Academic Programme Guide

of

Master of Pharmacy

(Pharmaceutical Chemistry)

Based on Choice Based Credit System (CBCS) / Elective Course System

w.e.f.

Academic Year: 2024-2025

Approved by the 26th Academic Council vide agenda item AC 26.4a dated 10th August 2024

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Chitkara University

Vision and Mission

Vision	To be a globally recognized organization promoting academic excellence through interdisciplinary applied research and to expand realms of knowledge through innovation.
Mission	• To carry out the academic processes in accordance with global standards through active teacher-student-industry participation.
	• To promote research, innovation and entrepreneurship in collaboration with industry, research laboratories and academic institutions of global repute.
	• To inculcate high moral, ethical and professional values amongst our students, faculty & staff.
	• To contribute in building skillful society.

Institute Vision and Mission

Vision	To excel as a premiere Centre of Excellence in Pharmaceutical Education, Research, Development & Innovation with Global Interaction.
Mission	• To contribute in building skillful society by preparing competent pharmacist.
	• To prepare globally recognized pharmaceutical professionals who can effectively contribute in new molecule research, formulation, preclinical and clinical growth and regulatory submissions.
	• To prepare efficient leaders providing academic and other interactions in various stages of pharmaceutical operations, marketing and distribution.
	• To provide applied, industry relevant pharmaceutical education relevant globally.
	• To enhance and impart innovation, entrepreneurship, and social skills.

1. General Information

The academic program guide is a comprehensive document detailing course scheme, associated per course and the distribution of each course in lecture, tutorial, and practical hours. It also details the eligibility criteria for admission, for award of doctorate degree, the assessment and evaluation procedures along with a glimpse of the pedagogical aspects of the programs. This Guide is to be used in association with the Academic Regulations of the University to make a complete rule set. The course schemes given in this document are approved by respective Board of Studies and the Academic Council of Chitkara University.

M. Pharm (Pharmaceutical Chemistry) course is designed to explore the links between disease, mechanism of action and the development of safe, effective commercial drugs. This program disciplines at the intersection of chemistry, especially synthetic organic chemistry, medicinal chemistry and pharmacology and various other biological specialities, where it is involved with the design, chemical synthesis, and development for a market of pharmaceutical agents (drugs). So, the academic system at Chitkara college of Pharmacy has been framed taking into consideration the responsibility of graduate students to meet the demands of hi tech-pharmaceutical industry, at the same time ensuring that they confidently serve the requirements of chemistry and pharma industry. Conscious efforts are directed to inculcate research aptitude in its students through elective research projects and to keep them abreast of the requirements of the industry.

Program Objectives:

Objectives of M. Pharm (Pharmaceutical Chemistry) program is-

1. To develop skilled professionals who can play a key intermediately role in Pharmaceutical Chemistry & Analysis related processes.
2. To flourish students professionally complemented with hands-on training on various advanced analytical instrumental techniques for identification, characterization, and quantification of drugs. Instruments dealt are NMR, Mass spectrometer, IR, HPLC, GC etc.
3. To impart knowledge about recent advances in the field of medicinal chemistry at the molecular level including different techniques for the rational drug design.
4. To impart advanced knowledge and skills required to learn the concept of generic drug and their development, various regulatory filings in different countries, different phases of clinical trials and submitting regulatory documents.
5. To help students develop internationally accepted competencies to become world-class pharmaceutical professionals.

2. Program Outcomes M. Pharm. (Pharmaceutical Chemistry)

The proposed outcomes for M. Pharm. (Pharmaceutical Chemistry) course are suitable for those candidates who want to increase their knowledge for accelerating their career by exploring and acquiring a critical understanding of pharmaceutical chemistry. The course includes the study of drugs and drug development and other disciplines like concepts and processes of drug discovery, delivery, absorption, metabolism, etc. It also focuses on the ability of a graduating student to develop himself/herself as a competent professional with appropriate technical skills in Pharmaceutical Chemistry, clinical research, and scientific writing.

They are further classified as follows:

PO 1: To acquire adequate knowledge and to learn the necessary skills to perform pharmaceutical chemistry-related processes. To nurture students with adequate knowledge and scientific information regarding drug designing, development, and characterisations process.

PO 2: Pharmaceutical Chemistry professionals deal with the study of principles and applications of synthetic medicinal chemistry for manufacturing therapeutic drugs for prevention and cure of life-threatening diseases. To nurture students with adequate knowledge of classification, synthesis, structure activity relationships and pharmacology of various category of drugs.

PO 3: To gain adequate knowledge and training for reviewing and assessing all research documents and to impart knowledge and skills necessary to train the students on par with the routine of industrial activities in R&D and F&D.

PO 4: A pharmaceutical chemistry professionals shall be responsible for analyzing, designing, planning, and undertaking data from controlled lab-based examinations, investigations, trials, and experiments.

PO 5: A pharmaceutical chemistry professionals shall learn to identify project goals, research methods, variables, and other test parameters of a drug. Furthermore, they should be willing to participate in continuing education programs of Chitkara University to upgrade their knowledge and professional skills.

PO 6: The graduates should understand the various aspects of medicinal products and chemical biology, enzymology and structural biology, aiming at the discovery and development of new drugs. These drugs are used to provide therapeutic aid to patients suffering from various ailments, making it useful for the healthcare industry.

PO 7: The graduates should also understand the concept of advanced organic chemistry, different techniques of organic synthesis and their applications to process chemistry as well as drug discovery. They will learn about the identification, synthesis and analysis of medicines using chemical processes. These methods are implemented practically in Laboratories, and used in research organizations.

PO 8: Designed course will be able to assist students to write and comprehend critical reviews of scientific articles and peer evaluation; manage information effectively by competently undertaking research tasks and train students in using suitable statistical methods for interpretation of results and use a full range of learning resources in making literature searches via the library, PubMed, Science direct, Sci hub and in using on-line teaching material, word processors, spread sheets, and databases.

PO 9: Self-directed and Life-long Learning: To motivate the students to work in team for better outcomes and simultaneously to develop competence, confidence and analytical approach to work effectively with in a group or individually.

PO 10: To help students in developing communication skills to effectively communicate their ideas and information; also to demonstrate problem-solving skills by data interpretation and the designing of quality experimental protocols.

PO 11: Technology Competence: The program aim to prepare competent professional with advanced knowledge in *in-silico* docking and computational study tools and softwares required for reporting and data quality management and industry progress.

Mission:

M1: To carry out the academic processes in accordance with global standards through active teacher-student-industry participation.

M2: To promote research, innovation and entrepreneurship in collaboration with industry, research laboratories and academic institutions of global repute.

M3: To inculcate high moral, ethical and professional values amongst our students, faculty & staff.

M4: To contribute in building skilful society by preparing competent pharmacist.

M5: To prepare globally recognised pharmaceutical professional who can effectively contribute in new molecule research, formulation, preclinical and clinical growth and regulatory submissions.

M6: To become efficient leaders providing academic and other interactions in various stages of pharmaceutical operations, marketing and distribution.

Table 1: **The mapping of POs with University Mission**

PO No.	**PO Statement**	**Mission Statement**	**Vision Statement**
PO1	To acquire adequate knowledge and to learn the necessary skills to perform pharmaceutical chemistry-related processes. To nurture students with adequate knowledge and scientific information regarding drug designing, development, and characterizations process.	M2, M4	To be a globally recognized university, promoting academic excellence through interdisciplinary applied research and to expand realms of knowledge through innovation.
PO2	Pharmaceutical Chemistry professionals deal with the study of principles and applications of synthetic medicinal chemistry for manufacturing therapeutic drugs for prevention and cure of life-threatening diseases. To nurture students with adequate knowledge of classification, synthesis, structure activity relationships and pharmacology of various category of drugs.	M3, M4	
PO3	To gain adequate knowledge and training for reviewing and assessing all research documents and to impart knowledge and skills necessary to train the students on par with the routine of industrial activities in R&D and F&D.	M1, M5	
PO4	A pharmaceutical chemistry professionals shall be responsible for analyzing, designing, planning, and undertaking data from controlled lab-based examinations, investigations, trials, and experiments.	M6, M2	
PO5	A pharmaceutical chemistry professionals shall learn to identify project goals, research methods, variables, and other test parameters of a drug. Furthermore, they should be willing to participate in continuing education programs of Chitkara University to upgrade their knowledge and professional skills.	M1, M5	

PO6	The graduates should understand the various aspects of medicinal products and chemical biology, enzymology and structural biology, aiming at the discovery and development of new drugs. These drugs are used to provide therapeutic aid to patients suffering from various ailments, making it useful for the healthcare industry.	M6, M2	
PO7	The graduates should also understand the concept of advanced organic chemistry, different techniques of organic synthesis and their applications to process chemistry as well as drug discovery. They will learn about the identification, synthesis and analysis of medicines using chemical processes. These methods are implemented practically in Laboratories, and used in research organizations.	M2, M1	
PO8	Designed course will be able to assist students to write and comprehend critical reviews of scientific articles and peer evaluation; manage information effectively by competently undertaking research tasks and train students in using suitable statistical methods for interpretation of results and use a full range of learning resources in making literature searches via the library, PubMed, Science direct, Sci hub and in using on-line teaching material, word processors, spread sheets, and databases.	M1, M2	
PO9	Self-directed and Life-long Learning: To motivate the students to work in team for better outcomes and simultaneously to develop competence, confidence and analytical approach to work effectively with in a group or individually.	M4, M3	
PO10	To help students in developing communication skills to effectively communicate their ideas and information; also to demonstrate problem-solving skills by data interpretation and the designing of quality experimental protocols.	M4, M5	
PO11	Technology Competence: The program aim to prepare competent professional with advanced knowledge in *in-silico* docking and computational study tools and softwares required for reporting and data quality management and industry progress.	M1, M2, M6	

The graduating students are prepared for demonstrating knowledge of and ability to use principles of therapeutics, quality improvement, communication, economics, health behaviour, social and administrative sciences, health policy and legal issues in the practice of pharmacy. Each year, experts from different universities and pharmaceutical industry across the globe visits Chitkara College of Pharmacy, Chitkara University, Punjab to provide international exposure to students.
Aiming at developing student's personality through community service, NSS activities are offered to students to in still the idea of social welfare and to provide service to society without bias. To enrich student's interpersonal skills, variety of extracurricular activities have been inculcated in the course curriculum in the form of national level technical and cultural festivals such as Pharma-fest, International Pharmacist Day and National Pharmacy Week respectively on a yearly basis under the student club CHAMP (Chitkara House of Aspirants and Multitalented Pharmacists). A vital role is

played by CHAMP for overall progress & grooming of the student through organising industrial visits, workshops, debate, technical quizzes and research project paper presentation competitions in events like Pharma tech Trends, Pharmacy Practice Module and international conferences. The students are motivated to participate or organise such events. These value-added activities have been designed taken into account various Program Objectives (POs) such as PO6, PO7, PO8, PO9 and PO11.

The main aim of service training with focus on good health and well-being is accomplished by delivering sport-related events, NSS and NCC. The program also aims to develop professional with awareness of international standards as of global health has transcended beyond the idea of confining the pharmacist's work to a specific geographical location and broadened it to the global level. PO1, PO2, PO3, PO4, PO5, PO6 and PO7 promotes development of skills in graduates for pharmaceutical formulations, analytical experts, regulatory and dispensing skills for good practices in global health system.

Pharmacists have the opportunity to play an important role in both public health and global health. In particular, pharmacists can look at the varied global health practices established in medicine and use this as a framework to understand the potential role of the pharmacist within global health practice and program delivery, research, and policy. According to the Consortium of Universities for Global Health, global health should refer to the scope of a wider problem rather than a geographical location. The scope of work of pharmacists in diverse settings faces challenges of global health such as self-care & self-medication, management of diseases through medication therapy management, resistance to existing drugs or recreational drugs being abused, medicines supplied through unregistered online pharmacies, online advertising of prescription drugs, direct-to-consumer websites and the distribution of substandard & spurious, falsely-labeled, falsified or counterfeit medicines. POs are designed and oriented to meet the mission of university in professional ethics. The POs helps to produce pharmacy graduates with employable skills and high technical competence in pharmaceutical industry and health care sectors. POs helps to develop a sense of teamwork and awareness amongst students towards the importance of interdisciplinary approach for developing competence in solving complex problems in the area of Pharmaceutical Sciences. The POs inculcate research activity and develop passion for discovery and innovations. Pharmacy graduate develop entrepreneurship qualities that support growth of pharmaceutical intellectual property.

