed HPLC – Hyphenated techniques. 12 Hrs

Unit IV: IEC: Basic principle of ion exchange chromatography (IEC), instrumentation and application of Ion-Exchange chromatography (IEC). Theory of Gel Electrophoresis. Introduction, Optical activity, Optical rotation, Instrumentation. Optical rotatory dispersion, plain curve, rotatory dispersion & circular dichroism.

12 Hrs

Unit V: Flame Photometry, and Atomic Absorption Spectroscopy - Theory, Instrumentation and Applications. Colorimetry: Introduction, principle and theory, instrumentation and application. Spectrofluorimetry: Introduction, principle and theory, instrumentation and application.

10 Hrs

Books Suggested

S. No.	Unit	Books Suggested
1	I	1. Robert M. Silverstein, Francis X. Webster, Spectrometric identification of organic compounds, 6th ed. John Wiley and Sons-Inc 1998.
2	II	1. Robert M. Silverstein, Francis X. Webster, Spectrometric identification of organic compounds, 6th ed. John Wiley and Sons-Inc 1998. 2. Comin N. Banwell, Elian M. McCash, Fundamentals of molecular spectroscopy 4th ed. Tata McGraw -Hill Publishing Company Limited New Delhi, 1995.
3	III	1. Robert M. Silverstein, Francis X. Webster, Spectrometric identification of organic compounds, 6th ed. John Wiley and Sons-Inc 1998. 2. Sharma B. K., Instrumental Methods of Chemical analysis, Goel Publishing House, 2005.
4.	IV	1. Sharma B. K., Instrumental Methods of Chemical analysis, Goel Publishing House, 2005.
5.	V	1. Robert M. Silverstein, Francis X. Webster, Spectrometric identification of organic compounds, 6th ed. John Wiley and Sons-Inc 1998.

Course Name	Pharmacology	L	T	P	C
Course Code	PCC103	4	0	0	4

Course objective: The subject is designed to strengthen the basic knowledge in the field of pharmacology and to impart recent advances in the drugs used for the treatment of various diseases. In addition, this subject helps the students to understand the concepts of drug action and mechanisms involved.

Course Outcome:

On completion of this course, the students will be able to

CO1. Expose the historical development of Pharmacology and route of drug administration of drug

CO2. Learns about general principles of pharmacokinetics and its factors.

CO3. Gain knowledge of drug action.

CO4. Understand general concepts of toxicity and toxicity test.

CO5. Discuss the principles, general methods of several bio-assays and clinical pharmacology.

Course Content

Unit I: General Pharmacology 10 Hrs

Introduction, important aspects of pharmacology. History of pharmacology. Branches of pharmacology. General principles of pharmacology Pharmacopoeia. Nomenclature of drug. Classification and sources of drugs. Routes of drug administration.

Unit II: Pharmacokinetics 10 Hrs

Introduction, absorption of drug, Factors influencing absorption of drugs. Distribution of drug, plasma protein binding, cellular binding, Rate of blood flow into various organs, Metabolism of drugs, factors affecting metabolism, Excretion of drug.

Unit III: Pharmacodynamics 10 Hrs

Basic pharmacodynamics concepts, drug action through metal binding, drug action through cell membrane, drug action through physicochemical properties of drug, drug action through antibodies, drug action through enzyme and drug action through receptor.

Unit IV: Toxicity of drug

12 Hrs

Introduction, Adverse drug reactions, Toxic effects, Intolerance, Drug allergy. Drug interactions. General concepts of toxicity, acute, subacute & chronic toxicity, Teratogenicity, Carcinogenicity, Itrogenic diseases, LD₅₀, ED₅₀, tolerance, habituation & addiction. Poisoning: Introduction and General principle of poisoning, Management of Poisoning including metal-poisoning, drug-poisoning.

