

ANDHRA UNIVERSITY



MASTER OF PHARMACY

(2020)

Regulations and Syllabus

Four semester pattern

With effect from 2020-21

M.PHARM (2020) REGULATIONS AND SYLLABUS

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1. Admission, instruction and attendance

The degree of Master of Pharmacy of the Andhra University will be conferred on a candidate who has satisfied the following conditions:

- 1.1. The candidate must have passed the B.Pharm. Degree examination of this University or B.Pharm. Degree examinations of any other University recognized by the Academic Council as equivalent thereto in First or Second class; and must have qualified in any entrance examination, if prescribed.
- 1.2. Every student, selected for admission to PG 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.
- 1.3. The candidate should have undergone a regular course of study as prescribed hereunder extending over a period of four semesters, ordinarily consecutive, and satisfied the academic requirements as prescribed hereinafter. The course of instruction and periods of study shall be as given in the scheme of instruction and in the syllabus.
- 1.4. The subjects of specializations for Master of Pharmacy Course shall be as follows:
 1. Pharmaceutical Analysis
 2. Pharmaceutical Chemistry
 3. Pharmaceutics
 4. Pharmaceutical Biotechnology
 5. Pharmacology
 6. Pharmacognosy
 7. Pharmaceutical Regulatory Affairs
 8. Pharmaceutical Quality Assurance
 9. Industrial Pharmacy
 10. Pharmacy Practice
- 1.5. Instruction and examination in each academic year is spread over two semesters with a minimum of 96 working days in each semester (192 in any given academic year). The odd semesters shall be conducted from the month of July to November and the even semesters shall be conducted from the month of December to April.
- 1.6. Each period of instruction is of 45 minutes duration. Eight periods of instruction are provided on each day and there are six working days in a week (Monday to Saturday).
- 1.7. Attendance Requirements: A regular course of study during an academic semester means a minimum of average attendance of 80% of all the courses of the semester computed by totaling the number of periods of lectures and practicals, as the case may be, held in every course. In special cases where sufficient causes were shown, the Vice-

Chancellor may on the recommendation of the Principal concerned condone the deficiency in the average attendance to an extent of 9% for reasons such as ill health, if the application for condonation is submitted at the time of actual illness and is supported by certificate of; authorized Medical officer approved by the Principal. However, in the case of students, who participate in activities like N.S.S., N.C.C., Inter-Collegiate tournaments conducted by Andhra University, Inter-University tournaments conducted by Inter-university Board and any such other activities involving the representation of the College/University with the prior approval of the principal, the candidate may be deemed to have attended the college during the period solely for the purpose of the examination.

- 1.7. A candidate who cannot satisfy the attendance requirements in clause 1.5 because of late admission under special circumstances reasonable and acceptable to the University on the basis of document, shall fulfill the following conditions; Average attendance: A candidate shall have attended at least a total of 90% of the periods-lectures/practicals as the case may be held from the date of admission and also shall attend at least 50% of the total working days during that academic semester (Late admission means, admissions made after 45 days from date of commencement of the academic semester for the course).
- 1.8. If any candidate fails to satisfy the regulation under 1.5 or 1.6 she/he shall not be allowed for the University Examinations at the end of the semester, and he/she shall not be allowed for promotion to the next higher class of study. He/she shall be required to repeat the regular course of study of that academic semester along with the next regular batch.
- 1.9. A regular record of attendance 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.

2. Examinations – Internal assessment and Semester-end

- 2.1. Assessment for the award of degree shall consists of (a) internal assessment for 30 marks in each of the theory and practical courses separately. (b) Semester-end examination as detailed in the scheme of examination for 70 marks in each of the theory and practical separately.
- 2.2. Regulations concerning internal assessment: Internal assessment consist of continuous mode (10 marks for theory and 15 marks for practical) and sessional examinations (20 marks for theory and 15 marks for practical)
- 2.2.1. Scheme for awarding continuous mode marks for theory and practical

Theory-Criteria	Marks
Attendance	5
Student-Teacher Interaction	5
Theory sessional examination	20
Total theory internal assessment	30
Practical-Criteria	
Attendance	5
Record + Viva-voce	10
Practical sessional examination	15
Total practical internal assessment	30

2.2.1.1. Guidelines for the allotment of marks for attendance

Percentage of Attendance	Theory/Practical
95 -100	5
90-94	4
85-89	3
80-84	2
Less than 80	0

2.2.1.2. Guidelines for allotment of marks for Student-Teacher interaction

The teacher shall create some interactive sessions for theory topics and every student shall interact on the given topic relating to its application in pharmacy. The teacher should assess the student capacity for understanding of the concept taught. It shall not be like seminars.

2.2.1.3. Guidelines for allotment of marks Record + Viva-voce

The teacher should conduct viva-voce at the end of each practical and evaluate the record on continuous mode and shall award these marks.

2.2.4. Guidelines for sessional examinations

Two sessional examinations shall be conducted for each theory/practical course. The average marks of the two shall be computed.

The teacher who teaches the subject shall ordinarily to be the internal examiner.

There shall be no provision for the improvement of the sessional marks.

There is no minimum mark prescribed for sessional examination for pass in the end semester examination.

If any student is absent for a single or both sessional examinations, the candidate will be awarded “ZERO” in the respective examination.

The theory average sessional mark shall be finally computed for 20 marks and average practical sessional mark shall be finally computed for 15 marks.

2.3. Regulations concerning M.Pharm I and II semester evaluation pattern:

2.3.1. There shall be one semester end examination in each theory course based on the question paper set by an external paper setter and there shall be single valuation. There shall be one semester end examination in each practical course as per the scheme of examination and valuation shall be done by examiner. The duration of the practical examination is of 6 hours as prescribed.

2.3.2. However the student may apply for revaluation of any subject in theory papers after declaring the results as per University examination guide lines.

2.3.3. Seminar

A seminar at the end of first and second semesters is separately conducted keeping in view of the enrichment of required communication, presentation and explanatory skills. A minimum of four seminars shall be given during the semester before the Program Committee and other students and documented separately for record in a Semester Seminar Register.

2.3.4. Comprehensive viva

At the end of II Semester comprehensive viva will be conducted for all the subjects

covering the theory subjects of I & II semesters by the external examiner and eligible internal examiners (at least two from the college) who taught these subjects. The candidate should obtain minimum of 50% marks for passing the examination.