3. Eligibility for Admission

3.1. Pass in the following examinations:

B. Pharm Degree examination of an Indian university established by law in India from an institution approved by Pharmacy Council of India and has scored not less than 55 % of the maximum marks (aggregate of 4 years of B. Pharm.). Every student, selected for admission to post graduate pharmacy program in any PCI approved institution should have obtained registration with the State Pharmacy Council or should obtain the same within one month from the date of his/her admission, failing which the admission of the candidate shall be cancelled.

Note: It is mandatory to submit a migration certificate obtained from the respective university where the candidate had passed his/her qualifying degree (B. Pharm.).

3.2. Migration/Credit Transfer Policy

The following procedures will be followed for credit transfer for student under migration, studied in other Universities in India and Abroad:

"The credits earned by the student from the other universities in India or abroad shall be transferred as such. The Degree shall only be awarded to candidate subject to the condition that student earned

the minimum no. of credit defined by Academic Regulation/APG of the Program run by the Chitkara University." In case a student undergoes international exchange program or internship for 1 semester/ 1 year, then the courses, credits and grades earned by the student in abroad during that period should be reflected on the grade card issued by the Chitkara University. The courses will be marked as (*) on the grade card/transcript. The description of the (*) will be "credits and grades as adopted university/institute name during international exchange program. The minimum credit points required for the award of M. Pharm. degree is 100. However, based on the credit points earned by the students under the head of co-curricular activities, a student shall earn a maximum of 105 credit points. If consolidated credits are less than 100 credits, then the student has to earn extra credits to attain minimum credits requirement for M. Pharmacy degree. The instructions regarding this will be informed to the students by the department from time to time.

4. Program Duration

The program of study for M. Pharmacy shall extend over a period of four semesters (two academic years). The curricula and syllabi for the program shall be prescribed from time to time by Pharmacy Council of India, New Delhi.

4.1. Medium of instruction and examinations

Medium of instruction and examination shall be in English.

4.2. Working days in each semester

Each semester shall consist of not less than 100 working days. The odd semesters shall be conducted from the month of June/July to November/December and the even semesters shall be conducted from the month of December/January to May/June in every calendar year.

5. Pedagogical Aspects

Each course will be taught for 52-65 hrs. Every day there will be three to four lecture sessions of three to four courses of 1 hours each and twelve-hour practical divided into two days (pre-lunch and post-lunch). Activity and project hours will be other than these lecture hours depending upon the subject and relevance of the project. At least one week prior to the commencement of a particular course, the concerned faculty member or the course coordinator will circulate among the students the following pertaining to the course:

a) The course outlines containing the syllabus along with text books, reference books and other study material.
b) Day-to-day schedule to be followed-detailing the pace, coverage, prior reading assignments, case studies, home assignments to be perused by the students etc.
c) Various components of evaluation, such as quizzes (announced or unannounced), assignment, open book test, field work, group discussion, seminar, assignments, tests/examinations, class participation, mid-term and end term grading with relative weightage etc.
d) Other matters found desirable and relevant.

6. Apprenticeship/Internship embedded degree programs (AEDP)

The apprenticeship or internship is optional for M. Pharm students during their research work in Semester III & IV. The primary aim of the internship is to provide hands-on experience in a real-world setting. The internship is typically conducted in approved pharmacy institutions, hospitals, or pharmaceutical industries, where students can apply their academic knowledge to practical scenarios. The duration of the internship is usually specified by the university or institution in alignment with PCI guidelines.

7. Program Structure

As per the philosophy of Credit Based Semester System, certain quantum of academic work viz. theory classes, practical classes, seminars, assignments, etc. are measured in terms of credits. On satisfactory completion of the courses, a candidate earns credits. The amount of credit associated with a course is dependent upon the number of hours of instruction per week in that course. Similarly, the credit associated with any of the other academic, co/extra-curricular activities is dependent upon the quantum of work expected to be put in for each of these activities per week/per activity.

7.1. Credit assignment

7.1.1. Theory and Laboratory courses

Courses are broadly classified as Theory and Practical. Theory courses consist of lecture (L) and Practical (P) courses consist of hours spent in the laboratory. Credits (C) for a course is dependent on the number of hours of instruction per week in that course, and is obtained by using a multiplier of one (1) for lecture and a multiplier of half (1/2) for practical (laboratory) hours. Thus, for example, a theory course having four lectures per week throughout the semester carries a credit of 4. Similarly, a practical having four laboratory hours per week throughout semester carries a credit of 2. The contact hours of seminars, assignments and research work shall be treated as that of practical courses for the purpose of calculating credits. i.e., the contact hours shall be multiplied by 1/2. Similarly, the contact hours of journal club, research work presentations and discussions with the supervisor shall be considered as theory course and multiplied by 1.

7.2. Minimum credit requirements

The minimum credit points required for the award of M. Pharm. degree is 100. However, based on the credit points earned by the students under the head of co-curricular activities, a student shall earn a maximum of 105 credit points. These credits are divided into Theory courses, Practical, Seminars, Assignments, Research work, Discussions with the supervisor, Journal club and Co-Curricular activities over the duration of four semesters. The credits are distributed semester-wise as shown in Table 7. Courses generally progress in sequence, building competencies and their positioning indicates certain academic maturity on the part of the learners. Learners are expected to follow the semester-wise schedule of courses given in the syllabus.

7.3. Academic work

A regular record of attendance both in Theory, Practical, Seminar, Assignment, Journal club, Discussion with the supervisor, Research work presentation and Dissertation shall be maintained by the department / teaching staff of respective courses.

7.4. Course of study

The specialisation in M. Pharm program Pharmaceutical Chemistry is MPC. The course of study for M. Pharm specialisations shall include Semester wise Theory & Practical as given in **Table 2** and **3**. The number of hours to be devoted to each theory and practical course in any semester shall not be less than that shown in **Table 4** to **6**.

Table –2: Course of Study for M. Pharma (Pharmaceutical Chemistry)

Course Code	Course	Credit Hours	Credit Points	Hrs./ wk	Marks
Semester I					
MPC 101T	Modern Pharmaceutical Analytical Techniques	4	4	4	100
MPC 102T	Advanced Organic Chemistry-I	4	4	4	100
MPC 103T	Advanced Medicinal Chemistry-I	4	4	4	100
MPC 104T	Chemistry of Natural Products	4	4	4	100
MPC 105P	Pharmaceutical Chemistry Practical-I	12	6	12	150
MPC 106S	Seminar/Assignment	7	4	7	100
	Total	**35**	**26**	**35**	**650**
Semester II					
MPC 201T	Advanced Spectral Analysis	4	4	4	100
MPC 202T	Advanced Organic Chemistry-II	4	4	4	100
MPC 203T	Computer Aided Drug Design	4	4	4	100
MPC 204T	Pharmaceutical Process Chemistry	4	4	4	100
MPC 205P	Pharmaceutical Chemistry Practical-II	12	6	12	150
MPC 206S	Seminar/Assignment	7	4	7	100
DM 101	Disaster Management	3	3	3	50
	Total	**38**	**29**	**38**	**700**

Table – 3: Course of study for M. Pharm. III Semester (Common for All Specialisations)

Course Code	Course	Credit Hours	Credit Points
MRM 301T	Research Methodology and Biostatistics*	4	4
MPR 302J	Journal club	1	1
MPR 302P	Discussion / Presentation (Proposal Presentation)	2	2
MPR 302R	Research Work	28	14
HR 101	Human Values and Professional Ethics	2	2
	Total	**37**	**23**
* Non-University Exam			

Table – 4: Course of study for M. Pharm. IV Semester

	(Common for All Specializations)		
Course Code	**Course**	**Credit Hours**	**Credit Points**
MPR 401J	Journal Club	1	1
MPR 401R	Research Work and Colloquium	31	16
MPR 401D	Discussion/Final Presentation	3	3
MPR401C	Co-Curricular Activities	--	7*
	Total	**35**	**20**

Table – 5: Semester wise credits distribution

	Semester		**Credit Points**
	I		26
	II		29
	III		23
	IV		20
Co-curricular Activities			Minimum = 02
(Attending Conference, Scientific Presentations and Other Scholarly Activities)			Maximum = 07*

	Total Credit Points		Minimum = 100
			Maximum = 105*
*Credit Points for Co-curricular Activities			

Table – 6: Guidelines for Awarding Credit Points for Co-curricular Activities

Name of the Activity	Maximum Credit Points Eligible/Activity
Participation in National Level Seminar/Conference/Workshop/Symposium/Training Programs (related to the specialization of the student)	01
Participation in international Level Seminar/Conference/Workshop/Symposium/Training Programs (related to the specialization of the student)	02
Academic Award/Research Award from State Level/National Agencies	01
Academic Award/Research Award from International Agencies	02
Research / Review Publication in National Journals (Indexed in Scopus / Web of Science)	01
Research / Review Publication in International Journals (Indexed in Scopus / Web of Science)	02
Note: International Conference: Held Outside India International Journal: The Editorial Board Outside India	

* The credit points assigned for extracurricular and or co-curricular activities shall be given by the Principals of the colleges and the same shall be submitted to the University. The criteria to acquire this credit point shall be defined by the colleges from time to time.

7.5. Program Committee

The M. Pharm. program shall have a Program Committee constituted by the Head of the institution in consultation with all the Heads of the departments.

The composition of the Program Committee shall be as follows:

A teacher at the cadre of Professor shall be the Chairperson; One Teacher from each M. Pharm specialisation and four student representatives (two from each academic year), nominated by the Head of the institution.

7.5.1. Duties of the Program Committee

Periodically reviewing the progress of the classes. Discussing the problems concerning curriculum, syllabus and the conduct of classes. Discussing with the course teachers on the nature and scope of assessment for the course and the same shall be announced to the students at the beginning of respective semesters. Communicating its recommendation to the Head of the institution on academic matters. The Program Committee shall meet at least twice in a semester preferably at the end of each sessional exam and before the end semester exam.

8. Assessment & Evaluation

The schemes for internal assessment and end semester examinations are given in Table 7 and 8.

8.1 End semester examinations

The End Semester Examinations for each theory and practical course through semesters I to IV shall be conducted by the respective university except for the subject with asterix symbol (*) in **Table 7**and **8** for which examinations shall be conducted by the subject experts at college level and the marks/grades shall be submitted to the university.

Tables–7: Schemes for Internal assessments and End semester Examinations (Pharmaceutical Chemistry)

Course Code	Course	Internal Assessment				End Semester Exams		Total
		Continuous Mode	Sessional Exams		Total			
			Marks	Duration		Marks	Duration	Marks
SEMESTER I								
MPC 101T	Modern Pharmaceutical Analytical Techniques	10	15	1.5 Hrs	25	75	3 Hrs	100
MPC 102T	Advanced Organic Chemistry-I	10	15	1.5 Hrs	25	75	3 Hrs	100
MPC 103T	Advanced Medicinal Chemistry-I	10	15	1.5 Hrs	25	75	3 Hrs	100
MPC 104T	Chemistry of Natural Products	10	15	1.5 Hrs	25	75	3 Hrs	100
MPC 105P	Pharmaceutical Chemistry Practical-I	20	30	6 Hrs	50	100	6 Hrs	150
MPC 106S	Seminar/Assignment	-	-	-	-	-	-	100
Total								**650**
SEMESTER II								
MPC 201T	Advanced Spectral Analysis	10	15	1.5 Hrs	25	75	3 Hrs	100
MPC 202T	Advanced Organic Chemistry-II	10	15	1.5 Hrs	25	75	3 Hrs	100
MPC 203T	Computer Aided Drug Design	10	15	1.5 Hrs	25	75	3 Hrs	100
MPC 204T	Pharmaceutical Process Chemistry	10	15	1.5 Hrs	25	75	3 Hrs	100
MPC 205P	Pharmaceutical Chemistry Practical-II	20	30	6 Hrs	50	100	6 Hrs	150
MPC 206S	Seminar/Assignment	-	-	-	-	-	-	100
DM 101	Disaster Management	5	10	1 Hr	15	35	1.5 Hr	50
Total								**700**

Tables –8: Schemes for internal assessments and end semester examinations (Semester III & IV)

Course Code	Course	Internal Assessment				End Semester Exams		Total
		Continuous Mode	Sessional Exams		Total	Marks	Duration	Marks
			Marks	Duration				
SEMESTER III								
MRM 301T	Research Methodology and Biostatistics*	10	15	1.5 Hrs	25	75	3 Hrs	100
MPR 302J	Journal club	-	-	-	25	-	-	25
MPR 302P	Discussion / Presentation (Proposal Presentation)	-	-	-	50	-	-	50
MPR302R	Research Work	-	-	-	-	350	1 Hr	350
HR 101	Human Values and Professional Ethics	5	10	1 Hr	15	35	1.5 Hrs	50
Total								**575**
SEMESTER IV								
MPR 401J	Journal club	-	-	-	25	-	-	25
MPR 401D	Discussion / Final Presentation	-	-	-	75	-	-	75
MPR 401R	Research work and Colloquium	-	-	-	-	400	1 Hr	400
Total								**500**

*Non University Examination

8.2 Internal assessment: Continuous mode

The marks allocated for Continuous mode of Internal Assessment shall be awarded as per the scheme given below.