Unit VI: Bio-assays

15 Hrs

Introduction and basic principles, general methods, biological variations & animal ethics. Bioassays of insulin, heparin, d-tubocurarin, digitalis, acetylcholine, adrenaline, histamine. Clinical Pharmacology. Prescription writing, patient compliance, patient non-compliance, Polypharmacy and self-medication.

Book Suggested:

S. No.	Unit	Books Suggested
1	I	1. F.S.K. Barar, Essential of Pharmacotherapeutics, 3 rd ed. S. Chand and Company Ltd., New Delhi, 1995. 2. H. R., Derasari, T. P., Gandhi & R. K. Goyal, (1993). Elements of pharmacology.
2	II	1. Goodman & Gillman, The Pharmacological Basis of Therapeutics 9 th ed., McGraw Hill Companies, New York, USA, 1996 2. F.S.K. Barar, Essential of Pharmacotherapeutics, 3 rd ed. S. Chand and Company Ltd., New Delhi, 1995
3	III	1. K.D. Tripathi, Essentials of Medical Pharmacology, 9 th ed., Jaypee Brothers New Delhi, 1995 2. S. D. Seth, Text Book of Pharmacology, 2 nd ed. Churchill Livingstone Pvt. Ltd., New Delhi.
4	IV	1. H. R., Derasari, T. P., Gandhi & R. K. Goyal, (1993). Elements of pharmacology.
5	V	1. Laurence & Bennett, Clinical Pharmacology, 8 th ed., Churchill Livingstone, N. Y. 1997. 2. F.S.K. Barar, Essential of Pharmacotherapeutics, 3 rd ed. S. Chand and Company Ltd., New Delhi, 1995

Course Name	Stereochemistry and Reaction Mechanisms	L	T	P	C
Course Code	PCC104	4	0	0	4

Stereochemistry and Reaction Mechanisms

Course objective:

Topics in this course introduce the concepts optical activity, chirality, configuration of organic compounds. This course also deals with shape of six membered ring, aromatic electrophilic, nucleophilic substitution reaction, elimination reactions, free radical reactions, addition reactions. This course also covers name reactions in organic synthesis with mechanism.

Course Outcome:

On completion of this course, the students will be able to

CO1. Identify the symmetry elements and symmetry operations in molecules by optical activity and the criteria for chirality and discuss axial, planar and helical chirality and the methods of determination of relative and absolute configuration and geometrical isomerism & stereochemistry of olefins, and the configuration in E and Z isomers.

CO2. Estimate actual shape of six membered rings, conformation and its reactivity.

CO3. Understand mechanisms involving aromatic electrophilic reaction, aromatic nucleophilic reactions and benzyne mechanism, free radical reactions and elimination mechanism.

CO4. Learn about addition to carbon - carbon and carbon-hetero multiple bonds.

CO5. Know the uses of organic name reactions in organic synthesis with mechanism.

Course Content

Unit I: Stereochemistry: Optical activity and chirality. General consideration of molecular asymmetry and dissymmetry. Absolute configuration – R, S notation (CIP rule). Molecules with more than one asymmetric center. Geometrical isomerism. E, Z nomenclature of olefins. Stereochemistry of allenes, biphenyls. 8 Hrs

Unit II: Actual shape of six membered rings, conformation and reactivity in cyclo hexane. 5 Hrs

Unit III: Mechanism involving aromatic electrophilic substitution reactions, aromatic nucleophilic substitution reactions, Elimination Reaction, Free radical reactions. 12 Hrs

Unit IV: Addition to carbon - carbon and carbon-hetero multiple bonds: Electrophilic, nucleophilic addition reaction and neighbouring group participation, Addition of halogen and nitrosyl chloride to olefins. Hydration of olefins and acetylenes. 10 Hrs

Unit V: Name reactions: Condensation reactions: Aldol Condensation, Claisen's Condensation, Michael's Condensation. Rearrangement reactions: Fries Rearrangement Beckmann rearrangement, Hofmann rearrangement & Hoffmann's degradation, Pinacol-Pinacolone Rearrangement. Reduction reactions: Meerwein Ponderoff Valery Reduction, Birch Reduction, Clemmensen reduction, Wolf Kishner's Reduction, Cannizaro's Reaction. General name reaction: Curtius reaction, Schmidt Reaction, Wittig Reaction, Oppenauer oxidation, Reimer-Tiemann Reaction. 20 Hrs