2.3.4. Journal Club

In case of Journal Club, based on the research proposal, each student shall collect a minimum of 5 research papers (published in a reputed journal with impact factor of Thomson & Reuters of not less than 1.0) and should discuss in a Programme Committee (consisting of Head of the Department, Research Supervisor and other Senior faculty members) and documented separately for record in a Journal Club Register.

- 2.3.5. A student shall be eligible to carry forward all the courses of I, II semesters. However, he/she shall not be eligible to attend the courses of IV semester until the candidate clears III semester Midterm Project Review.

2.4. Regulations concerning M. Pharm. III and IV Semester evaluation pattern:

- 2.4.1. Evaluation of the seminar on the objectives and work plan of the proposed project is to be completed within one month from the commencement of the project date with three examiners from the same college consisting of research guide, another teacher in the concerned specialization and third teacher from different specialization. These teachers must fulfill the eligibility criteria laid down in Section 3.
- 2.4.2. Evaluation of the M.Pharm III Semester Mid-term project review and seminar on selected topic will be done by the research guide and external examiner. The seminar on the selected topic shall not be the one connected with the topic of the thesis work but should be related to concerned specialization.
- 2.4.3. A candidate shall submit four copies of his/her thesis either printed or typed, embodying the results of research work done by him under direction of an approved research director following the specific guidelines as stipulated under Section 5. All the candidates must submit their thesis within the prescribed date as per the academic calendar.
- 2.4.4. The thesis submitted by the candidate shall be examined by a Board of Examiners consisting of an External Examiner and the research director and shall have to be approved after holding a viva voce examination to test the knowledge of the candidate in the subject. The thesis will be evaluated independently by the external examiner and research director and in case the difference between examiners is more than 20%, the thesis shall be sent to a second external examiner whose award shall be the final. The viva-voce examination will be jointly conducted both by the external examiner and research director. A candidate can re-submit the thesis in a revised form after further work, if required to do so.
- 2.4.5. A candidate desires of improving his/her class shall take either or both of the first two semesters as a whole.

2.5. Guidelines for writing the thesis

The thesis should have the following pages in order:

1. Title page highlighting the title, name of the candidate, reg. no., guide name, college name and month and year of submission.
2. The inner title page containing the same details on white background.
3. Certificate from the Head of the institution
4. Certificate from the Research Director
5. Certificate from the ethical committees for approval of study, if any

6. Declaration by the student
7. Acknowledgements
8. Index highlighting chapter titles and sections titles
9. Index for tables, figures and plates, if any
10. Abbreviations and symbols
11. Materials used in the investigation with their procurement details like name of the company, batch number etc.
12. Equipment used in the study with the model number and other details
13. The thesis should contain the following chapters:
 - a) Aim and objectives of the investigation
 - b) Introduction and literature survey
 - c) Description: Methods and Materials, etc.
 - d) Experimental work
 - e) Results and discussion
 - f) Summary and conclusions
 - g) References (The references may be included at the end of each chapter or at the end of the thesis according to the convenience)
- 2.5.1. The thesis should be typed in times new roman in 12 font size with 1.5 line spacing from the beginning of the thesis including titles to the chapters and sections. Bold font may be used wherever necessary. The students are expected to follow scientific grammar for writing *in vivo* etc. which should be in italics.
- 2.5.2. The citation of references should be done carefully by citing the complete reference i.e. name of all the authors. Usage of et al. is not allowed in the citation of reference. The students are expected to give the primary references rather than secondary or higher levels of references. The presentation of reference must be in Vancouver style.
- 2.5.3. No code names or numbers are allowed to be written in the thesis for the materials used in the project.
- 2.5.4. The examiners of thesis evaluation are expected to verify all this and appropriate corrections are to be made before conducting the viva-voce examination.
- 2.5.5 Project Work/IV Semester Assessment – Division of Marks:

Course 402 -Thesis Evaluation (Max. Marks – 150)

Criteria of Evaluation	Marks
Seminar/Presentation of work	20
Objective(s) of the work done	20
Methodology adopted	40
Results and Discussion	40
Conclusions and Outcomes	30
Total	150

The division of marks shall be clearly indicated for every candidate in the marks statement being sent to the University.

2.6. End Semester examinations

The End Semester examination for each theory, practical and other courses through

semesters I to IV shall be conducted by the University except for the subject with asterisk symbol (*) in the tables of the each specialization courses (Non University Examinations) for which examinations shall be conducted by the subject experts at college level and the marks/grades shall be submitted to the University. In case of theory examinations, the question paper of the corresponding subject shall be mailed (Official mail id) to the Controller of Examinations and Chairman, BOS with signature of the Head of the Institute in PDF format within twenty four hours after completion of the examination.

3. Eligibility criteria for appointment as examiner for M.Pharm examination

- 3.1. In order to eligible to be appointed as an internal examiner for the semester end examination in the respective specialization, a teacher shall have M. Pharm. or Ph.D. in the respective specialization with at least three years of M.Pharm teaching experience for the course concerned.
- 3.2. The eligibility of a teacher for guiding the M.Pharm III and IV semester project is as follows:
 - 3.2.1. The teacher must have M.Pharm/Ph.D. in the respective specialization with an experience of minimum 3 years of Post Graduate teaching in the respective specialization.
 - 3.2.2. The eligibility of such teachers qualified for guiding M.Pharm projects must be ratified by the Board of Studies before commencement of M.Pharm guidance.
 - 3.2.3. The recognized M.Pharm guides are not eligible to guide more than 6 students in one academic year including joint guidance.

4. Regulations for pursuing M.Pharm III and IV Semester project

- 4.1. Students desirous of pursuing M.Pharm III and IV semester projects outside college are required to get the approval from the college before one month from the commencement of the project work. The research work can be carried out in a GMP compliant industry (as approved by WHO, USFDA etc.) and Central research laboratories like IICT, CDRI, NIH etc. or DSIR and Drug Control Administration recognized laboratories. A certificate to that effect must be incorporated in the M.Pharm thesis indicating the duration of stay. If the duration of stay is less than nine months the remaining period of stay in the college should be certified by the research supervisor and the Principal.
- 4.2. All the students should present a seminar on the objectives of their work, work plan, etc. within one month from the commencement of the project. The students should attend a mid-term review seminar in the presence of a committee consisting of one external examiner, research director. The suggestions made by the committee are to be taken into consideration for further work and should be presented in the thesis.