Table – 9: Scheme for awarding internal assessment: Continuous mode

Theory	
Criteria	**Maximum Marks**
Attendance (Refer Table 9)	8
Student – Teacher interaction	2
Total	**10**
Practical	
Attendance (Refer Table 9)	10

Based on Practical Records, Regular viva voce, etc.	10
Total	**20**

Table – 10: Guidelines for the allotment of marks for attendance

Percentage of Attendance	Theory	Practical
95 – 100	8	10
90 – 94	6	7.5
85 – 89	4	5
80 – 84	2	2.5
Less than 80	0	0

9. Rules for Attendance

A candidate is required to put in at least 80% attendance in individual courses considering theory and practical separately. The candidate shall complete the prescribed course satisfactorily to be eligible to appear for the respective examinations.

10.Promotion & Award of grades

The Pharmacy Council of India (PCI) has established guidelines to ensure uniformity in the promotion and grading of M. Pharm students across PCI-approved institutions. These guidelines emphasize the importance of internal assessments, which are mandatory and contribute significantly to the final grades. Assessments include both formative (continuous evaluation) and summative (end-semester exams) components, aligned with the PCI syllabus. To be promoted to the next semester, students must secure a minimum of 50% marks in both internal assessments and end-semester examinations. Those failing to meet this criterion must reappear for supplementary exams conducted by their institution, with all subjects required to be cleared within the stipulated time frame outlined by PCI regulations. The grading system follows a credit-based semester system (CBSS), awarding grades from "O" (Outstanding) for scores 90% and above to "F" (Fail) for scores below 50%, with students needing at least a "B" grade (50%-59%) to pass. Additionally, students must maintain a minimum of 75% attendance in theory and practical sessions, with exceptions granted only under exceptional circumstances like medical emergencies, subject to academic council approval. M. Pharm programs also require students to undertake research projects or dissertations in their final year, evaluated through internal assessments by supervisors and external viva voce examinations conducted by PCI-appointed examiners, with significant weightage given to project work in determining final grades. Students who fail any subject are allowed supplementary examinations, with a maximum number of attempts specified by PCI guidelines, typically within twice the duration of the program. Migration between PCI-approved institutions is permitted only under exceptional circumstances and requires fulfilment of academic requirements at the current institution along with approvals from both institutions involved. These guidelines ensure standardization in academic progression while maintaining rigorous evaluation standards for postgraduate pharmacy education.

11. Carry forward of marks

In case a student fails to secure the minimum 50% in any Theory or Practical course as specified in 10, then he/she shall reappear for the end semester examination of that course. However his/her marks of the Internal Assessment shall be carried over and he/she shall be entitled for grade obtained by him/her on passing.

12. Improvement of Internal Assessment

A student shall have the opportunity to improve his/her performance only once in the sessional exam component of the internal assessment. The re-conduct of the sessional exam shall be completed before the commencement of next end semester theory examinations.

13. Re-examination of end semester examinations

Reexamination of end semester examination shall be conducted as per the schedule given in **Table 11**. The exact dates of examinations shall be notified from time to time.

Table 11: Schedule of end semester examinations

Semester	For Regular Candidates	For Failed Candidates
I and III	November / December	May / June
II and IV	May / June	November / December

Question paper pattern for end semester theory examinations

For 75 marks paper

I. Short Answer Questions (3 out of 4) = 5 x 3 = 15

II. Long Answers (Answer 6 out of 7) = 6 x10 = 60

Total = 75 marks

Question paper pattern for end semester practical examinations

I. Synopsis	=	10
II. Major Experiments	=	35
II. Minor Experiments	=	25
IV. Viva voce + File	=	30
Total	=	100 marks

14. Allowed to keep terms (ATKT)

The Pharmacy Council of India (PCI) has reiterated its guidelines regarding the "allowed to keep terms" policy for pharmacy students. This policy is crucial for ensuring that students maintain the necessary academic standards to progress through their respective programs. According to the latest updates, institutions must adhere strictly to the Education Regulations set forth by the PCI, which include maintaining adequate faculty qualifications, infrastructure, and equipment.

Students are generally allowed to keep terms if they meet specific criteria, such as maintaining a minimum attendance percentage and achieving passing marks in internal assessments. Institutions are responsible for monitoring these criteria closely and must report any non-compliance to the PCI.

Additionally, the PCI has emphasized that institutions must apply through the DIGI-PHARMed portal for any approvals related to course continuations or admissions, ensuring that all processes are transparent and standardized. Institutions failing to comply with these guidelines risk not being included in the approved list for future admissions, which could lead to a "No Admission Year" scenario for them.

To summarize, adherence to PCI regulations is essential for pharmacy institutions and students alike, ensuring that educational standards are upheld and that students are given fair opportunities to progress in their studies.

15. Grading System

A student shall be declared PASS and eligible for getting grade in a course of M. Pharm programme if he/she secures at least 50% marks in that particular course including internal assessment.

15. 1. Grading of Performances

15.1.1. Letter grades and grade points allocations:

Based on the performances, each student shall be awarded a final letter grade at the end of the semester for each course. The letter grades and their corresponding grade points are given in **Table 12.**

Table – 12: Letter grades and grade points equivalent to Percentage of marks and performances

Percentage of Marks Obtained	Letter Grade	Grade Point	Performance
90.00 – 100	O	10	Outstanding
80.00 – 89.99	A	9	Excellent
70.00 – 79.99	B	8	Good
60.00 – 69.99	C	7	Fair
50.00 – 59.99	D	6	Average
Less than 50	F	0	Fail
Absent	AB	0	Fail

A learner who remains absent for any end semester examination shall be assigned a letter grade of AB and a corresponding grade point of zero. He/she should reappear for the said evaluation/examination in due course.

16. The Semester grade point average (SGPA)

The performance of a student in a semester is indicated by a number called 'Semester Grade Point Average' (SGPA). The SGPA is the weighted average of the grade points obtained in all the courses by the student during the semester. For example, if a student takes five courses (Theory/Practical) in a semester with credits C1, C2, C3 and C4 and the student's grade points in these courses are G1, G2, G3 and G4, respectively, and then students' SGPA is equal to:

$$SGPA = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4G_4}{C_1 + C_2 + C_3 + C_4}$$

The SGPA is calculated to two decimal points. It should be noted that, the SGPA for any semester shall take into consideration the F and ABS grade awarded in that semester. For example, if a learner has a F or ABS grade in course 4, the SGPA shall then be computed as:

$$SGPA = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4 * ZERO}{C_1 + C_2 + C_3 + C_4}$$

17. Cumulative Grade Point Average (CGPA)

The CGPA is calculated with the SGPA of all the IV semesters to two decimal points and is indicated in final grade report card/final transcript showing the grades of all IV semesters and their courses. The CGPA shall reflect the failed status in case of F grade(s), till the course(s) is/are passed. When the course(s) is/are passed by obtaining a pass grade on subsequent examination(s) the CGPA shall only reflect the new grade and not the fail grades earned earlier. The CGPA is calculated as:

$$CGPA = \frac{C_1S_1 + C_2S_2 + C_3S_3 + C_4S_4}{C_1 + C_2 + C_3 + C_4}$$

where C_1, C_2, C_3,. is the total number of credits for semester I, II, III, …. and S_1, S_2, S_3,....is the SGPA of semester I, II, III, …. .

18. Declaration of class

The class shall be awarded on the basis of CGPA as follows:

First Class with Distinction = CGPA of. 7.50 and above

First Class = CGPA of 6.00 to 7.49

Second Class = CGPA of 5.00 to 5.99

19. Project work

All the students shall undertake a project under the supervision of a teacher in Semester III to IV and submit a report. 4 copies of the project report shall be submitted (typed & bound copy not less than 75 pages).

The internal and external examiner appointed by the University shall evaluate the project at the time of the Practical examinations of other semester(s). The projects shall be evaluated as per the criteria given below.

Evaluation of Dissertation Book:

Objective(s) of the work done	50	Marks
Methodology adopted	150	Marks
Results and Discussions	250	Marks
Conclusions and Outcomes	50	Marks
Total	**500**	**Marks**

Evaluation of Presentation:

Presentation of work	100	Marks
Communication skills	50	Marks
Question and answer skills	100	Marks
Total	**250**	**Marks**

20. Award of Ranks

Ranks and Medals shall be awarded on the basis of final CGPA. However, candidates who fail in one or more courses during the M. Pharm program shall not be eligible for award of ranks. Moreover, the candidates should have completed the M. Pharm program in minimum prescribed number of years, (two years) for the award of Ranks.

21. Award of Degree Candidates

Who fulfil the requirements mentioned above shall be eligible for award of degree during the ensuing convocation.

22. Duration for completion of the program of study

The duration for the completion of the program shall be fixed as double the actual duration of the program and the students have to pass within the said period, otherwise they have to get fresh Registration.

23. Revaluation & Retotaling of answer papers

There is no provision for revaluation of the answer papers in any examination. However, the candidates can apply for re-totalling by paying prescribed fee.

24. Re-admission after break of study

Candidate who seeks re-admission to the program after break of study has to get the approval from the university by paying a condonation fee.

25. Promotion and Registration

A student shall be declared PASS and eligible for getting grade in a course of M. Pharm program if he/she secures at least 50% marks in that particular course including internal assessment.

26. Provision of Grace Marks

The following rule for the award of grace marks to the students was approved by the Academic Council:
The University shall award grace-marks as per following:
"One percent of the total marks of theory examination of all the semesters may be given for improving the division of a candidate. Grace marks given to a candidate in semester examination may be deducted from total grace marks to be given for improvement of the division."

A maximum of One percent of the total marks of theory examination as grace marks at the end of the each semester/year, provided that a student secures a minimum of 15% marks in the respective subject/s of the End Semester/yearly Examination.

OR

The remainder or part there of the 1% grace marks of first semester/year plus 1 percent grace-marks of second year, provided that a student secures a minimum of 15% marks in the respective subject/s of the End Semester Examination, similarly for next semesters/years.

For internal Examination:

Carry forward of marks in case a student fails to secure the minimum 50% in any Theory or Practical course as specified in 12, then he/she shall reappear for the end semester examination of that course. However, his/her marks of the Internal Assessment shall be carried over and he/she shall be entitled for grade obtained by him/her on passing.

Note: Grade AB should be considered as failed and treated as one head for deciding ATKT. Such rules are also applicable for those students who fail to register for examination(s) of any course in any semester.

27. Placement Opportunities:

1. Research & Formulation Development Executive: Development of new formulations
2. Production Executive: Managing and supervising production of formulations
3. Project Manager: Coordinating the research, production and marketing activities in a Pharmaceutical organization, deciding as to what and how to develop a new product and plan production and marketing activity as per available capacity.
4. Project Manager: coordinating & erection, installation commissioning of production in a new plant / facility and ensuring that all installation and procedures are as per compliance norms laid out by regulatory agencies.
5. Manager (Administration & Finance): in a pharmaceutical organization.
6. Executive/Manager, Regulatory affairs: Helping the research team to compile drug master files for new drug products for registration and approval with the food & Drug authority of different countries.