Books Suggested

S. No.	Unit	Books Suggested
1	I	1. Advanced Organic Chemistry, Reaction, Mechanism and Structure, Jerry March, 6 th Ed., John Wiley. 2. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press. 3. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.
2	II	1. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.
3	III	1. Reaction Mechanism in Organic Chemistry, Mukherji and Singh, Macmillan. 2. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.
4	IV	1. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International. 2. Organic Chemistry, Boyd and Morrison, Prentice Hall of India.
5	V	1. Advanced Organic Chemistry, Reaction, Mechanism and Structure, Jerry March, 6 th Ed., John Wiley. 2. Organic Chemistry, Boyd and Morrison, Prentice Hall of India.

Course Name	Lab-I [Quantitative Chemical Analysis]	L	T	P	C
Course Code	PCC 106	0	0	4	2

Lab-I [Quantitative Chemical Analysis]

Course objective:

Determine the concentration of unknown compounds by titrimetric analysis.

Course Outcome:

On completion of this course, the students will be able to

CO1. Define the concept of pharmaceutical analysis, its scope and methods of expressing concentration.

CO2. Determine the methods for detection of end point of Acid base titration, precipitation titration, complexometric titration, redox titration and Non-aqueous titration.

CO3. Perform assay and standardization of volumetric preparations.

CO4. Estimate the concentration of unknown samples by titrimetric analysis.

CO5. Apply the concept for the analysis of pharmaceutical dosage forms.

Course Content

Titrimetric analysis including acid base titration, redox titration, precipitation titrations, gravimetric analysis. 30 Hrs

1. Preparation and standardization of 0.1N NaOH with Oxalic acid
2. Preparation and standardization of 0.1N HCl with Na₂CO₃.
3. Preparation and standardization of 0.1N NaOH with 0.1 N HCl.
4. Assay of NaOH.
5. To estimate the amount of NaOH and Na₂CO₃ in a given sample.
6. To estimate the amount of Na₂CO₃ and NaHCO₃ in a given sample.
7. Preparation and standardization of 0.1 N AgNO₃ with NaCl.
8. Preparation and standardization of 0.1 N KMnO₄ with oxalic acid.
9. Assay of Acetic acid.
10. Preparation & Standardization of 0.05M EDTA with CaCl₂.

Books Suggested

S. No.	Books Suggested
1	A. H. Becket and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I, 4 th ed., CBS Publishers & Distributors, New Delhi, 1997

2	G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney Vogel's Text Book of Quantitative Chemical Analysis 5th ed., ELBS, U.K., 1989
3	A. Keneth & A. Connors, A Text Book of Pharmaceutical Analysis, 3 rd ed., Wiley Interscience Singapore, 1982.

Course Name	Lab-II [Pharmaceutical Chemistry]	L	T	P	C
Course Code	PCC 107	0	0	4	2

Lab-II [Pharmaceutical Chemistry]

Course objective: This subject deals with identification, characterization of organic compounds, mixtures based upon their solubility, melting point determination, Elemental analysis, and by characteristic chemical test and also to synthesize some simple organic compounds and derivatives.

Course Outcome:

On completion of this course, the students will be able to 30 Hour

CO1. Practical exposé for the Identification of Organic compounds

CO2. Estimate and identify the given organic mixture

CO3. Determine given organic mixture on the basis of solubility

CO4. Understand reaction mechanism involve in synthesis of organic compound.

CO5. Findout melting point and percentage yield of organic compound.