5. Declaration of results and classification:

- 5.1. A candidate shall be declared to have passed the examination held at the end of each semester if obtains i) not less than 40% in the each theory and 50% in each practical, seminar, comprehensive viva, thesis and thesis viva-voce at the end of each semester end examination and ii) an aggregate of 50% of all examinations of that semester including sessionals. There are no minimum marks prescribed for sessional examination.
- 5.2. A candidate who has successfully completed the examination in a course by securing not less than 50% of marks shall not be permitted to retake the examination in that course.
- 5.3. A candidate who fails to secure 50% of marks on the aggregate but secures 50% or

more in some courses and between 40-49% in the other courses, he/she shall be required to retake the semester and supplementary examination in one or more of the courses in which he/she secures less than 50% of marks as per his/her choice to satisfy the requirement of 50% aggregate.

5.4. Declaration of class

The classes 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

6. Grading system:

6.1. Appropriate letter grades are awarded in each theory and practical subject to only such candidates who have passed in the university examinations. Internal assessment marks and university examination marks put together will be taken into account for the letter grading system in each subject separately.

6.2. A candidate registered for the university examination but fails to appear or fails to score the minimum required 40% marks in the university examination will get a grade 'F', indicating failure or grade of incompleteness.

6.3. A subject successfully completed cannot be repeated. Final evaluation of each subject (theory and practical separately) will be carried out on a 10- point grading system corresponding to the marks obtained in that subject. Each subject letter grade is converted into a specific grade value associated with the letter grade as given below (Table).

6.4. Grading of performances

Based on the performance, 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 below.

10-Point grading system

Percentage of marks	Grade	Grade points
90.00 - 100	O	10.0
80.00 - 89.99	A	9.0
70.00 – 79.99	B	8.0
60.00 – 69.99	C	7.0
50.00 – 59.99	D	6.0
40.00 – 49.99	E	5.0
< 40.00	F (Fail)	0.0
The grade W represents failure due to insufficient attendance in the semester or year	W	0.0
Incomplete (subsequently to be changed into pass or E or O or F grade in the same semester)	I	0.0

6.5 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:

$$\text{SGPA} = \frac{C1G1+C2G2+C3G3+C4G4}{C1+C2+C3+C4}$$

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 AB grade awarded in that semester. For example if a learner has F or AB grade in course 4, the SGPA shall then be computed as:

$$\text{SGPA} = \frac{C1G1+C2G2+C3G3+C4*ZERO}{C1+C2+C3+C4}$$

The credits allotted to each course are given in the respective specialization **Tables 1-10.**

6.6. 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:

$$\text{CGPA} = \frac{C1S1+C2S2+C3S3+C4S4}{C1+C2+C3+C4}$$

Where C₁, C₂, C₃, C₄...is the total number of credits for semester I, II, III and IV and S₁, S₂, S₃ and S₄ are the SGPA of semester I, II, III and IV.

7. Guidelines for paper setting and model papers.

7.1. Guidelines for theory paper setting for semester end examinations

- 7.1.1. The semester end question paper in each theory course is to be set for a total of 70 marks by an external paper setter as per the general model given below.
- 7.1.2. Question paper consists of 5 questions each carrying 5 marks out of which 4 questions are to be answered by the candidate and 7 questions each carrying 10 marks out of which 5 questions are to be answered by the candidate for a total of 70 marks. Each main question may contain subsections like a, b, c etc.
- 7.1.3. The questions given should be spread over the entire syllabus in an even manner covering all the units as per the pattern of the question paper given below.
- 7.1.4. Model question paper for theory course:

Course No.

Specialization Name:

Title of the course:

Time: 3 Hours

Max. Marks: 70

Part A (Question Numbers 1-5)

Answer any **four** questions out of five questions

4X5=20

One question has to be set from each unit.

Part B

Answer any **five** questions out of **seven** questions (Question Numbers 6-12) 5X10=50

Five questions are to be set from five units and the remaining two should cover at least four out of five units. The main questions may contain sub question like 6(a), 6(b) etc.

7.2. Guidelines for practical paper setting for semester end examination

7.2.1. The question paper in each semester end practical examination is to be set jointly by two examiners and evaluated, one external and one internal as per the general model provided below.

7.2.2. Model question paper for practical course:

Course No.

Title of the course

Time: 6 hrs.

1. Synopsis	10 marks
2. Major experiment	30 marks
3. Minor experiment	20 marks
4. Viva voce	10 marks

Total: 70 marks

7.3. Guidelines for theory/practical sessional examination paper setting:

Question paper pattern for theory Sessional examinations

Max. Marks: 30

Time: 2 Hours

Part A

Answer any **two** questions out of three questions 2X5=10

Part B

Answer any **two** questions out of three questions 2X10=20

Each of the sessional examination question paper should cover at least half the units of the syllabus.

Question paper pattern for practical sessional examinations

Max. Marks: 30

Time: 4 hours

1. Synopsis	5 Marks
2. Experiment	20 Marks
3. Viva	5 Marks

Total: 30 Marks

Table 2: Pharmaceutical Chemistry (MPC)

Code	Course	Credits	Hours/ week	Internal Assessment			Semester End Exam	Total
				Continuous mode	Sessional Exam	Total		
I Semester								
MPC 101T	Modern Pharmaceutical Analytical Techniques	4	4	10	20	30	70	100
MPC 102T	Advanced Organic Chemistry - I	4	4	10	20	30	70	100
MPC 103T	Advanced Medicinal Chemistry	4	4	10	20	30	70	100
MPC 104T	Chemistry of Natural Products	4	4	10	20	30	70	100
MPC 105P	Pharmaceutical Chemistry Practical - I	2	6	15	15	30	70	100
MPC 106P	Pharmaceutical Chemistry Practical - II	2	6	15	15	30	70	100
MPC 107	Seminar*	2	4	50	---	---	---	50
	Total	22	32	---	---	---	---	650
II Semester								
MPC 201T	Advanced Spectral Analysis	4	4	10	20	30	70	100
MPC 202T	Advanced Organic Chemistry - II	4	4	10	20	30	70	100
MPC 203T	Computer Aided Drug Design (CADD)	4	4	10	20	30	70	100
MPC 204T	Pharmaceutical Process Chemistry	4	4	10	20	30	70	100
MPC 205P	Pharmaceutical Chemistry Practical - III	2	6	15	15	30	70	100
MPC 206	Comprehensive Viva	2	---	---	---	---	---	50
MPC 207	Seminar*	2	2	50	---	---	---	50
	Total	22	26	---	---	---	---	600