28. Program Overview: M. Pharmacy (Pharmaceutical Chemistry)

The Program consists of subjects under the following categories:

Table 13: Program Scheme: **M. Pharmacy (Pharmaceutical Chemistry)**

Year 1 Semester 1												
S. No.	**Course Name**	**Course Code**	**Level**	**Category (Type of Course)**	**Credits (Course wise)**	**Hours per Week**			**Marks Distribution**			**Total Credits (Semester wise)**
						L	**T**	**P**	**I**	**E**	**TL**	
1	**Modern Pharmaceutical Analytical Techniques**	MPC 101T	500-599	DC	4	4			25	75	100	**26**
2	**Advanced Organic Chemistry-I**	MPC 102T	500-599	DC	4	4			25	75	100	
3	**Advanced Medicinal Chemistry-I**	MPC 103T	500-599	DC	4	4			25	75	100	
4	**Chemistry of Natural Products**	MPC 104T	500-599	DC	4	4			25	75	100	
5	**Pharmaceutical Chemistry Practical-I**	MPC 105P	500-599	DC	6			12	50	100	150	
6	**Seminar/Assignments**	MPC 106S	500-599	DC	4	7			100		100	
Year 1 Semester 2												
7	**Advanced Spectral Analysis**	MPC 201T	500-599	DC	4	4			25	75	100	**29**
8	**Advanced Organic Chemistry-II**	MPC 202T	500-599	DC	4	4			25	75	100	
9	**Computer Aided Drug Design**	MPC 203T	500-599	DC	4	4			25	75	100	
10	**Pharmaceutical Process Chemistry**	MPC 204T	500-599	DC	4	4			25	75	100	
11	**Pharmaceutical Chemistry Practical-II**	MPC 205P	500-599	DC	6			12	50	100	150	
12	**Seminar/Assignments**	MPC 206S	500-599	DC	4	7			100		100	
13	**Disaster Management**	DM 101	500-599	UNI	3	3			15	35	50	

Year 2 Semester 3												
14	**Research Methodology and Biostatistics***	MRM 301T	500-599	DC	4	4			25	75	100	**23**
15	**Journal club**	MPR 302J	500-599	DC	1	1			25		25	
16	**Discussion / Presentation (Proposal Presentation)**	MPR 302P	500-599	DC	2	2			50		50	
17	**Research Work**	MPR 302R	500-599	DC	14	28				350	350	
18	**Human Values and Professional Ethics**	HR 101	500-599	UNI	3	3			15	35	50	
Year 2 Semester 4												
19	**Journal Club**	MPR 401J	500-599	DC	1	1			25		25	**20**
20	**Research Work and Colloquium**	MPR 401R	500-599	DC	16	31				400	400	
21	**Discussion/Final Presentation**	MPR 401D	500-599	DC	3	3			75		75	

CHITKARA UNIVERSITY

1st Semester

MODERN PHARMACEUTICAL ANALYSIS (MPC 101T)

Scope

This subject deals with various advanced analytical instrumental techniques for identification, characterization and quantification of drugs. Instruments dealt are NMR, Mass spectrometer, IR, HPLC etc..

Objectives

After completion of course student is able to know,

- ✓ The analysis of various drugs in single and combination dosage forms
- ✓ Theoretical and practical skills of the instruments

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01:	Develop the basic theoretical education of the instrumentation techniques available.
CO 02:	Compare and contrast the various method of analysis and their outcomes.
CO 03:	Demonstrate Practical skills for the analysis of drugs and excipients using various instrumentation techniques.
CO 04:	Interpret analytical data, prepare analytical reports, and communicate results in a clear and concise manner.
CO 05:	Understand the ethical considerations and professional conduct in pharmaceutical analytical research.

THEORY **60 Hrs**

1. **Chromatography:** Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution and applications of the following: a) Paper chromatography b) Thin Layer chromatography c) Ion exchange chromatography d) Column chromatography e) High Performance Liquid chromatography 7 Hrs
2. **IR Spectroscopy**: Theory, Modes of Molecular vibrations, Sample handling, Instrumentation of Dispersive and Fourier - Transform IR Spectrometer, Factors affecting vibrational frequencies, Applications and interpretation of IR spectroscopy. 07 Hrs
3. **NMR spectroscopy**: Quantum numbers and their role in NMR, Principle, Instrumentation, Solvent requirement in NMR, 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 and interpretation of ^{1}H &^{13}C-NMR spectroscopy, Brief introduction about 2D-NMR: DEPT, COSY, NOESY. 15 Hrs

4. **Mass Spectroscopy**: Introduction, Principle, Theory, Instrumentation of Mass Spectroscopy, Different types of ionization like ESI, chemical ionization, MALDI, and FAB; factors affecting fragmentation , ion analysis, ion abundance, Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, Isotopic peaks, McLafferty rearrangement, Nitrogen rule, Analyzers of Quadrupole and Time of Flight and Applications of Mass spectroscopy 11 Hrs
5. **UV-Visible & fluorescence spectroscopy**: Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy, Choice of solvents and solvent effect and Applications of UV-Visible spectroscopy, Spectroflourimetry: Theory of Fluorescence, Factors affecting fluorescence, Quenchers, Instrumentation and Applications of fluorescence spectrophotometer. 08 Hrs
6. **X ray Crystallography:** Bragg's law, Rotating crystal technique, X ray powder technique, Types of crystals and applications of X-ray diffraction. 06 Hrs
7. **Thermal methods of analysis:** Introduction, principle, instrumentation and application of DSC, DTA and TGA. 06 Hrs

REFERENCES

1. Spectrometric Identification of Organic compounds - Robert M Silverstein, 6 th edition, John Wiley & Sons, 2004.
2. Principles of Instrumental Analysis - Doglas A Skoog, F. James Holler, Timothy A. Nieman, 5 th edition, Eastern press, Bangalore, 1998.
3. Instrumental methods of analysis – Willards, 7 th edition, CBS publishers.
4. Practical Pharmaceutical Chemistry – Beckett and Stenlake, Vol II, 4 th edition, CBS Publishers, New Delhi, 1997.
5. Organic Spectroscopy - William Kemp, 3 rd edition, ELBS, 1991.
6. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3 rd Edition, CBS Publishers, New Delhi, 1997. 7. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series

ADVANCED ORGANIC CHEMISTRY-I (MPC 102T)

Scope: The subject is designed to provide in-depth knowledge about advances in organic chemistry, different techniques of organic synthesis and their applications to process chemistry as well as drug discovery.

Objectives: Upon completion of course, the student shall be to understand

- ✓ The mechanism & applications of various named reactions
- ✓ The concept of stereochemistry of organic compounds.
- ✓ To Formulate mechanistic study of organic reactions and synthesis.

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01:	explain the basic concepts of organic chemistry towards professional education.
CO 02:	understand the various reactive intermediates in organic synthesis for drug development
CO 03:	understand reaction mechanisms of various named reactions in heterocyclic chemistry.
CO 04:	know about the types of synthetic reagents and role of protecting groups in synthetic chemistry.
CO 05:	discuss Synthon approach and retrosynthetic applications for innovative development of new drug molecules.

THEORY **60 Hrs**

1. Basic Aspects of Organic Chemistry: **12 hrs**

1. Organic intermediates: Carbocations, carbanions, free radicals, carbenes and nitrenes. Their method of formation, stability and synthetic applications.
2. Types of reaction mechanisms and methods of determining them,
3. Detailed knowledge regarding the reactions, mechanisms and their relative reactivity and orientations.

Addition reactions

a) Nucleophilic uni- and bimolecular reactions (SN1 and SN2)
b) Elimination reactions (E1 & E2; Hoffman & Saytzeff's rule)
c) Rearrangement reaction

2 Study of mechanism and synthetic applications of following named Reactions: 12 Hrs

Ugi reaction, Brook rearrangement, Ullmann coupling reactions, Dieckmann Reaction, Doebner-Miller Reaction, Sandmeyer Reaction, Mitsunobu reaction, Mannich reaction, Vilsmeyer-Haack Reaction, Sharpless asymmetric epoxidation, Baeyer-Villiger oxidation, Shapiro & Suzuki reaction, Ozonolysis and Michael addition reaction

3 Synthetic Reagents & Applications: **12 hrs**

Aluminiumisopropoxide, N-bromosuccinamide, diazomethane, dicyclohexylcarbodimide, Wilkinson reagent, Witting reagent. Osmium tetroxide, titanium chloride, diazopropane, diethyl azodicarboxylate, Triphenylphosphine, Benzotriazol-1-yloxy) tris (dimethylamino) phosphonium hexafluoro-phosphate (BOP).

Protecting groups

a. Role of protection in organic synthesis

b. Protection for the hydroxyl group, including 1,2-and1,3-diols: ethers, esters, carbonates, cyclic acetals & ketals
c. Protection for the Carbonyl Group: Acetals and Ketals
d. Protection for the Carboxyl Group: amides and hydrazides, esters
e. Protection for the Amino Group and Amino acids: carbamates and amides

4 Heterocyclic Chemistry **12 hrs**

Organic Name reactions with their respective mechanism and application involved in synthesis of drugs containing five, six membered and fused hetrocyclics such as Debus-Radziszewski imidazole synthesis, Knorr Pyrazole Synthesis Pinner Pyrimidine Synthesis, Combes Quinoline Synthesis, Bernthsen Acridine Synthesis, Smiles rearrangement and Traube purine synthesis. Synthesis of few representative drugs containing these hetrocyclic nucleus such as Ketoconazole, Metronidazole, Miconazole, celecoxib, antipyrin, Metamizole sodium, Terconazole, Alprazolam, Triamterene, Sulfamerazine, Trimethoprim, Hydroxychloroquine, Quinine, Chloroquine, Quinacrine, Amsacrine, Prochlorpherazine, Promazine, Chlorpromazine,Theophylline , Mercaptopurine and Thioguanine.

5 Synthon approach and retrosynthesis applications **12 Hrs**

i. Basic principles, terminologies, and advantages of retrosynthesis; guidelines for dissection of molecules. Functional group interconvertion and addition (FGI and FGA)
ii. C-X disconnections; C-C disconnections – alcohols and carbonyl compounds; 1,2, 1,3,1,4, 1,5, 1,6-difunctionalized compounds
iii. Strategies for synthesis of three, four, five and six-membered ring.

REFERENCES

1. “Advanced Organic chemistry, Reaction, Mechanisms and Structure”, J March, John Wiley and Sons, New York.
2. “Mechanism and Structure in Organic Chemistry”, ES Gould, Hold Rinchart and Winston, New York.
3. “Organic Chemistry” Clayden, Greeves, Warren and Woihers., Oxford University Press 2001.
4. “Organic Chemistry” Vol I and II. I.L. Finar. ELBS, Pearson Education Lts, Dorling Kindersley 9India) Pvt. Ltd.,.
5. A guide to mechanisms in Organic Chemistry, Peter Skyes (Orient Longman, New Delhi).
6. Reactive Intermediates in Organic Chemistry, Tandom and Gowel, Oxford & IBH Publishers. 7. Combinational Chemistry – Synthesis and applications – Stephen R Wilson & Anthony W Czarnik, Wiley – Blackwell.
8. Carey, Organic Chemistry, 5 th Edition (Viva Books Pvt. Ltd.)
9. Organic Synthesis - The Disconnection Approach, S. Warren, Wily India
10. Principles of Organic Synthesis, ROC Norman and JM Coxan, Nelson Thorns.
11. Organic Synthesis - Special Techniques. VK Ahluwalia and R Agarwal, Narosa Publishers. 12. Organic Reaction Mechanisms IV thEdtn, VK Ahluwalia and RK Parashar, Narosa Publishers.

ADVANCED MEDICINAL CHEMISTRY-I (MPC 103T)

Scope: The subject is designed to impart knowledge about recent advances in the field of medicinal chemistry at the molecular level including different techniques for rational drug design.

Objectives: At completion of this course it is expected that students will be able to understand.