Course Content

Experiments on identification of organic compounds and mixtures and synthesis of organic compounds:-

1. To identify the given organic compound Sample No.- 1
2. To identify the given organic compound Sample No.- 2
3. To identify the given organic compound Sample No.- 3
4. To separate out and detection of given Binary mixture Sample No.-1
5. To separate out and detection of given Binary mixture Sample No.-2
6. To separate out and detection of given Binary mixture Sample No.-3
7. To separate out and detection of given Binary mixture Sample No.-4
8. To synthesize Benzil from Benzoin.
9. To synthesize Phthalimide from Phthalic Anhydride
10. To Synthesize Phenyl azo β -Naphthol from aniline.

Books Suggested

S. No.	Books Suggested
1	Agarwal, O. P. (2006). Advances Practical Organic Chemistry. Krishna Prakashan Media.
2	Furniss, B. S. (Ed.). (2011). Vogel's textbook of practical organic chemistry. Pearson Education India.
3	Caron, S. (Ed.). (2020). Practical synthetic organic chemistry: reactions, principles, and techniques. John Wiley & Sons.

M. Sc Pharmaceutical Chemistry 2nd Semester

Course Code	Course Type	Course Name	Load			Credits
			L	T	P	
PCC201	Core	Drug Dosage & Delivery System	4	-	-	4
PCC202	Core	Advance Analytical Techniques	4	-	-	4
PCC203	Core	Medicinal Chemistry -I	4	-	-	4
PCC204	Core	Chemistry of Natural Products	4	-	-	4
PCC205	Core	Lab-I [Pharmaceutical Formulations]	-	-	4	2
PCC206	Core	Lab-II [Chemistry of Natural Products]	-	-	4	2
PCC207	Core	Internship	4	-	-	4
Total Credits						24

Course Name	Drug Dosage & Delivery System	L	T	P	C
Course Code	PCC201	4	0	0	4

Drug Dosage & Delivery System

Course objective: This course is designed to impart knowledge on the area of advances in novel drug delivery systems.

Course Outcome:

On completion of this course, the students will be able to

CO1. Acquire knowledge of types, advantages, disadvantages & formulation of oral dosage forms like solution, syrups, suspension emulsion, tablet and capsule.

CO2. Learn about the controlled release modified-release and targeted release dosage forms.

CO3. Understand the importance of transdermal and vaccine drug delivery system.

CO4. Provide knowledge of Physiological barriers to drug delivery, bioavailability and bioequivalence studies.

CO5. Provide knowledge of sterile dosage forms.

Course Content

Unit I: Dosage form

20 Hrs

Principles of dosage form design. Classification of dosage form. Dosage form Types, advantages, disadvantages, formulation and evaluation of;

- a) Liquid dosage forms like solution, syrups, suspension & emulsion.
- b) Solid dosage forms like tablets, capsules etc.
- c) Topical semi-solid dosage forms like Ointment, Cream and Gels.

Unit II: Controlled Release Dosage forms:

10 Hrs

Introduction, factors in the design of controlled release drug delivery system and classification. Modified-release drug products and targeted drug delivery systems

Unit III: Transdermal and Vaccine Drug Delivery Systems:

15 Hrs

Introduction, Advantage and disadvantages of TDDSs. Vaccine delivery systems: Vaccines, uptake of antigens, single shot vaccines, mucosal and transdermal delivery of vaccines.

Unit IV: Bioavailability and Physiological barriers to drug delivery:

06 Hrs

Introduction, factors affecting bioavailability, methods of estimation of bioavailability, bioequivalence studies. Physiological barriers to drug delivery.

Unit V: Parenteral Dosage Forms:

06 Hrs

Introduction, Classification. Parenteral route of administration, methods of sterilization, Industrial preparation of parenteral dosage forms.