Table 2: Pharmaceutical Chemistry (MPC) continued

III Semester								
MRM 301T	Research Methodology and Biostatistics*	2	4	10	20	30	70	100
MPC 302	Journal Club*	2	2	50	---	---	---	50
MPC 303	Discussion /Presentation (Dissertation Title & Project Proposal)*	2	---	50	---	---	---	50
MPC 304	Seminar on selected topic	4	4	---	---	---	100	100
MPC 305	Research Work Progress (Mid Term Report)	10	20	---			200	100
	Total:	20	30	---	---	---	---	400
IV Semester								
MPC 401	Journal Club*	2	2	50	---	---	---	50
MPC 402	Thesis evaluation	12	20	---	---	---	150	150
MPC 403	Thesis viva	4	---	---	---	---	50	50
	Total:	20	22	---	---	---	---	250

* Non-University Examination

PHARMACEUTICAL CHEMISTRY

PROGRAM OUTCOMES

PO1: Students will be able to develop disciplinary knowledge and skill of applying modern technologies, handling advanced instruments and Chemistry related soft-wares for chemical analysis, characterization of materials and in separation technology

PO2: The curriculum of the program combines fundamental knowledge and more advanced skills to prepare students to present their research both orally and in technical writing

PO3: Students will be able to reason and use a comparative chemistry method that is supported by evidence to explain chemical synthesis and analysis

PO4: Students will develop critical thinking and also to design, carry out, record and analyze the results of chemical reactions performed during their program period

PO5: Through proper questioning, planning, and reporting of experimental study, it is anticipated that the program curriculum will foster an inquisitive nature in the students

PO6: As a result of program design, a student will be able to become a skilled candidate by acquiring knowledge about writing, planning, studying ethical standards, and laws and regulations relevant to scientific project operation

PO7: The program content is designed in such a manner, that students in chemistry can use a variety of chemistry-based software, good instruments, and technologies to synthesise, characterise, and analyse chemical substances with ease. Such a practice will give students a strong possibility to find employment outside of academic and administrative positions

PO8: The program also helps them to understand the causes of environmental pollution and thereby applying eco-friendly policies instead of hazardous ones in every aspect

PROGRAMSPECIFIC OUTCOMES(PSOs)

PSO1: The students in pharmaceutical chemistry are expected to gain knowledge of the fundamental concepts of chemistry and applied chemistry through theory and practical

PSO2: To possess minimum standards of communication skills to read and understand documents so that they can solve their problems very methodically, independently and with logical argument.

PSO3: Students are expected to achieve critical thinking ability to design, carry out, record and analyze the results of chemical reactions.

PSO4: Students are expected to possess basic psychological skills so that they can deal with individuals and students of various socio-cultural, economic and educational levels.

PSO5: Program will enable the students to be well trained with problem-solving philosophical approaches that are pertinent across the disciplines.

PSO6: The design of the program will help students to be team players, with productive co-operations involving members from diverse socio-cultural backgrounds.

PSO7: Students are expected to be technically well trained with modern devices and Chemistry based software and has powerful knowledge in different disciplines of Chemistry so they can easily involve themselves in theory and laboratory-based research activities.

PSO8: Creates awareness of contemporary issues related the pharmaceutical chemistry.

PROGRAM EDUCATIONAL OBJECTIVES(PEOs)

1. The students after completion of the program at postgraduation level in pharmaceutical chemistry, will finally develop an understanding of various major concepts
2. Also, they can develop an understanding of theoretical principles and experimental findings in pharmaceutical chemistry
3. Students of the program go into a variety of career or work environments like educational institutions, industries, business, research laboratories, etc
4. At the end of the program, students will be able to explore different corners of research areas.
5. Inculcate leadership capabilities through effective communications, appropriate time management and self-upgradation
6. By using formal and informal learning opportunities, helps students to maintain and enhance technical excellence and professional growth
7. Program facilitates to establish closer ties between overseas alumni and graduate students to help them provide crucial benefits like inspiration, reputation and financial support
8. To foster ambitious desire among students to pursue higher studies and career growth

MPC 104, Subject : Chemistry of Natural Products

Course Outcome

1. To attain detailed knowledge about chemistry of medicinal compounds from natural origin.
2. To understand general methods of structural elucidation of medicinally active natural compounds.
3. To attain knowledge regarding isolation and purification of medicinal compounds from natural origin.
4. To characterize products by physical and spectroscopic means including IR, NMR, GC, and MS.
5. To identify different types of natural products, their occurrence, structure, biosynthesis and properties.
6. To know the use of natural products as starting materials

Course Educational Objectives

1. Learn the different types of alkaloids, glycosides & terpenes etc and their chemistry and medicinal importance.
2. Explain the importance of natural compounds as lead molecules for new drug discovery.
3. Learn the constituent present in crude drugs responsible for anti-diabetic activity
4. Discuss rDNA technology tool for new drug discovery.
5. Explain vitamins Chemistry and Physiological significance of Vitamin
6. Elaborate general methods of structural elucidation of compounds of natural origin.
7. Learn advanced methods of structural elucidation of compounds of natural origin.
8. Understand isolation, purification and characterization of simple chemical constituents from the natural source

Learning outcomes

Unit 1

1. Discuss the drug affecting the central nervous system i.e Morphinealkaloids
2. Discuss the anticancer drugs like paclitaxel, docetaxel, etoposide andteniposide
3. Explain the cardiovascular drugs lovastatin, teprotide and dicoumarol
4. Explain neuromuscular blocking drugs curarealkaloids
5. Discuss antimalarial drugs andanalogues
6. Describe chemistry of macrolidantibiotics

Unit 2

1. Describe classification, isolation, purification ofalkaloids
2. Explain general methods of structural determination ofalkaloids
3. Discuss elucidation and stereochemistry of ephedrine andmorphine
4. Discuss elucidation and stereochemistry of ergot, emetine andreserpine
5. Discuss isolation and purification of flavonoids, General methods ofstructural determination offlavonoids
6. Explain Structural elucidation ofquercetin.
7. Discuss General introduction, chemistry of sterols, sapogenin and cardiacglycosides.
8. Discuss Stereochemistry and nomenclature of steroids, chemistry of contraceptive agents male & female sexhormones

Unit 3

1. Classification, isolation, isoprene rule and general methods of structural elucidationof Terpenoids.
2. Structural elucidation of drugs belonging to mono, di and triterpenoids
3. Discuss Chemistry and Physiological significance ofVitamin

Unit 4

1. Discuss rDNA technology, hybridomatechnology.

2. Explain New pharmaceuticals derived from biotechnology.
3. Discuss Clinical application and recent advances in gene therapy, principles of RNA & DNA estimation
4. Explain Active constituent of certain crude drugs used in Indigenous system Diabetic therapy.