- ✓ Role of medicinal chemistry in drug research.
- ✓ Concept of MOA and uses of various categories of drugs.
- ✓ Basic principles of biological drug targets and Drug receptor theories.
- ✓ Principles of design of prodrugs
- ✓ Knowledge of the structure-activity relationships (SAR) of drug molecules

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01:	history and role of medicinal chemistry in drug research and physiochemical and stereochemical aspects vs biological action.
CO 02:	gain an in-depth knowledge of the structure-activity relationships (SAR) of drug molecules and the factors that affect their biological activity and selectivity.
CO 03:	understand the principles of design of prodrugs and analogs to improve drug potency, selectivity, and pharmacokinetic properties.
CO 04:	understand the concept of autonomic drugs, NSAID's antihistaminics, anticancer agents including pharmacology and uses.
CO 05:	understand mechanism of action and synthesis of new generation molecules of various categories of drugs using varied green chemistry based methods to reduce its impact on environment

THEORY **60 Hrs**

1. **Introduction to Medicinal Chemistry:** History and development of medicinal chemistry; Physicochemical properties in relation to biological action; Solubility, Partition Coefficient, Acid Base properties, Chemical bonding, Chelation. Stereochemistry and drug action. **Drug metabolism**: Drug metabolism principles- Phase I and Phase II. Factors affecting drug metabolism. 12 Hrs

2. **Biological drug targets:** Receptors, types, binding and activation, theories of drug receptor interaction, drug receptor interactions, agonists vs antagonists, artificial enzymes**.** 8 Hrs
3. **Medicinal chemistry aspects of the following class of drugs**: Study of the development of the following classes of drugs, Classification, mechanism of action, uses of drugs mentioned in the course, Structure activity relationship of selective class of drugs as specified in the course and synthesis of drugs superscripted (*)

a) Autonomic Nervous System: Adrenergic (Agonists and antagonists) (Phenylephrine*, Salbutamol*, Tolazoline*, Propranolol*) & Cholinergic agents (Agonists and Antagonists)(Carbachol*, Ipratropium bromide*, Dicyclomine hydrochloride*) 14 Hrs

b) H1 & H2 receptor antagonist (Diphenhydramine hydrochloride*,Triprolidine hydrochloride*, Promethazine hydrochloride*, Cimetidine*. NSAID's (Chemistry of prostaglandins, leukotrienes and thromboxanes) (Mefenamic acid*, Ibuprofen*, Aspirin*) Antineoplastic agents (Meclorethamine*,Mercaptopurine*,Methotrexate*) 12 Hrs

4. Prodrug Design, Analog design and Peptidomimetics: 14 Hrs

a) Prodrug design: 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.

b) Analog Design: Introduction, Classical & Non classical, Bioisosteric replacement strategies, rigid analogs.

c) Peptidomimetics: Therapeutic values of Peptidomimetics, design of peptidomimetics by manipulation of the amino acids, modification of the peptide backbone, incorporating conformational constraints locally or globally.

REFERENCES

1. Medicinal Chemistry by Burger, Vol I –VI.
2. Wilson and Gisvold'sText book of Organic Medicinal and Pharmaceutical Chemistry, 12 th Edition, Lppincott Williams & Wilkins, Woltess Kluwer (India) Pvt.Ltd, New Delhi.
3. Comprehensive Medicinal Chemistry – Corwin and Hansch.
4. Computational and structural approaches to drug design edited by Robert M Stroud and Janet. F Moore 80
5. Introduction to Quantitative Drug Design by Y.C. Martin.
6. Principles of Medicinal Chemistry by William Foye, 7 th Edition, Ippincott Williams & Wilkins, Woltess Kluwer (India) Pvt.Ltd, New Delhi.
7. Drug Design Volumes by Arienes, Academic Press, Elsevier Publishers, Noida, Uttar Pradesh.
8. Principles of Drug Design by Smith.
9. The Organic Chemistry of the Drug Design and Drug action by Richard B.Silverman, II Edition, Elsevier Publishers, New Delhi.
10. An Introduction to Medicinal Chemistry, Graham L.Patrick, III Edition, Oxford University Press, USA.
11. Biopharmaceutics and pharmacokinetics, DM.Brahmankar, Sunil B. Jaiswal II Edition, 2014, VallabhPrakashan, New Delhi.
12. Peptidomimetics in Organic and Medicinal Chemistry by Antonio Guarna and Andrea Trabocchi, First edition, Wiley publishers.

CHEMISTRY OF NATURAL PRODUCTS (MPC 104T)

Scope: The subject is designed to provide detail knowledge about chemistry of medicinal compounds from natural origin and general methods of structural elucidation of such compounds. It also emphasizes on isolation, purification, and characterization of medicinal compounds from natural origin.

Objectives: At completion of this course, it is expected that students will be able to understand-

- ✓ Different types of natural compounds and their chemistry and medicinal importance
- ✓ The importance of natural compounds as lead molecules for new drug discovery
- ✓ The concept of rDNA technology tool for new drug discovery
- ✓ General methods of structural elucidation of compounds of natural origin
- ✓ Isolation, purification and characterization of simple chemical constituents from natural source

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01: Learn different types of natural compounds and their chemistry and medicinal importance.

CO 02: Understand about natural products as lead molecule in drug discovery process.

CO 03: Know about alkaloids, terpenoids, vitamins, their extraction methods and biological effects.

CO 04: Understand in detail about Recombinant DNA technology and drug discovery.

CO 05: Gain knowledge in detail about structural characterization of natural compounds.

THEORY **60 Hrs**

1. Study of Natural products as leads for new pharmaceuticals for the following class of drugs **12 hrs**

a) Drugs Affecting the Central Nervous System: Morphine Alkaloids
b) Anticancer Drugs: Paclitaxel and Docetaxel, Etoposide, and Teniposide
c) Cardiovascular Drugs: Lovastatin, Teprotide and Dicoumarol
d) Neuromuscular Blocking Drugs: Curare alkaloids
e) Anti-malarial drugs and Analogues
f) Chemistry of macrolid antibiotics (Erythromycin, Azithromycin, Roxithromycin, and Clarithromycin) and β - Lactam antibiotics (Cephalosporins and Carbapenem)

2 a) Alkaloids: **12 hrs**

General introduction, classification, isolation, purification, molecular modification and biological activity of alkaloids, general methods of structural determination of alkaloids, structural elucidation and stereochemistry of ephedrine, morphine, ergot, emetine, and reserpine.

b) Flavonoids:

Introduction, isolation and purification of flavonoids, General methods of structural determination of flavonoids; Structural elucidation of quercetin.

c) Steroids:

General introduction, chemistry of sterols, sapogenin and cardiac glycosides. Stereochemistry and nomenclature of steroids, chemistry of contraceptive agent's male & female sex hormones, (Testosterone, Estradiol, Progesterone), adrenocorticoids (Cortisone), contraceptive agents and steroids (Vit – D).

3 a) Terpenoids **12 hrs**

Classification, isolation, isoprene rule and general methods of structural elucidation of Terpenoids; Structural elucidation of drugs belonging to mono (citral, menthol, camphor), di (retinol, Phytol, taxol) and tri terpenoids (Squalene,Ginsenoside) carotinoids (β carotene).

b) Vitamins Chemistry and Physiological significance of Vitamin A, B1, B2, B12, C, E, Folic acid and Niacin.

4 a) Recombinant DNA technology and drug discovery **12 hrs**

rDNA technology, hybridoma technology, New pharmaceuticals derived from biotechnology; Oligonucleotide therapy. Gene therapy: Introduction, Clinical application and recent advances in
gene therapy, principles of RNA & DNA estimation

b) Active constituent of certain crude drugs used in Indigenous system Diabetic therapy – Gymnema sylvestre, Salacia reticulate, Pterocarpus marsupiam, Swertia chirata, Trigonella foenum graccum; Liver dysfunction – Phyllanthus niruri; Antitumor – Curcuma longa Linn.

5 Structural Characterization of natural compounds **12 hrs**

Structural characterization of natural compounds using IR, 1HNMR, 13CNMR and MS Spectroscopy of specific drugs e.g., Penicillin, Morphine, Camphor, Vit-D, Quercetin and Digitalis glycosides.

REFERENCES

1. Modern Methods of Plant Analysis, Peech and M.V.Tracey, Springer –Verlag, Berlin, Heidelberg.
2. Phytochemistry Vol. I and II by Miller, Jan Nostrant Rein Hld.
3. Recent advances in Phytochemistry Vol. I to IV – Scikel Runeckles, Springer Science & Business Media.
4. Chemistry of natural products Vol I onwards IWPAC.
5. Natural Product Chemistry Nakanishi Gggolo, University Science Books, California.
6. Natural Product Chemistry "A laboratory guide" – Rapheal Khan.
7. The Alkaloid Chemistry and Physiology by RHF Manske, Academic Press.
8. Introduction to molecular Phytochemistry – CHJ Wells, Chapmannstall.
9. Organic Chemistry of Natural Products Vol I and II by Gurdeep and Chatwall, Himalaya Publishing House.
10. Organic Chemistry of Natural Products Vol I and II by O.P. Agarwal, Krishan Prakashan.
11. Organic Chemistry Vol I and II by I.L. Finar, Pearson education.
12. Elements of Biotechnology by P.K. Gupta, Rastogi Publishers.
13. Pharmaceutical Biotechnology by S.P.Vyas and V.K.Dixit, CBS Publishers.
14. Biotechnology by Purohit and Mathur, Agro-Bios, 13th edition.
15. Phytochemical methods of Harborne, Springer, Netherlands.
16. Burger's Medicinal Chemistry.

Pharmaceutical Chemistry Practical-I (MPC 105P) **12 Hrs**

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01: Interpret the results of various analytical techniques, including FT-IR, ^{1}H NMR, ^{13}C NMR, Mass spectra, high-performance liquid chromatography (HPLC), TGA and UV-Vis spectroscopy.

CO 02: Analyze the of compounds through TLC, FT-IR, 1H NMR, C13 NMR and Mass spectra.

CO 03: Develop strong critical thinking and problem-solving skills to excel in industrial pharmacy.

CO 04: Improve communication skills, both oral and written, for effectively presenting scientific data, preparing reports, and communicating with stakeholders.

CO 05: Design various experimental protocols, and the interpretation of obtained data.

(1) Analysis of Pharmacopoeial compounds and their formulations by UV Vis spectrophotometer, RNA & DNA estimation.
(2) Simultaneous estimation of multi component containing formulations by UV spectrophotometry.
(3) Experiments based on Column chromatography.
(4) Experiments based on HPLC.
(5) Experiments based on Gas Chromatography.
(6) Estimation of riboflavin/quinine sulphate by fluorimetry.
(7) Estimation of sodium/potassium by flame photometry

To perform the following reactions of synthetic importance

(1) Purification of organic solvents, column chromatography
(2) Claisen-schimidt reaction.
(3) Benzyllic acid rearrangement.
(4) Beckmann rearrangement.
(5) Hoffmann rearrangement
(6) Mannich reaction
(7) Synthesis of medicinally important compounds involving more than one step along with purification and Characterization using TLC, melting point and IR spectroscopy (4 experiments)
(8) Estimation of elements and functional groups in organic natural compounds
(9) Isolation, characterization like melting point, mixed melting point, molecular weight determination, functional group analysis, co-chromatographic technique for identification of isolated compounds and interpretation of UV and IR data.
(10) Some typical degradation reactions to be carried on selected plant constituents

2nd SEMESTER

ADVANCED SPECTRAL ANALYSIS (MPC 201T)

Scope: This subject deals with various hyphenated analytical instrumental techniques for identification, characterization, and quantification of drugs. Instruments dealt are LC-MS, GC-MS, ATR-IR, DSC etc.

Objectives

At completion of this course, it is expected that students will be able to understand-

- ✓ Interpretation of the NMR, Mass, and IR spectra of various organic compounds
- ✓ Theoretical and practical skills of the hyphenated instruments
- ✓ Identification of organic compounds

COURSE OUTCOMES

Upon completion of the course the student shall be able to

CO 01:	Comprehend and analyze UV and IR spectroscopy in depth, including advanced techniques and their applications.
CO 02:	Analyze and evaluate the advanced skills of NMR and MASS spectroscopy and interpretation of organic compounds.
CO 03:	Develop innovative approaches to enhance the capabilities and applications of spectroscopic techniques.
CO 04:	Understand thermal analysis methods, Raman spectroscopy, and radioimmunoassay (RIA).
CO 05:	Understand and adhere to ethical standards and safety protocols in the use of spectroscopic methods.

THEORY **60Hrs**

1. UV and IR spectroscopy **12 hrs**

Woodward-Fieser rule for 1,3- butadienes, cyclic dienes and α, β-carbonyl compounds and interpretation compounds of enones. ATR-IR, IR Interpretation of organic compounds.

2. NMR spectroscopy: **12 hrs**

1-D and 2-D NMR, NOESY and COSY, HETCOR, INADEQUATE techniques, Interpretation of organic compounds.

3. Mass Spectroscopy **12 hrs**

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.

4.Chromatography **12 hrs**

Principle, Instrumentation and Applications of the following:

a) GC-MS b) GC-AAS c) LC-MS d) LC-FTIR e) LC-NMR f) CEMS g) High Performance Thin Layer chromatography h) Super critical fluid chromatography i) Ion Chromatography j) I-EC (Ion- Exclusion Chromatography) k) Flash chromatography

5 a). Thermal methods of analysis **12 hrs**

Introduction, principle, instrumentation and application of DSC, DTA and TGA.

b). Raman Spectroscopy Introduction, Principle, Instrumentation and Applications.

c). Radio immuno assay: Biological standardization, bioassay, ELISA, Radioimmuno assay of digitalis and insulin.