Book Suggested:

S. No.	Unit	Books Suggested
1	I	1. B. M. Mithal, A Text book of pharmaceutical formulation. Edition, 6. Publisher, VallabhPrakashan, 1997. ISBN, 8185731047 2. A. H. Becket and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I, 4 th ed., CBS Publishers & Distributors, New Delhi, 1997
2	II	1. D. M. Brahmanekar & Jaiswal, S. B. (1995). Biopharmaceutics and pharmacokinetics a treatise. Delhi: VallabhPrakashan, 335-338.
3	III	1. A. Keneth & A. Connors, A Text Book of Pharmaceutical Analysis, 3 rd ed., Wiley Interscience Singapore, 1982.
4	IV	1. Mitra, Ashim K., Deep Kwatra, and Aswani Dutt Vadlapudi. Drug Delivery (book). Jones & Bartlett Publishers, 2014. 2. D. M. Brahmanekar & Jaiswal, S. B. (1995). Biopharmaceutics and pharmacokinetics a treatise. Delhi: VallabhPrakashan, 335-338.
5	V	1. B. M. Mithal, A Text book of pharmaceutical formulation. Edition, 6. Publisher, VallabhPrakashan, 1997. ISBN, 8185731047 2. D. M. Brahmanekar & Jaiswal, S. B. (1995). Biopharmaceutics and pharmacokinetics a treatise. Delhi: VallabhPrakashan, 335-338.

Course Name	Advance Analytical Techniques	L	T	P	C
Course Code	PCC202	4	0	0	4

Advance Analytical Techniques

Course objective:

This course explains spectroscopic techniques used in pharmaceutical chemistry. This course provides knowledge of UV, IR, Mass, NMR, Raman and molecular emission spectroscopy.

Course Outcome:

On completion of this course, the students will be able to

CO1. Learn principle and theory of UV Spectroscopy and its instrumentation and application. Spectroscopic techniques like NMR, MS, Raman and Molecular Emission.

CO2. Understand principle and theory of IR Spectroscopy and its instrumentation and application.

CO3. Acquire knowledge about Theory of mass spectroscopy and interpretation of spectra of Mass spectroscopy.

CO4. Apply and discuss the knowledge of NMR Spectroscopy and identify Chemical compounds.

CO5. Describe theory and principle of Raman and Molecular emission spectroscopy.

Course Content

Unit I: UV-Spectroscopy: Introduction, Theory & Principle, Electronic excitation, types of transitions, Lambert-Beer's Law, Chromophores, auxochromes, shifts and their interpretation (Woodward's Fischer Rule). Instrumentation and application of UV-Vis Spectrophotometer.

10 Hrs

Unit II: IR Spectroscopy: Introduction, principle, Theory of molecular vibration, Number of vibration, selection rule, functional group frequency. Factor affecting vibration frequency. Instrumentation and application of IR-Spectroscopy. Interpretation of IR spectrum. FT-IR.

12 Hrs

Unit III: Mass Spectroscopy: Principle & theory, determination of molecular formula, fragmentation pattern, metastable ion & peaks, Nitrogen rule, Interpretation of mass spectrum. Instrumentation & application of Mass spectrophotometer. GC-MS and LC-MS-principle and application.

12 Hrs

Unit IV: NMR Spectroscopy: Introduction, Principle & theory, relaxation process, ¹HNMR, Number of signals (non-equivalent protons), chemical shift, factor affecting chemical shift,

splitting of signals (spin-spin coupling), coupling constant, geminal coupling, AMX, ABX, ABC system, shift reagents & interpretation of spectra. ¹³CNMR, Introduction and application. 14 Hrs

Unit V: Molecular Emission Spectroscopy: Introduction, principle and theory, Florescence and Phosphorescence, factor affecting florescence. Application of molecular emission spectroscopy.