Unit 5

1. Discuss the Structural characterization of Quercetin by using NMR, IR.
2. Discuss the Structural characterization of Digitalis glycosides by using NMR, IR
3. Discuss the Structural characterization of Morphine by using NMR, IR
4. Discuss the Structural characterization of Camphor by using NMR, IR
5. Discuss the Structural characterization of Penicillin, by using NMR, IR

Course: M. Pharmacy, Subject code: MPC 102T, Subject: Advanced organic chemistry

Course Outcome

1. the hybridization and geometry of atoms and the three-dimensional structure of organic molecules
2. the reactivity and stability of an organic molecule based on structure, including conformation and stereochemistry
3. an understanding of nucleophiles, electrophiles, electronegativity, and resonance
4. the prediction of mechanisms for organic reactions
5. how to use their understanding of organic mechanisms to predict the outcome of reactions
6. how to design syntheses of organic molecules

7. how to determine the structure of organic molecules using IR and NMR spectroscopic techniques

Course Objectives

1. The principles and applications of retrosynthesis
2. The mechanism & applications of various named reactions
3. The concept of disconnection to develop synthetic routes for small target molecule.
4. The various catalysts used in organic reactions
5. The chemistry of heterocyclic compounds

Learning outcomes

Unit 1

Basic Aspects of Organic Chemistry:

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

Unit 2

Study of mechanism and synthetic applications of following named Reactions: Ugi reaction, Brook rearrangement, Ullmann coupling reactions, Dieckmann Reaction, Doebner-Miller Reaction, Sandmeyer Reaction, Mitsunobu reaction, Mannich reaction, Vilsmeier-Haack Reaction, Sharpless asymmetric epoxidation, Baeyer-Villiger oxidation, Shapiro & Suzuki reaction, Ozonolysis and Michael addition reaction

Unit 3

Synthetic Reagents & Applications: Aluminiumisopropoxide, N-bromosuccinamide, diazomethane, dicyclohexylcarbodiimide, Wilkinson reagent, Wittig reagent. Osmium tetroxide, titanium chloride, diazopropane, diethyl azodicarboxylate, Triphenylphosphine, Benzotriazol-1-yloxy) tris (dimethylamino) phosphoniumhexafluoro-phosphate (BOP).

Protecting groups

- a. Role of protection in organic synthesis
- b. Protection for the hydroxyl group, including 1,2-and 1,3-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'

Unit 4

Heterocyclic Chemistry: Organic Name reactions with their respective mechanism and application involved in synthesis of drugs containing five, six membered and fused heterocyclics 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 heterocyclic nucleus such as Ketoconazole, Metronidazole, Miconazole, celecoxib, antipyrin, Metamizole sodium, Terconazole, Alprazolam, Triamterene, Sulfamerazine,

Trimethoprim, Hydroxychloroquine, Quinine, Chloroquine, Quinacrine, Amsacrine, Prochlorperazine, Promazine, Chlorpromazine, Theophylline, Mercaptopurine and Thioguanine.

Unit 5

Synthon approach and retrosynthesis applications

- i. Basic principles, terminologies and advantages of retrosynthesis; guidelines for dissection of molecules. Functional group interconversion 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.

PHARMACEUTICAL CHEMISTRY (MPC 101T)

First Semester

MODERN PHARMACEUTICAL ANALYTICAL TECHNIQUES (MPC 101T)

(Note: Common paper for MPA, MPC, MPH, MPB, MPL, MPG, MQA, & MIP, specializations)

Unit 1:

a. UV-visible spectroscopy: Introduction, theory, laws and instrumentation associated with UV-visible spectroscopy, choice of solvents and solvent effect and applications of UV-visible spectroscopy.

b. IR spectroscopy: Theory, modes of molecular vibrations, sample handling, instrumentation of dispersive and Fourier-Transform IR Spectrometer, factors affecting vibrational frequencies and applications of IR spectroscopy, data interpretation.

c. Spectrofluorimetry: Theory of fluorescence, factors affecting fluorescence (characteristics of drugs that can be analyzed by fluorimetry), quenchers, instrumentation and Applications of fluorescence spectrophotometer.

d. Flame emission spectroscopy and Atomic absorption spectroscopy: Principle, instrumentation, interferences and applications. **12 Hours**

Unit 2:

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 ¹³C NMR. Applications of NMR spectroscopy. **10 Hours**

Unit 3:

Mass Spectroscopy: Principle, Theory, Instrumentation of Mass Spectroscopy, Different types of ionization like electron impact, chemical, field, FAB and MALDI, APCI, ESI, APPI Analyzers of Quadrupole and Time of Flight, Mass fragmentation and its rules, Meta stable ions, Isotopic peaks and Applications of Mass spectroscopy. **10 Hours**

Unit 4:

Chromatography: Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution, isolation of drug from excipients, data interpretation and applications of the following:

a) Thin Layer chromatography b) High Performance Thin Layer Chromatography c) Ion exchange chromatography d) Column chromatography e) Gas chromatography f) High Performance Liquid chromatography g) Ultra High Performance Liquid chromatography h) Affinity chromatography i) Gel Chromatography. **14 Hours**

Unit 5:

a. Electrophoresis: Principle, Instrumentation, Working conditions, factors affecting separation and applications of the following: a) Paper electrophoresis b) Gel electrophoresis c) Capillary electrophoresis d) Zone electrophoresis e) Moving boundary electrophoresis f) Iso electric focusing.

b. X ray Crystallography: Production of X rays, Different X ray methods, Bragg's law, Rotating crystal technique, X ray powder technique, Types of crystals and applications of X-ray diffraction.

c. Thermal Techniques: Principle, instrumentation, advantage and disadvantages, Pharmaceutical applications of DSC, DTA & TGA.

d. Microscopic techniques: Principles and applications of Scanning Electron Microscopy

and Transmission Electron Microscopy analysis.