REFERENCES

1. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.

2. Principles of Instrumental Analysis - Doglas A Skoog, F. James Holler, Timothy A. Nieman, 5th edition, Eastern press, Bangalore, 1998.

3. Instrumental methods of analysis – Willards, 7th edition, CBS publishers.

4. Organic Spectroscopy - William Kemp, 3rd edition, ELBS, 1991.

5. Quantitative analysis of Pharmaceutical formulations by HPTLC - P D Sethi, CBS Publishers, New Delhi.

6. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3rd Edition, CBS Publishers, New Delhi, 1997.

7. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series

ADVANCED ORGANIC CHEMISTRY-II (MPC 202T)

Scope: The subject is designed to provide in-depth knowledge about advances in organic chemistry, different techniques of organic synthesis and their applications to drug discovery.

Objectives Upon completion of course, the student shall be to understand:

- ✓ The mechanism & applications of various named reactions.
- ✓ The various catalysts used in organic reactions.
- ✓ The chemistry of heterocyclic compounds.

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01:	Know about 12 principles of Green chemistry and its applications for sustainable growth.
CO 02:	Design of Domino, Cascade, and Tandem reactions, multi-component reactions.
CO 03:	Understand Stereochemical and asymmetric aspects towards economic and sustainable routes for new drug development.
CO 04:	Know about various types of catalysts and their use in synthetic chemistry.
CO 05:	Learn the fundamental principles of photochemical reactions. towards green environment.

THEORY **60 Hrs**

1. **Green Chemistry** **12 Hrs**

Introduction, principles of green chemistry, Microwave assisted reactions: Merit and demerits of its use, mechanism, effects of solvents in microwave assisted synthesis, microwave technology in process optimization, its applications in various organic reactions and heterocycles synthesis.Ultrasound assisted reactions: Types of sonochemical reactions, homogenous, heterogeneous liquid-liquid and liquid-solid reactions, synthetic applications.

2. Chemistry of peptides **12 Hrs**

a. Coupling reactions in peptide synthesis

b. Principles of solid phase peptide synthesis, t-BOC and FMOC protocols, various solid supports and linkers: Activation procedures, peptide 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, overactivation and side reactions of individual amino acids.

3. **Photochemical Reactions** Basic principles of photochemical reactions. Photo-oxidation and photo-addition. Pericyclic reaction: Types of pericyclic reactions such as cyclo addition,

electrocyclic reaction and sigmatrophic rearrangement reactions with examples, Norrish type-I, II reactions. **12 hrs**

4.Catalysis: Types of catalysis, heterogeneous and homogenous catalysis, advantages and disadvantages, Heterogeneous catalysis-catalyst deactivation, kinetics, and regeneration, some examples of heterogeneous catalysis used in synthesis of drugs, Homogenous catalysis, hydrogenation, hydroformylation, Wilkinson catalysts, Ziegler-Natta catalysts, Biocatalysis: Use of enzymes in organic synthesis, immobilized enzymes/cells in organic reaction. **12 hrs**

5. Stereochemistry & Asymmetric Synthesis **12 hrs**

a. Basic concepts in stereochemistry – optical activity, specific rotation, racemates and resolution of racemates, the Cahn, Ingold, Prelog (CIP) sequence rule, meso compounds, pseudo asymmetric centres, axes of symmetry, Fischers D and L notation, cis-trans isomerism, E and Z notation.

b. Methods of asymmetric synthesis using chiral pool, chiral auxiliaries and catalytic asymmetric synthesis, enantiopure separation and Stereo selective synthesis with examples.

References

1. Stereochemistry - Eliel
2. Advanced Organic Chemistry – Jerry March.
3. Advanced Organic Chemistry, F. A. Carey, R. J. Sundberg, Volume I and II
4. Highlights of Organic Chemistry, W.J. L. Nobel; An Advanced Text Book.
5. Stereochemistry conformation and Mechanism – P. S. Kalsi

COMPUTER AIDED DRUG DESIGN (MPC 203T)

Scope: The subject is designed to impart knowledge on the current state-of-the-art techniques involved in computer assisted drug design.

Objectives: At completion of this course, it is expected that students will be able to understand

- ✓ Role of CADD in drug discovery
- ✓ Different CADD techniques and their applications
- ✓ Various strategies to design and develop new drug like molecules
- ✓ Working with molecular modeling softwares to design new drug molecules
- ✓ The Insilco virtual screening protocols.

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01: Learn Modern drug discovery techniques for sustianable future.

CO 02: Perform QSAR analysis for innovative drug development.

CO 03: Run Molecular Modeling and various virtual screening techniques for drug discovery

CO 04: Predict and analyse ADMET/De novo drug design/Homology modeling

CO 05: Carry out Molecular docking analysis to understand various drug receptor interactions

THEORY **60 Hrs**

1. **Introduction to Computer Aided Drug Design (CADD)**: An overview of modern drug discovery process: Target identification, target validation, lead identification and lead Optimization. Combinatorial chemistry & high throughput screening. History, different techniques, and applications. **06Hrs**
2. **Quantitative Structure Activity Relationships**: Quantitative Structure Activity Relationships: Basics History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (log P, pi-substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters. Applications 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. **15 Hrs**
3. **Molecular Modeling and Docking** a) Molecular and Quantum Mechanics in drug design. 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) **12 Hrs**

a. **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 modeling and generation of 3D-structure of protein. **15 Hrs**

b. **Pharmacophore Mapping and Virtual Screening** Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophore modeling; 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. **12 Hrs**

REFERENCES

1.Computational and structural approaches to drug discovery, Robert MStroud and Janet.F Moore, RCS Publishers.
2. Introduction to Quantitative Drug Design by Y.C. Martin, CRC Press, Taylor & Francis group.
3. Drug Design by Ariens Volume 1 to 10, Academic Press, 1975, Elsevier Publishers.
4. Principles of Drug Design by Smith and Williams, CRC Press, Taylor & Francis.
5. The Organic Chemistry of the Drug Design and Drug action by Richard B. Silverman, Elsevier Publishers.
6. Medicinal Chemistry by Burger, Wiley Publishing Co. 92
7. An Introduction to Medicinal Chemistry –Graham L. Patrick, Oxford University Press.
8. Wilson and Gisvold'sText book of Organic Medicinal and Pharmaceutical Chemistry, Ippincott Williams & Wilkins.
9. Comprehensive Medicinal Chemistry – Corwin and Hansch, Pergamon Publishers.
10. Computational and structural approaches to drug design edited by Robert M Stroud and Janet. F Moore

PHARMACEUTICAL PROCESS CHEMISTRY (MPC 204T)

Scope: The goal of a process chemist is to develop synthetic routes that are safe, cost-effective, environmentally friendly, and efficient. The subject is designed to impart knowledge on the development and optimization of a synthetic route/s and the pilot plant procedure for the sustainable manufacturing of Active Pharmaceutical Ingredients (APIs) and new chemical entities (NCEs) for the drug development phase.

Objectives

At completion of this course, it is expected that students will be able to understand.

- ✓ The strategies of scale up process of apis and intermediates.
- ✓ The various unit operations and various reactions in process chemistry.

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01:	Know about Status of bulk drugs, natural products and formulations in India vis-a-vis industrialized nations
CO 02:	design robust reaction conditions, organic reactions in water, and sustainable development of a process
CO 03:	Use of Domino, Cascade, and Tandem reactions, multi-component reactions.
CO 04:	Scale-up techniques for process optimization, maximization of productivity, in-process control techniques.
CO 05:	Learn about Industrial safety and reaction kinetics and fermentation process.

THEORY **60 Hrs**

1. Process chemistry **12 hrs**

Introduction, Synthetic strategy

Stages of scale up process: Bench, pilot and large scale process.

In-process control and validation of large scale process.

Case studies of some scale up process of APIs.

Impurities in API, types and their sources including genotoxic impurities

2 Unit operations **12 hrs**

a) Extraction: Liquid equilibria, extraction with reflux, extraction with agitation, counter current extraction.

b) Filtration: Theory of filtration, pressure and vacuum filtration, centrifugal filtration,

c) Distillation: azeotropic and steam distillation

d) Evaporation: Types of evaporators, factors affecting evaporation.

e) Crystallization: Crystallization from aqueous, nonaqueous solutions factors affecting crystallization, nucleation. Principle and general methods of Preparation of polymorphs, hydrates, solvates and amorphous APIs.

3 Unit Processes – I **12 hrs**

a) Nitration: Nitrating agents, Aromatic nitration, kinetics and mechanism of aromatic nitration, process equipment for technical nitration, mixed acid for nitration,

b) Halogenation: Kinetics of halogenations, types of halogenations, catalytic halogenations. Case study on industrial halogenation process.

c) Oxidation: Introduction, types of oxidative reactions, Liquid phase oxidation with oxidizing agents. Nonmetallic Oxidizing agents such as H2O2, sodium hypochlorite, Oxygen gas, ozonolysis.

4 Unit Processes – II **12 hrs**

a) **Reduction**: Catalytic hydrogenation, Heterogeneous and homogeneous catalyst; Hydrogen transfer reactions, Metal hydrides. Case study on industrial reduction process.

b) **Fermentation**: Aerobic and anaerobic fermentation. Production of

i. Antibiotics; Penicillin and Streptomycin,

ii. Vitamins: B2 and B12

iii. Statins: Lovastatin, Simvastatin

c) **Reaction progress kinetic analysis**

i. Streamlining reaction steps, route selection,

ii. Characteristics of expedient routes, characteristics of cost-effective routes, reagent selection, families of reagents useful for scale-up.

5 Industrial Safety **12 hrs**

a) MSDS (Material Safety Data Sheet), hazard labels of chemicals and Personal Protection Equipment (PPE)

b) Fire hazards, types of fire & fire extinguishers

c) Occupational Health & Safety Assessment Series 1800 (OHSAS-1800) and ISO 14001(Environmental Management System), Effluents and its management

REFERENCES

1. Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever-Changing Climate-An Overview; K. Gadamasetti, CRC Press.
2. Pharmaceutical Manufacturing Encyclopedia, 3rd edition, Volume 2.
3. Medicinal Chemistry by Burger, 6th edition, Volume 1-8.
4. W.L. McCabe, J.C Smith, Peter Harriott. Unit operations of chemical engineering, 7th edition, McGraw Hill
5. Polymorphism in Pharmaceutical Solids. Dekker Series Volume 95 Ed: H G Brittain (1999)
6. Regina M. Murphy: Introduction to Chemical Processes: Principles, Analysis, Synthesis
7. Peter J. Harrington: Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale-Up
8. P.H.Groggins: Unit processes in organic synthesis (MGH)
9. F.A.Henglein: Chemical Technology (Pergamon)
10. M.Gopal: Dryden's Outlines of Chemical Technology, WEP East-West Press
11. Clausen,Mattson: Principle of Industrial Chemistry, Wiley Publishing Co.,
12. Lowenheim & M.K. Moran: Industrial Chemicals
13. S.D. Shukla & G.N. Pandey: A textbook of Chemical Technology Vol. II, Vikas Publishing House
14. J.K. Stille: Industrial Organic Chemistry (PH)
15. Shreve: Chemical Process, Mc Grawhill.
16. B.K.Sharma: Industrial Chemistry, Goel Publishing House
17. ICH Guidelines
18. United States Food and Drug Administration official website www.fda.gov

CHITKARA UNIVERSITY

PHARMACEUTICAL CHEMISTRY PRACTICAL-II (MPC 205P) 12 Hrs

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01: Perform various Oxidation, Esterification and hydrolysis processes.

CO 02: Interpret the organic compounds by FT-IR, NMR, MS. etc.

CO 03: Use various spectroscopy techniques for characterizations and practical applications.

CO 04: Know about various hetrocyclic moieties and their synthetic/medicinal applications.

CO 05: Perform experiments to understand Lipinski's rule of five, 2D QSAR, 3D QSAR.