Raman Spectroscopy: Introduction, principle and theory, Raman scattering, Raman shift, Interpretation of raman spectroscopy, Difference between raman and IR spectroscopy. Instrumentation and application of raman spectrophotometer. 12 hrs

Books Suggested:

S. No.	Unit	Books Suggested
1	I	1. Y R Sharma, Elementary Organic Spectroscopy, S Chand and Company Pvt. Ltd. 2013. 2. W. Kemp, Organic Spectroscopy, 1st ed. ELBS/Macmillan, London, 1975.
2	II	1. Y R Sharma, Elementary Organic Spectroscopy, S Chand and Company Pvt. Ltd. 2013. 2. Robert M. Silverstein, Francis X. Webster, Spectrometric identification of organic compounds, 6th ed. John Wiley and Sons-Inc 1998.
3	III	1. Y R Sharma, Elementary Organic Spectroscopy, S Chand and Company Pvt. Ltd. 2013. 2. Robert M. Silverstein, Francis X. Webster, Spectrometric identification of organic compounds, 6th ed. John Wiley and Sons-Inc 1998.
4.	IV	1. W. Kemp, Organic Spectroscopy, 1st ed. ELBS/Macmillan, London, 1975. 2. Robert M. Silverstein, Francis X. Webster, Spectrometric identification of organic compounds, 6th ed. John Wiley and Sons-Inc 1998.
5.	V	1. Y R Sharma, Elementary Organic Spectroscopy, S Chand and Company Pvt. Ltd. 2013. 2. Sharma B. K., Instrumental Methods of Chemical analysis, Goel Publishing House, 2005.

Course Name	Medicinal Chemistry -I	L	T	P	C
Course Code	PCC203	4	0	0	4

Medicinal Chemistry –I

Course objective:

Course Outcome:

On completion of this course, the students will be able to

CO1. Understand classification SAR and mode of action of Penicillins and cephalosporins.

CO2. Learn about classification, SAR and mode of action of Tetracycline, sulphonamides and aminoglycosides antibiotics.

CO3. Know the structural activity relationship of different class of drugs like antimalarial, antimycobacterial, anti-T.B and antileprosy drugs.

CO4. Well acquainted with the antiprotozoal drugs.

CO5. Acquire knowledge in the chemotherapy for cancer and different anti-viral and anti-fungal agents.

Course Content

Classification, SAR, Mode of action, & uses of following class of drugs (synthesis of individually mentioned drugs only).

Unit I: Antibiotics: Penicillin, Semisynthetic penicillin, Cephalosporin, Synthesis: Methicilline, Amoxicillin, Chloramphenicol, Ampicillin,

14 Hrs

Unit II: Tetracyclines, Sulphonamide, Aminoglycosides, Macrolides.

Synthesis: Doxycycline, Sulphanilamide, Azithromycin. 12 Hrs

Unit III: Antimalarial, Antimycobacterial agents-anti-T.B., antileprosy drugs.

Synthesis: Chloroquine, Isoniazid, Rifampin, ethambutol, dapsone. 12 Hrs

Unit IV: Antiporozoal durgs: Antiamoebic, Antihelmintics.

Synthesis: Metronidazole, Albendazole. 10 Hrs

Unit V: Antifungal, anticancer, antiviral agents.

Synthesis: 5-fluorouracil, cyclophosphamide, Clotrimazole, Zidovudine 12 Hrs

Books Suggested

S. No.	Unit	Books Suggested
1	I	1. William O. Foye, Principles of Medicinal Chemistry, 3rd ed., Varghese Publishing House, Mumbai, 1989. 2. Kadam & Mahadik, Bothara, Principles of Medicinal Chemistry vol. I & II, 4th ed. Nirali Prakash Pune, 1997
2	II	1. Jaime N. Delgado & William A. Remers, Wilson and Gisvold's, Text Book of Organic Medicinal and Pharmaceutical Chemistry, 9th ed. J.B. Lippincott Company, Philadelphia, 1991. 2. Manfred E. Wolff, Burger's medicinal Chemistry and Drug Discovery, Vol. I to V, 5th ed., A John Wiley & Sons, Inc. (New York), 1995.
3	III	1. William O. Foye, Principles of Medicinal Chemistry, 3rd ed., Varghese Publishing House, Mumbai, 1989. 2. Manfred E. Wolff, Burger's medicinal Chemistry and Drug Discovery, Vol. I to V, 5th ed., A John Wiley & Sons, Inc. (New York), 1995.
4	IV	1. William O. Foye, Principles of Medicinal Chemistry, 3rd ed., Varghese Publishing House, Mumbai, 1989.
5	V	1. Kadam & Mahadik, Bothara, Principles of Medicinal Chemistry vol. I & II, 4th ed. Nirali Prakash Pune, 1997