14 Hours

REFERENCES

1. Spectrometric Identification of Organic compounds - Robert M Silverstein. 6th ed. John Wiley & Sons, 2004.
2. Principles of Instrumental Analysis - Douglas A Skoog, F. James Holler & Timothy A Nieman. 5th ed. Eastern Press, Bangalore, 1998.
3. Instrumental Methods of Analysis – Willards. 7th ed. CBS Publishers, New Delhi.
4. Practical Pharmaceutical Chemistry – Beckett and Stenlake. Vol 2. 4th ed. CBS Publishers, New Delhi
5. Organic Spectroscopy - William Kemp. 3rd ed. ELBS, 1991.
6. Quantitative Analysis of Drugs in Pharmaceutical Formulation – P.D. Sethi. 3rd ed. CBS Publishers, New Delhi, 1997.
7. Pharmaceutical Analysis - Modern Methods – Part B – J.W. Munson. Vol 11. Marcel-Dekker Series.
8. Spectroscopy of Organic Compounds - P.S. Kalsi. 2nd ed. Wiley Eastern Ltd., Delhi.
9. Textbook of Pharmaceutical Analysis – K.A. Connors. 3rd ed. John Wiley & Sons.

ADVANCED ORGANIC CHEMISTRY – I (MPC 102T)

Unit 1:

Basic aspects of organic chemistry:

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.

12 Hours

Unit 2:

Study of mechanism and synthetic applications of following named reactions: Ugi reaction, Brook rearrangement, Ullmann coupling reactions, Dieckmann Reaction, Doebner-Miller Reaction, Sandmeyer Reaction, Mitsunobu reaction, Mannich reaction, Vilsmeier-Haack Reaction, Sharpless asymmetric epoxidation, Baeyer-Villiger oxidation, Shapiro & Suzuki reaction, Ozonolysis and Michael addition reaction.

12 Hours

Unit 3:

Synthetic reagents & applications: Aluminium isopropoxide, N-bromo succinamide, diazomethane, dicyclo hexyl carbodimide, Wilkinson reagent, Witting reagent. Osmium tetroxide, titanium chloride, diazopropane, diethyl azido carboxylate, triphenyl phosphine, benzotriazol-1-yloxy) tris(dimethylamino) phosphonium hexafluoro-phosphate (BOP), potassium-t-butoxide, lead tetra acetate, sodium methoxide

Protecting groups

- a. Role of protection in organic synthesis
- b. Protection for the hydroxyl group, including 1,2-and 1,3-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

12 Hours

Unit 4:

Heterocyclic chemistry:

Organic name reactions with their respective mechanism and application involved in synthesis of drugs containing five, six membered and fused heterocyclics 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 heterocyclic nucleus such as ketoconazole, metronidazole, miconazole, celecoxib, antipyrin, metamizole sodium, terconazole, alprazolam, triamterene, sulfamerazine, trimethoprim, hydroxy chloroquine, quinine, chloroquine, quinacrine, amsacrine, prochlorperazine, promazine, chlorpromazine, theophylline, mercaptopurine and thioguanine.

12 Hours

Unit 5:

Synthon approach and retrosynthesis applications

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

12 Hours

REFERENCES

1. Advanced Organic Chemistry, Reaction, Mechanisms and Structure – J. March. John Wiley & Sons, New York.
2. Mechanism and Structure in Organic Chemistry – E.S. Gould, Hold Rinchart & Winston.
3. Organic Chemistry - Clayden, Greeves, Warren & Wothers. Oxford University Press 2001.
4. Organic Chemistry - I.L. Finar. Vol 1 and 2. ELBS, Pearson Education.
5. A guide to Mechanisms in Organic Chemistry - Peter Skyes. Orient Longman, New Delhi.
6. Reactive Intermediates in Organic Chemistry - Tandon & Gowel. Oxford & IBH Publishers.
7. Combinational Chemistry - Synthesis and Applications – Stephen R Wilson & Anthony W Czarnik. Wiley-Blackwell.
8. Organic Chemistry – Carey. 5th ed. Viva Books Pvt. Ltd.
9. Organic Synthesis - The Disconnection Approach - S. Warren. Wiley India
10. Principles of Organic Synthesis – R.O.C. Norman & J.M. Coxan. Nelson Thorns.
11. Organic Synthesis - Special Techniques – V.K. Ahluwalia and R. Agarwal. Narosa Publishers.
12. Organic Reaction Mechanisms – V.K. Ahluwalia & R.K. Parashar 4th ed. Narosa Publishers.

ADVANCED MEDICINAL CHEMISTRY (MPC 103T)

Unit 1:

Drug discovery: Stages of drug discovery, lead discovery; identification, validation and diversity of drug targets. Biological drug targets: Receptors, types, binding and activation, theories of drug receptor interaction, drug receptor interactions, agonists vs. antagonists,

artificial enzymes.

12 Hours

Unit 2:

Pro-drug design and analog design:

1. Pro-drug design: Basic concept, Carrier linked pro-drugs/Bio-precursors, pro-drugs of functional group, pro-drugs to improve patient acceptability, drug solubility, drug absorption and distribution, site specific drug delivery and sustained drug action. Rationale of pro-drug design and practical consideration of pro-drug design.
2. Combating drug resistance: Causes for drug resistance, strategies to combat drug resistance in antibiotics and anticancer therapy, genetic principles of drug resistance.
3. Analog design: Introduction, classical & non classical, bio-isosteric replacement strategies, rigid analogs, alteration of chain branching, changes in ring size, ring position isomers, design of stereo isomers and geometric isomers, fragments of a lead molecule, variation in inter-atomic distance.

12 Hours

Unit 3:

1. **Medicinal chemistry aspects** of the following classes of drugs, systematic study, SAR, mechanism of action and synthesis of new generation molecules of following classes of drugs:

a) Anti-hypertensive drugs, psycho-active drugs, anti-convulsant drugs, H₁ & H₂ receptor antagonist, COX-1 & COX-2 inhibitors, adrenergic & cholinergic agents, anti-neoplastic and antiviral agents. b) Stereochemistry and drug action: Realization that stereo selectivity is a pre-requisite for evolution. Role of chirality in selective and specific therapeutic agents. Case studies, enantio selectivity in drug adsorption, metabolism, distribution and elimination.

12 Hours

Unit 4:

Rational design of enzyme inhibitors: Enzymes as targets - enzyme kinetics & principles of enzyme inhibitors, enzyme inhibitors in medicine, enzyme inhibitors in basic research, rational design of non-covalently and covalently binding enzyme inhibitors.

12 Hours

Unit 5:

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. Chemistry of prostaglandins, leukotrienes and thromboxones.