(1) Synthesis of organic compounds by adapting different approaches involving (3 experiments)
   (a) Oxidation
   (b) Reduction/hydrogenation
   (c) Nitration
(2) Comparative study of synthesis of APIs/intermediates by different synthetic routes (2 experiments)
(3) Assignments on regulatory requirements in API (2 experiments)
(4) Comparison of absorption spectra by UV and Wood ward – Fieser rule
(5) Interpretation of organic compounds by FT-IR
(6) Interpretation of organic compounds by NMR
(7) Interpretation of organic compounds by MS
(8) Determination of purity by DSC in pharmaceuticals
(9) Identification of organic compounds using FT-IR, NMR, CNMR and Mass spectra
(10) To carry out the preparation of following organic compounds
(11) Preparation of 4-chlorobenzhydrylpiperazine. (an intermediate for cetirizine HCl).
(12) Preparation of 4-iodotolene from p-toluidine.
(13) NaBH4 reduction of vanillin to vanillyl alcohol
(14) Preparation of umbelliferone by Pechhman reaction
(15) Preparation of triphenyl imidazole
(16) To perform the Microwave irradiated reactions of synthetic importance (Any two)
(17) Determination of log PMR, hydrogen bond donors and acceptors of selected drugs using softwares
(18) Calculation of ADMET properties of drug molecules and its analysis using softwares Pharmacophore modeling
(19) 2D-QSAR based experiments
(20) 3D-QSAR based experiments
(21) Docking study based experiment
(22) Virtual screening based experiment

DM 101 DISASTER MANAGEMENT (THEORY) **3 HOURS/WEEK**

Scope and Objectives of the Course

1. To provide students an exposure to disasters, their significance and types
2. To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
3. To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
4. To enhance awareness of institutional processes in the country
5. To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

Theory Course content: **60 Hrs**

UNIT I:

Disasters: Classification, Causes, Impacts

- Introduction to Disasters: Concepts, and definitions (Disaster, Hazard, Vulnerability,Resilience, Risks)
- Impacts (including social, economic, political, environmental, health, psychosocial, etc.Differential impacts- in terms of caste, class, gender, age, location, disability) Classification of hazards/disasters and causes

UNIT II: **15 Hrs**

Principles of disaster management

- Approaches to Disaster Risk reduction: Disaster cycle - its analysis, Phases, Culture of safety, prevention, mitigation and preparedness,
- Community based DRR, Components of Disaster Relief: Water, Food, Sanitation, Shelter, and Health,

Structural and non-structural measures.

UNIT III: **15 Hrs**

Hazard Profile (India) , Disaster Risk Management in India

- Hazard and Vulnerability profile of India

Institutional arrangements (Mitigation, Response and Preparedness ,DM Act and Policy, Other related policies, plans, programs and legislation) ,Role of Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), states, Centre, and other stake-holders.

UNIT IV: **15 Hrs**

Disaster and Development

- Inter-relationship between Disasters and Development: Factors affecting Vulnerabilities, impact of Development projects such as dams, embankments, changes in Land-use etc. urban disasters, Waste Management

Global trends in disasters & Adaptation: Global Trends, Complex emergencies, Pandemics Climate change and Adaptation, Relevance of indigenous knowledge, appropriate technology and local resources

CHITKARA UNIVERSITY

3rd SEMESTER

RESEARCH METHODOLOGY AND BIOSTATISTICS (MRM 301T)

Scope:

This subject deals with descriptive statistics, Graphics, Correlation, Regression, logistic regression Probability theory, Sampling technique, Parametric tests, Non Parametric tests, ANOVA, Introduction to Design of Experiments, Phases of Clinical trials and Observational and Experimental studies, SPSS , R and MINITAB statistical software's , analyzing the statistical data using Excel.

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01:	Develop the ability to apply the statistical techniques and methods while working on a research project work by using softwares.
CO 02:	Understand the appropriate statistical methods required for a particular research design.
CO 03:	Choose the appropriate research design and develop an appropriate research hypothesis for a research project.
CO 04:	Develop a appropriate framework for research studies, study designs and their strengths and limitations.
CO 05:	Analyze of statistical results and communicate findings effectively.

Theory Course content: **60 Hrs**

UNIT I: **10 Hrs**

Introduction: Statistics, Biostatistics, Frequency distribution

Measures of central tendency: Mean, Median, Mode- Pharmaceutical examples

Measures of dispersion: Dispersion, Range, standard deviation, Pharmaceutical problems

Correlation: Definition, Karl Pearson's coefficient of correlation, Multiple correlation - Pharmaceuticals examples.

UNIT II **10 Hrs**

Introduction to Research: Need for research, Need for design of Experiments, Experiential Design Technique.

Graphs: Histogram, Pie Chart, Cubic Graph, response surface plot, Counter Plot graph

Designing the methodology: Sample size determination and Power of a study, Report writing and presentation of data, Protocol, Cohorts studies, Observational studies, Experimental studies, Designing clinical trial, various phases.

UNIT III: **10 Hrs**

Preview of statistical parameters. Different distributions, fiducial limits, linear regression and correlation analysis, and their significance, parametric tests, type of errors, hypothesis testing, experimental designs, statistics in bioequivalence testing, statistical quality control, in-vitro in-vivo correlation. Probability determination, student T-test and chi square test and wilcoxan's rank sum tests.

UNIT IV: **10 Hrs**

Application and Methodology of One way, two way, three way and repeated measures ANOVA. With post hoc tests like Fischer LSD test Tukey's multiple range tests, Bonferroni's test, Sheffe's test and Dennett's test.

Unit-VI **10 Hrs**

Design and Analysis of experiments:

Factorial Design: Definition, 2^2, 2^3 designs. Advantage of factorial design

Response Surface methodology: Central composite design, Historical design, Optimization Techniques

Recommended Books:

7. Clinical Pharmacokinetics Concepts and Applications 3rd edition by Malcolm Rowland and Thomas N. Tozer, Lea and Febiger, Philadelphia, 1987.
8. Gupta, S. (2003) Research Methodologies and Statistical Techniques, Deep and Deep Publications Pvt. Ltd., New Delhi
9. Kothari, C.R. (2003) Research Methodologies: Methods and Techniques, Wishwa Prakashan, New Delhi
10. Pharmaceutical statistics- Practical and clinical applications, Sanford Bolton, publisher Marcel Dekker Inc. New York.
11. Fundamental of Statistics – Himalaya Publishing House- S.C.Gupta
12. Design and Analysis of Experiments –PHI Learning Private Limited, R. Pannerselvam,
13. Design and Analysis of Experiments – Wiley Students Edition, Douglas and C. Montgomery

CHITKARA UNIVERSITY

HR 101 HUMAN VALUES AND PROFESSIONAL ETHICS 2 HOURS/ WEEK

1. **Scope & Objective of the Course:**
   The course provides a vide scope of learning & understanding of the subject and after completion of the subject the student will have the ability to develop human values and its importance in their professional life. The student will also have good knowledge of human rights.

COURSE OUTCOMES:

Upon completion of the course the student shall be able to

CO 01:	Develop critical thinking about character formation, Personal development and value education.
CO 02:	Enhance the knowledge in understanding National and Professional Values.
CO 03:	Deepen the awareness about Fundamental Rights.
CO 04:	Promote compliance with International and National concepts of Human Rights.
CO 05:	Nurture respect to women and children by clearing he concept of their human rights.

General Concepts Introduction about human rights and value education, aim of education, concept of human values and its type

Personal development: Self -analysis, gender equality, respect to age, experience, maturity, family member, coworker. Personality development and its importance in professional world

Character formation through human values: Truthfulness, sacrifice, sincerity ,self-control, tolerance, positive attitude, dignity, ethics

National values : Democracy, socialism, secularism , equality, justice, liberty, freedom

Social values : sympathy, universal brother-hood, duty towards our society

Professional Values: Knowledge thirst ,sincerity towards responsibility, ethics, regularity, punctuality, and faith

Religious values: Accept and respect others believes, tolerance, understanding, faith

Fundamental rights: Introduction and importance of fundamental rights of Indian constitution

Right to Equality: Introduction and its importance, types of rights of equality, equality before law, abolition of untouchability, abolition of titles

Rights to freedom: Introduction and its importance, types of rights, freedom of speech ,freedom to reside and settle , freedom to practice any profession

Rights against exploitation and right to freedom of religion: Introduction and its importance and its effect on human life

Cultural and educational rights and rights to constitutional remedies

Right to property and right to education : Introduction and its importance, importance of education on our life

Human rights-general: Concepts of human rights and its Indian and international perspective, evolution of human rights, Universal Declaration of Human Rights, significance of the UDHR, analysis of the declaration

Therapeutic Measures : Control of mind through physical exercise, meditation

Meditation and Yoga: Introduction and its effects on human mind, types of yoga, how to control our thought through yoga and meditation

Human rights of women and children: Social practice and constitutional safeguards, gender discrimination in workplace

Female foeticide , physical assault and harassment, domestic violence, condition of working of women, child labour, violation by individuals, nuclear weapons and terrorism safeguard

1. **Recommended Books (Reference Books/Text Books):**

- ✓ RB01: Value Education and Human Rights, R.P. Shukla
- ✓ TB01: Introduction to Human Rights and Duties, Dr. T. S. N. Sastry
- ✓ TB02: Value Education and Education For Human Rights, V.C. Pandey

28. Examples of few questions statements pertaining to different levels of Bloom's Taxonomy

A lot of emphasis is laid on, so as to make sure that all assessment components are conducted while following different levels of Bloom's Taxonomy as mentioned in figure.

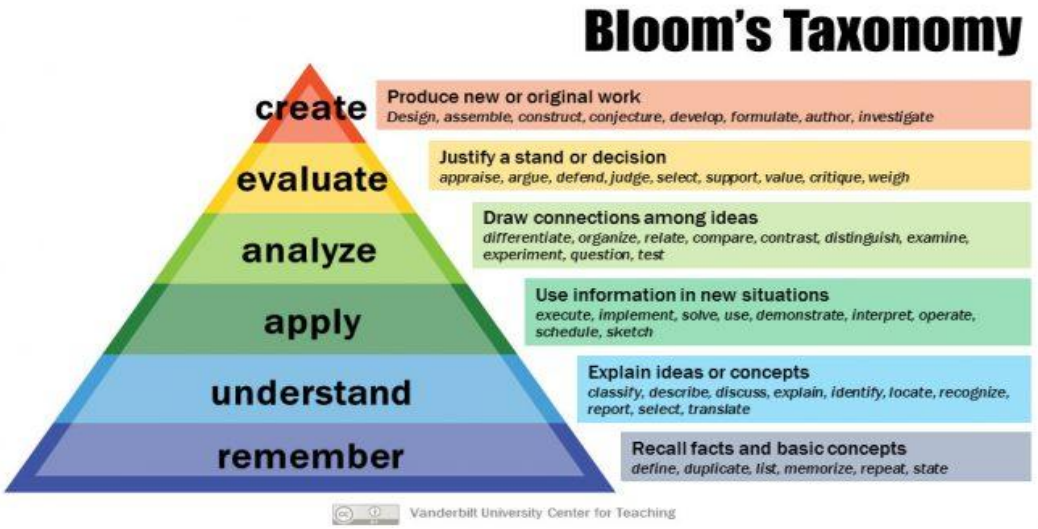

Figure 1. Bloom's Taxonomy [7]

Further a focused effort if also made to align every single Further a focused effort if also made to align every single test item in assessment components with one or the other course learning outcome.

Retrieving, recognizing, and recalling relevant knowledge from long-term memory.

Sample Questions

1. Classify antitubercular drugs into first line and second line drugs.

2. Enlist the major classes of antithyroid drugs.

Understand

Constructing meaning from oral, written and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing and explaining.

Sample Questions

1. Explain the different types of oral contraceptives.

2. How can an understanding of chronotherapy, which involves timing medication administration based on circadian rhythms, help in the management of these conditions?

Applying

Carrying out or using a procedure through executing or implementing.

Sample Questions

1. Enumerate the different types of oral contraceptives. Mention composition of each. What are the primary mechanisms of action of these oral contraceptives, and what are some common side effects associated with their use, aiding in a foundational understanding of how these medications prevent pregnancy and their potential risks?

2. What are the main classes of oral hypoglycemic medications, and how do they work to lower blood sugar levels in patients with diabetes, fostering a foundational understanding of their pharmacological mechanisms? Mention the side effect of each drug.

Analyzing

Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing and attributing

Sample Questions

1. Compile the main mechanisms of action of antitubercular drugs aiding in the treatment of tuberculosis? Mention briefly the management of tuberculosis emphasizing the main goals of antitubercular chemotherapy.

2. Enumerate the primary mechanisms of action of antithyroid drugs in individuals with hyperthyroidism, facilitating a basic comprehension of their pharmacological effects?

Creating & Evaluating

Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning or producing. Making judgments based on criteria and standards through checking and critiquing

Sample Questions

1. Review how corticosteroids exert their pharmacological effects in the body, fostering a basic understanding of their uses. What are the pharmacological actions of these drugs on various organs and site the side effects of these drugs?