Course Name	Chemistry of Natural Products	L	T	P	C
Course Code	PCC204	4	0	0	4

Chemistry of Natural Products

Course objective:

Structural study of different natural products, classification, nomenclature, methods of isolation and purifications, study of the various properties and their reactions. student will be familiar with nomenclature, structure elucidation, general properties and methods of preparation of natural products.

Course Outcome:

On completion of this course, the students will be able to

CO1 Understanding of Carbohydrates and Glycosides: Students will be able to explain the introduction, nomenclature, and classification of carbohydrates, including their structural features and mutarotation.

CO2. Comprehensive Knowledge of Alkaloids: Students will gain a thorough understanding of alkaloids, including their introduction, occurrence, classification, and the processes involved in their isolation and purification.

CO3. Proficiency in Terpenoids: Students will learn about the introduction, occurrence, and classification of terpenoids, including their structural features and the Isoprene rule. They will be skilled in the isolation and purification processes and will be able to elucidate the structures of terpenoids such as citral, menthol, and camphor.

CO4. Expertise in Heterocyclic Compounds: Students will acquire knowledge of the nomenclature, structure, preparation, and properties of heterocyclic compounds. This includes both five- and six membered benzofused heterocycles.

Course Content

Unit-I: Carbohydrate: Introduction, Nomenclature and classification, mutarotation, configuration of monosaccharides, ring structure of glucose, determination of structure (elucidation) of sucrose, maltose, lactose & starch. Glycosides: Introduction, arbutin, amygdaline. 14 Hrs

Unit II: Alkaloids: Introduction, Occurrence, Classification, Isolation and Purification, determination of molecular structure (elucidation) of alkaloids. Structure elucidation of atropine, quinine, nicotine.

12 Hrs

Unit III: Terpenoids: Introduction, Occurrence, Classification, structure feature of terpenoids, Isoprene rule, Isolation and Purification, structure elucidation of citral, menthol, camphor.

10 Hrs

Unit IV: Heterocyclic Compounds: Nomenclature, Structure, Preparation & Properties: Five membered benzofused heterocycles: Furan, Thiophene, pyrrole, thiazole, pyrazole, oxazole. Six membered benzofused heterocycles: Pyridine, Pyrimidine, Quinoline.

20 Hrs

Book Suggested:

S. No.	Unit	Books Suggested
1	I	I. L. Finar, Organic chemistry, Vol. II, 1st Indian ed., Pearson Education Pte Ltd Indian Branch, Delhi, 2002.
2	II	1. O.P. Agarwal, Chemistry of Natural Products, Vol. I & II, 7th ed., Goel Publishing House, Meerut, 1983.
3	III	I. L. Finar, Organic chemistry, Vol. II, 1st Indian ed., Pearson Education Pte Ltd Indian Branch, Delhi, 2002.
4.	IV	1. O.P. Agarwal, Chemistry of Natural Products, Vol. I & II, 7th ed., Goel Publishing House, Meerut, 1983.

Course Name	Lab-I [Pharmaceutical Formulations]	L	T	P	C
Course Code	PCC205	0	0	4	2

Lab-I [Pharmaceutical Formulations]

Course Objective: To introduce the concept of cosmetics in terms of chemistry and their formulation. To make students understand the role of each ingredients in the preparation of the cosmetic products and give an idea about the role of herbal ingredients in the making of any cosmetic product

Course Outcome:

On completion of this course, the students will be able to

CO1. Familiar with the basic principles of various cosmetic formulations.

CO2. Aware of different ingredients and their roles in cosmetic products.

CO3. Appreciate the role of herbal ingredients in various cosmetic products.