12 Hours

REFERENCES

1. Medicinal Chemistry – Burger. Vol. 1 –6.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, 12th ed. Lippincott, New Delhi.
3. Comprehensive Medicinal Chemistry - Corwin & Hansch. Pergamon Publishers.
4. Computational and Structural Approaches to Drug Design - Robert M Stroud
5. Introduction to Quantitative Drug Design - Y.C. Martin.
6. Principles of Medicinal Chemistry - William Foye. 7th ed. Lippincott, New Delhi.
7. Drug Design Volumes – Arienes. Academic Press, Elsevier Publishers, Noida, UP.
8. Principles of Drug Design - Smith.
9. The Organic Chemistry of the Drug Design and Drug Action - Richard B Silverman. 2nd ed. Elsevier Publishers, New Delhi.
10. An Introduction to Medicinal Chemistry - Graham L Patrick. 3rd ed. Oxford University Press, USA.

11. Biopharmaceutics and Pharmacokinetics – D.M. Brahmkar. 2nd ed. Vallabh Prakashan.
12. Peptidomimetics in Organic and Medicinal Chemistry - Antonio Guarna & Andrea Trabocchi. 1st ed. Wiley Publishers.

CHEMISTRY OF NATURAL PRODUCTS (MPC 104T)

Unit 1:

Study of Natural products as leads for new pharmaceuticals for the following classes of drugs: 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) Neuro-muscular blocking drugs: curare alkaloids e) Anti-malarial drugs and analogues f) Chemistry of macrolide antibiotics: erythromycin, azithromycin, roxithromycin, and clarithromycin, tetracycline and β - lactam antibiotics (cephalosporins and carbapenem). **12 Hours**

Unit 2:

1. Alkaloids: 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, Cinchona alkaloids, artemisin and its derivatives.

2. Flavonoids: Introduction, isolation and purification of flavonoids, general methods of structural determination of flavonoids; Structural elucidation of quercetin.

3. Steroids: General introduction, chemistry of sterols, sapogenin and cardiac glycosides. Stereochemistry and nomenclature of steroids, chemistry of contraceptive agents male & female sex hormones (testosterone, estradiol, progesterone), adrenocorticoids (cortisone), contraceptive agents and steroids (vitamin D). **12 Hours**

Unit 3:

1. Terpenoids: 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).

2. Vitamins: Chemistry and physiological significance of vitamin A, B₁, B₂, B₁₂, C, E, folic acid and niacin. **12 Hours**

Unit 4:

1. Recombinant DNA technology and drug discovery: rDNA technology, hybridoma technology, new pharmaceuticals derived from biotechnology; oligo-nucleotide therapy. Gene therapy: Introduction, clinical application and recent advances in gene therapy, principles of RNA & DNA estimation.

2. Active constituent of certain crude drugs used in indigenous system diabetic therapy - *Gymnema sylvestre*, *Salacia reticulate*, *Pterocarpus marsupium*, *Swertia chirata*, *Trigonella foenum graecum*; Liver dysfunction – *Phyllanthus niruri*; Antitumor – *Curcuma longa* Linn. **12 Hours**

Unit 5: Structural characterization of natural compounds: Structural characterization of natural compounds using IR, ¹H NMR, ¹³C NMR and MS spectroscopy of specific drugs, e.g., penicillin, morphine, camphor, vitamin D, quercetin and digitalis glycosides. **12 Hours**

REFERENCES

1. Modern Methods of Plant Analysis - Peech & M.V. Tracey. Springer-Verlag, Berlin.
2. Phytochemistry – Miller - Jan Nostrant Rein Hld, Vol. 1 and 2.
3. Recent Advances in Phytochemistry - Scikel Runeckles. Vol. 1 to 4. Springer Science.

4. Chemistry of Natural Products, Vol 1 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 - RHF Manske. Academic Press.
8. Introduction to Molecular Phytochemistry – C.H.J. Wells. Chapmanstall.
9. Organic Chemistry of Natural Products - Gurdeep & Chatwall, Vol 1 and 2. Himalaya Publishing House.
10. Organic Chemistry of Natural Products - O.P. Agarwal, Vol 1 and 2. Krishan Prakashan.
11. Organic Chemistry - I.L. Finar. Vol 1 and 2. Pearson Education.
12. Elements of Biotechnology - P.K. Gupta. Rastogi Publishers.
13. Pharmaceutical Biotechnology - S.P.Vyas and V.K. Dixit. CBS Publishers, New Delhi.
14. Biotechnology - Purohit and Mathur. 13th ed. Agro-Bios.
15. Phytochemical Methods of Harborne. Springer, Netherlands.
16. Medicinal Chemistry – Burger. Vol. 1-6.

PHARMACEUTICAL CHEMISTRY PRACTICAL – I (MPC 105P)

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

PHARMACEUTICAL CHEMISTRY PRACTICAL - II (MPC 106P)

To perform the following reactions of synthetic importance:

1. Purification of organic solvents, column chromatography
2. Claisen-Schmidt 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

Second Semester

ADVANCED SPECTRAL ANALYSIS (MPC 201T)

Unit 1:

UV and IR spectroscopy: Wood Ward – 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. **12 Hours**

Unit 2:

NMR spectroscopy: 1-D and 2-D NMR, NOESY and COSY, HECTOR, INADEQUATE techniques, interpretation of organic compounds. **12 Hours**

Unit 3:

Mass spectroscopy: Mass fragmentation and its rules, fragmentation of important functional groups like alcohols, amines, carbonyl groups and alkanes, meta stable ions, Mc Lafferty rearrangement, ring rule, isotopic peaks, interpretation of organic compounds. **12 Hours**

Unit 4:

Chromatography: 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) Supercritical fluid chromatography i) Ion chromatography j) I-EC (Ion-exclusion chromatography) k) Flash chromatography. **12 Hours**

Unit 5:

1. Thermal methods of analysis: Introduction, principle, instrumentation and application of DSC, DTA and TGA.

2. Raman Spectroscopy, introduction, principle, instrumentation and applications.

3. Immuno and radio immuno assay, biological standardization, bioassay, ELISA, radioimmunoassay of digitalis and insulin. **12 Hours**

REFERENCES

1. Spectrometric Identification of Organic Compounds - Robert M Silverstein. 6th ed. John Wiley.
2. Principles of Instrumental Analysis - Douglas A Skoog, F. James Holler & Timothy A Nieman. 5th ed. Eastern Press, Bangalore, 1998.
3. Instrumental Methods of Analysis – Willards. 7th ed. CBS Publishers, New Delhi.
4. Organic Spectroscopy - William Kemp. 3rd ed. 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 ed. CBS Publishers, New Delhi.
7. Pharmaceutical Analysis- Modern Methods - Part B – J.W. Munson. Vol 11. Marcel Dekker.