2. Define circadian rhythm, and how does it influence various bodily functions and disease processes such as cardiovascular disease, diabetes, asthma, and peptic ulcer?

29. Course Handout Specimen:

An elaborate document named 'Course Handout' providing details about every single course is shared with students at the beginning of every semester. This document typically has various components like –

Institute/School Name			
Department Name			
Program Name			
Course Name		Session	
Course Code		Semester/Batch	
L-T-P(Per Week)		Course Credits	
Pre-requisite		NHEQF Level	
Course Coordinator			

1. Objectives of the Course

<< Provide a brief overview and objectives of this course in not more than 100 words. >>

2. Course Learning Outcomes (CLOs)

Student should be able to:

	CLOs	Program Outcomes (PO)	NHEQF Level Descriptor	No. of Lectures
CLO01				
CLO02				
CLO03				
CLO04				
CLO05				
CLO06 (Only for lab components)				
Total Contact Hours				

CLO-PO Mapping

CLO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CLO01											
CLO02											
CLO03											
CLO04											
CLO05											
CLO06											

H=High, M=Medium, L=Low

3. **Recommended Books:**

B01:
B02:
B03:
B04:
B05

4. **Other readings and relevant websites:**

SerialNo	Link of Journals, Magazines, websites and Research Papers
1.	
2.	
3.	
4.	
5.	

5. **Recommended Tools and Platforms**

<<Mention Tools and Platforms required for the course if required>>

6. **Course Plan: Theory+**

Lab Plan Theory

Plan

Lect. No.	Topic(s)
ST1	
	ST2

	End Term Exam

Lab Plan

Lab No.	Topic(s)
Continuous Evaluation1 (15marks)	
Continuous Evaluation2 (15Marks)	

7. Delivery/Instructional

Resources Theory Plan:

Lect. No.	Topics	Book No, CH No, Page No	TLM	ALM	Web References	Audio-Video
		B01, CH 1.1-1.5, Page no 3-13				

8.

Lab Plan:

Lab No.	Experiment	TLM	ALM	Web References	Audio-Video

8. Remedial Classes[1]

<<Supplement course handout, which may perhaps include special lectures and discussions that would be planned, and schedule notified accordingly.>>

9. Self-Learning[2]

Assignments to promote self-learning, survey of contents from multiple sources.

S.No	Topics	CO	ALM	References/MOOCS

[1] Refer to Annexure
[2] Refer to Annexure

10. Delivery Details of Content Beyond Syllabus[3]

Content beyond syllabus covered (if any) should be delivered to all students that would be planned, and schedule notified accordingly.

S.No	Advanced Topics, Additional Reading, Research papers and any	CO	POs	ALM	References/MOOCS

11. Evaluation Scheme & Components:

Assessment Type	Evaluation Component	Type of Component	No. of Assessments	% Weightage of Component	Max. Marks	Mode of Assessment
Formative	Component1	Continuous Lab Evaluations	02*	30%		Offline
Summative	Component2	Sessional Tests(STs)	02**	20%		Offline
Summative	Component3	End Term Examination	01***	50%		Offline
	Total		**100%**			

Note: Details in above table are sample for the reference, The department decides the assessment policy for each course.

12. Syllabus of the Course:

Subject:			
S.No.	**Topic(s)**	**No. of Lectures**	**Weightage %**

13. Academic Integrityy Policy:

Education at Chitkara University builds on the principle that excellence requires freedom where Honesty and integrity are its prerequisites. Academic honesty in the advancement of knowledge requires that all students and Faculty respect the integrity of one another's work and recognize the importance of acknowledging and safeguarding intellectual property. Any breach of the same will be tantamount to severe academic penalties.

[3] Refer to Annexure

This Document is approved by:

Designation	Name	Signature
Course Coordinator		
Head-Academic Delivery		
Dean		
Date(DD/MM/YYYY)		

Faculty members are expected to religiously follow the contents of the course handout in complete letter and spirit.

29. Mapping of Program Outcomes (POs) with Course Outcomes (COs)

Sr. No.	Course Name	Course Code	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
1	Modern Pharmaceutical Analytical Techniques	MPC101T	**CO 1** Develop the basic theoretical education of the instrumentation techniques available.	H	L	M	H			H	M			
			CO 2 Compare and contrast the various method of analysis and their outcomes.	H	L		H			H			M	
			CO 3 Demonstrate Practical skills for the analysis of drugs and excipients using various instrumentation techniques.	H			H	L	M	H			M	
			CO 4 Interpret analytical data, prepare analytical reports, and communicate results in a clear and concise manner.				M		L	M	H		M	
			CO 5 Understand the ethical considerations and professional conduct in pharmaceutical analytical research.					M	L			H		
2	Advanced Organic Chemistry-I	MPC 102T	**CO 1** explain the basic conceots of organic chemistry towards professional education.	H	H				L	H	M			
			CO 2 understand the various reactive intermediates in organic synthesis for drug development	H	H				L	L	M			
			CO 3 understand reaction mechanisms of various named reactions in heterocyclic chemistry.	H	H				M	H	M			
			CO 4 know about the types of synthetic reagents and role of protecting groups in synthetic chemistry.	H	M	L	H	L	L	H			L	

			CO 5 discuss Synthon approach and retrosynthetic applications for innovative development of new drug molecules.	H	H	M	H	M	M	H				L
3	Advanced Medicinal Chemistry-I	MPC 103T	**CO 1** history and role of medicinal chemistry in drug research and physiochemical and stereochemical aspects vs biological action.	H	M	L								
			CO 2 gain an in-depth knowledge of the structure-activity relationships (SAR) of drug molecules and the factors that affect their biological activity and selectivity.	H	M	L		M		L	H	M		M
			CO 3 understand the principles of design of prodrugs and analogs to improve drug potency, selectivity, and pharmacokinetic properties.	H	H	M	L		H	H	M	M		L
			CO 4 understand the concept of autonomic drugs, NSAID's antihistaminics, anticancer agents including pharmacology and uses.	H	M	M	L	H	M		H			M
			CO 5 understand mechanism of action and synthesis of new generation molecules of various categories of drugs using varied green chemistry based methods to reduce its impact on environment		M		H		H		M	L	H	M
4	Chemistry of Natural Products	MPC 104T	**CO 1** Learn different types of natural compounds and their chemistry and medicinal importance.	H	M	M		M	H		H	M		L
			CO 2 Understand about natural products as lead molecule in drug discovery process.	H	M	L		M	H		H		L	

			CO 3 Know about alkaloids, terpenoids, vitamins, their extraction methods and biological effects.	H		L	L		M		M		H	M
			CO 4 Understand in detail about Recombinant DNA technology and drug discovery.	H	L		L		M		H		M	L
			CO 5 Gain knowledge in detail about structural characterization of natural compounds.	H	L		M	L		L	H		L	M
5	Pharmaceutical Chemistry Practical-I	MPC105P	**CO 1** Interpret the results of various analytical techniques, including FT-IR, 1H NMR, C13 NMR, Mass spectra, high-performance liquid chromatography (HPLC), TGA and UV-Vis spectroscopy.	H	H			L		H		L		H
			CO 2 Analyze the of compounds through TLC, FT-IR, 1H NMR, C13 NMR and Mass spectra.	H		L	H	H	L	H	L		L	H
			CO 3 Develop strong critical thinking and problem-solving skills to excel in industrial pharmacy.	H		H	H	H	L	H	H		H	L
			CO 4 Improve communication skills, both oral and written, for effectively presenting scientific data, preparing reports, and communicating with stakeholders.	H	L	H	L	H				L	H	
			CO 5 Design various experimental protocols, and the interpretation of obtained data.				M	H		L	L	L		M
6	Advanced Spectral Analysis	MPC 201T	**CO 1** Comprehend and analyze UV and IR spectroscopy in depth, including advanced techniques and their applications.	H	L		M			H	M			

			CO 2 Analyze and evaluate the advanced skills of NMR and MASS spectroscopy and interpretation of organic compounds.	H	L		M			H	M			
			CO 3 Develop innovative approaches to enhance the capabilities and applications of spectroscopic techniques.	H	L		M			H	M			
			CO 4 Understand thermal analysis methods, Raman spectroscopy, and radioimmunoassay (RIA).	H	L		M			H	M			
			CO 5 Understand and adhere to ethical standards and safety protocols in the use of spectroscopic methods.	L						M				
7	Advanced Organic Chemistry-II	MPC 202T	**CO 1** Know about 12 principles of Green chemistry and its applications for sustainable growth.	H		L		M				M		M
			CO 2 Design of Domino, Cascade, and Tandem reactions, multi-component reactions.	H	H		L		L		L		L	
			CO 3 Understand Stereochemical and asymmetric aspects towards economic and sustainable routes for new drug development.	H	H	L	M		M	L		M		L
			CO 4 Know about various types of catalysts and their use in synthetic chemistry.	M	H			L		L			L	
			CO 5 Learn the fundamental principles of photochemical reactions. towards green environment.	H		H	L			H	L			L
8	Computer Aided Drug Design	MPC 203T	**CO 1** Learn Modern drug discovery techniques for sustianable future.	H	H	M		H	L		M		L	H
			CO 2 Perform QSAR analysis for innovative drug development.	H	L	M	M	H		L		L	L	H

			CO 3 Run Molecular Modeling and various virtual screening techniques for drug discovery	H	H	H		M			M	L	L	H
			CO 4 Predict and analyse ADMET/De novo drug design/Homology modeling	H	H	H	L	M	L		M	M	L	H
			CO 5 Carry out Molecular docking analysis to understand various drug receptor interactions	H	H	H	M	M		L	L	M	M	H
9	Pharmaceutical Process Chemistry	MPC 204T	**CO 1** Know about Status of bulk drugs, natural products and formulations in India vis-a-vis industrialized nations	M	L	L	L	H		H		M	M	H
			CO 2 design robust reaction conditions, organic reactions in water, and sustainable development of a process	H	M	L	L		L	H	L		H	
			CO 3 Use of Domino, Cascade, and Tandem reactions, multi-component reactions.	H				H		H		M		H
			CO 4 Scale-up techniques for process optimization, maximization of productivity, in-process control techniques.	H	H	L	L		M		M	H		L
			CO 5 Learn about Industrial safety and reaction kinetics and fermentation process.	H	H			L		H		L		H
10	Pharmaceutical Chemistry Practical-II	MPC 205P	**CO 1** Perform various Oxidation, Esterification and hydrolysis processes.	H		L	H	H	L	H	L		L	H
			CO 2 Interpret the organic compounds by FT-IR, NMR, MS. etc.	H		H	H	H	L	H	H		H	L
			CO 3 Use various spectroscopy techniques for characterizations and practical applications.	H	L	H	L	H				L	H	

			CO 4 Know about various heterocyclic moieties and their synthetic/medicinal applications.	M	H	H				H			L	
			CO 5 Perform experiments to understand Lipinski's rule of five, 2D QSAR, 3D QSAR.		H			M		M		L		H
11	Disaster Management	DM 101	C01: Understand the relationship between vulnerability, disasters, prevention and disaster			H	M		L					
			CO2: Enhance knowledge on disasters, impact on social, economic, political, psychosocial, health etc.	H		M			L					
			CO3: Comprehend the significance of disasters and their types.	H			M					L	H	
			CO 4: Analyze the global trends of disasters and adaptation.		H					M				L
			CO5: Impart the learning opportunities to understand the vulnerabilities, urban disasters and waste management	H			M				L			
12	Research Methodology and Biostatistics	MRM 301T	**CO 1:** Develop the ability to apply the statistical techniques and methods while working on a research project work by using software's.	H	H	H		H		H				H
			CO 2 Understand the appropriate statistical methods required for a particular research design.	H	H	H		H		H				H

			CO 3 Choose the appropriate research design and develop an appropriate research hypothesis for a research project.	H	H	H		H		H				H
			CO 4 Develop a appropriate framework for research studies, study designs and their strengths and limitations.	H	H	H		H		H				H
			CO 5 Analyze statistical results and communicate findings effectively.	H	H	H		H		H				H
13	Human Values & Professional Ethics	HR101	CO1: Develop critical thinking about character formation, Personal development and value education.	H		M			L					
			CO2: Enhance the knowledge in understanding National and Professional Values.	H	M				L				H	
			CO3: Deepen awareness about Fundamental Rights.		H		M		L					
			CO4: Promote compliance with International and National concepts of Human Rights.	H		M					L			
			CO5: Nurture respect to women and children by clearing the concept of their human rights.		H		L			M				