CO4. Use safe, economic and body-friendly cosmetics.

CO5. Prepare new innovative formulations to achieve the aimed efficacies and effects.

Course Content

Different type cosmetics formulation.

30 Hrs

1. To prepare and submit cold cream.
2. To prepare and submit face mask.
3. To prepare and submit cleansing cream.
4. To prepare and submit liquid soap.
5. To prepare and submit liquid soap
6. To prepare and submit lip –balm
7. To prepare and submit vanishing cream
8. To prepare and submit shampoo.
9. To prepare and submit complexion lotion
10. To prepare and submit astringent lotion.
11. To prepare and submit moisturizing lotion.
12. To prepare and submit conditioners.

Books Suggested

S. No.	Books Suggested
1	Gilchrist, Alastair J. Making Quality Cosmetics: Good Manufacturing Practice and ISO 22716: 2007. Royal Society of Chemistry, 2022
2	Baki, Gabriella. Introduction to cosmetic formulation and technology. John Wiley & Sons, 2022.
3	Saraf, Swarnlata, and Shailendra Saraf. Cosmetics: A practical manual. PharmaMed Press, 2008.

Course Name	Lab-II [Chemistry of Natural Products]	L	T	P	C
Course Code	PCC206	0	0	4	2

Lab-II [Chemistry of Natural Products]

Course objective: This course provides an overview of the field of natural product chemistry and different types of natural products, their occurrence, structure, biosynthesis and properties will be emphasized.

Course Outcome:

On completion of this course, the students will be able to 30 Hour

CO1. Impart practical knowledge based on extraction and isolation of compounds from the different plants.

CO2. Estimate yield, melting point and confirmatory test different types of natural products.

CO3. Determine structure and extraction method of nicotine

CO4. Expose for the different extractions method.

CO5. Discuss the use of natural products as starting materials for medicines

Course Content

30 Hrs

Extraction and isolation of compound from the different plants.

1. To extract Caffeine from Tea leaves.
2. To extract Lawsone from Henna leaves.
3. To extract Nicotine from Tobacco leaves.
4. To extract Calcium citrate from Lemon juice.
5. To extract Pectin from Orange Peels.
6. To extract hesperidin from powdered orange Peels.
7. To isolate Piperine from powdered black Pepper.
8. To isolate curcumin from turmeric.

Book Suggested

S. No.	Books Suggested
1	I.L. Finar, Organic chemistry, Vol. II, 1st Indian ed., Pearson Education Pte Ltd Indian Branch, Delhi, 2002
2	C.K. Kokate. Practical Pharmacognosy. Nirali Prakashan, 2008. ISBN, 8185790361

Course Name	Internship	L	T	P	C
Course Code	PCC207	4	0	0	4

Internship

Course objective:

The purpose of Internship is to expose students to real work of environment experience at industry and at the same time, to gain the knowledge through hands on observation and job execution. From the industrial training, the students will also develop skills in work ethics, communication, management and others. Moreover, this practical training program allows students to relate theoretical knowledge with its application in the pharmaceutical industry.

Course Outcome:

On completion of this course, the students will be able to

CO1. Know the various types of industries.

CO2. Learn the procedure of identifying, approaching, applying and getting approval of internship from a leading industry.

CO3. Witness the entire work area of the industry.

CO4. Understand the nature of job involved in the various sector of the industry.

CO5. Adapt with the working people.

Course Content

Requirements

Students wishing to receive credit for internship are required to find, apply for, and be selected for a Pharmaceutical Chemistry or materials related internship position with an organization of their choice. They will then need to seek permission from the Department to register for the appropriate internship course.

The student must complete at least 90 hrs of work during the semester for each hour of academic credit awarded, and these work hours must be completed during the term (odd or even semester vacation) in which the student is registered for the internship course.

After the student has completed the internship, the student must submit the final evaluation report of the internship experience and 20 minute presentation to department at conclusion of semester. The Department head and class coordinator will allot the mark for the internship evaluation report.