ADVANCED ORGANIC CHEMISTRY – II (MPC 202T)

Unit 1:

Green chemistry: Introduction, principles of green chemistry. Microwave assisted reactions: Merit and demerits of its use, increased reaction rates, mechanism, superheating effects of microwave, effects of solvents in microwave assisted synthesis, microwave technology in process optimization, its applications in various organic reactions and heterocycle synthesis. Ultrasound assisted reactions: Types of sonochemical reactions, homogenous, heterogeneous liquid-liquid and liquid-solid reactions, synthetic applications. Continuous flow reactors: Working principle, advantages and synthetic applications. **12 Hours**

Unit 2:

Chemistry of peptides: Coupling reactions in peptide synthesis. 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. Segment and sequential strategies for solution phase peptide synthesis with any two case studies. Side reactions in peptide synthesis: Deletion peptides, side reactions initiated by proton abstraction, protonation, over activation and side reactions of individual amino acids. **12 Hours**

Unit 3: Photochemical reactions: Basic principles of photochemical reactions. Photo-oxidation, photo-addition and photo-fragmentation. Pericyclic reactions Mechanism, Types of pericyclic reactions such as cyclo addition, electrocyclic reaction and sigmatropic rearrangement reactions with examples. **12 Hours**

Unit 4:

Catalysis: Types of catalysis, heterogeneous and homogeneous catalysis, advantages and disadvantages. Heterogeneous catalysis – preparation, characterization, kinetics, supported catalysts, catalyst deactivation and regeneration, some examples of heterogeneous catalysis used in synthesis of drugs. Homogeneous catalysis, hydrogenation, hydro formylation, hydrocyanation, Wilkinson catalysts, chiral ligands and chiral induction, Ziegler-Natta catalysts, some examples of homogeneous catalysis used in synthesis of drugs. Transition-metal and organo-catalysis in organic synthesis: Metal-catalyzed reactions. Biocatalysis: Use of enzymes in organic synthesis, immobilized enzymes/cells in organic reaction. Phase transfer catalysis - theory and applications, ionic liquids. **12 Hours**

Unit 5:

Stereochemistry & asymmetric synthesis: 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. Methods of asymmetric synthesis using chiral pool, chiral auxiliaries and catalytic asymmetric synthesis, enantiopure separation and Stereo selective synthesis with examples. **12 Hours**

REFERENCES

1. Advanced Organic Chemistry, Reaction, Mechanisms and Structure – J. March. John Wiley & Sons, New York.
2. Mechanism and Structure in Organic Chemistry – E.S. Gould, Hold Rinchart & Winston.
3. Organic Chemistry - Clayden, Greeves, Warren & Wothers. Oxford University Press 2001.
4. Organic Chemistry - I.L. Finar. Vol 1 and 2. ELBS, Pearson Education.
5. Organic Chemistry – Carey. 5th ed. Viva Books Pvt. Ltd.
6. Organic Synthesis - The Disconnection Approach - S. Warren. Wiley India
7. Principles of Organic Synthesis – R.O.C. Norman & J.M. Coxan. Nelson Thorns.
8. Organic Synthesis - Special Techniques – V.K. Ahluwalia & R. Agarwal. Narosa Publishers.
9. Organic Reaction Mechanisms – V.K. Ahluwalia and R.K. Parashar 4th ed. Narosa Publishers.

COMPUTER AIDED DRUG DESIGN (CADD) (MPC 203T)

Unit 1:

Introduction to Computer Aided Drug Design (CADD): History, different techniques and applications. Quantitative Structure Activity Relationships: Basics, History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters (σ), lipophilicity effects and parameters ($\log P$, π -substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters. **12 Hours**

Unit 2:

Quantitative Structure Activity Relationships/Applications: Hansch analysis, Free Wilson analysis, 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. **12 Hours**

Unit 3:

Molecular modeling and docking: Molecular and Quantum mechanics in drug design. Energy minimization methods: comparison between global minimum conformation and bioactive conformation. 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 Hours**

Unit 4:

Molecular properties and drug design: Prediction and analysis of ADMET properties of new molecules and its importance in drug design. 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. Homology modeling and generation of 3D-structure of protein. **12 Hours**

Unit 5:

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. Application of bioinformatics in drug design. **12 Hours**

REFERENCES

1. Computational and Structural Approaches to Drug Discovery - Robert M Stroud and Janet F Moore. RCS Publishers.
2. Introduction to Quantitative Drug Design - Y.C. Martin. CRC Press, Taylor & Francis.
3. Drug Design – Ariens. Vol 1 to 10. Academic Press, 1975, Elsevier Publishers.
4. Principles of Drug Design - Smith & Williams. CRC Press, Taylor & Francis.
5. The Organic Chemistry of the Drug Design and Drug Action - Richard B Silverman. Elsevier Publishers.
6. Medicinal Chemistry - Burger, Vol. 1 –6.
7. An Introduction to Medicinal Chemistry - Graham L Patrick. 3rd ed. Oxford University Press, USA.
8. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry. 12th ed. Lippincott, New Delhi.
9. Comprehensive Medicinal Chemistry – Corwin & Hansch. Pergamon Publishers.

10. Computational and Structural Approaches to Drug Discovery - Robert M Stroud & Janet F Moore. RCS Publishers.

PHARMACEUTICAL PROCESS CHEMISTRY (MPC 204T)

Unit 1:

Process chemistry: 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. **12 Hours**

Unit 2:

Operations: Extraction: Liquid equilibria, extraction with reflux, extraction with agitation, counter current extraction. Filtration: Theory of filtration, pressure and vacuum filtration, centrifugal filtration. Distillation: azeotropic and steam distillation. Evaporation: types of evaporators, factors affecting evaporation. Crystallization: crystallization from aqueous, non-aqueous solutions, factors affecting crystallization, nucleation. Principle and general methods of preparation of polymorphs, hydrates, solvates and amorphous APIs. **12 Hours**

Unit 3:

Unit processes - I: Nitration: Nitrating agents, aromatic nitration, kinetics and mechanism of aromatic nitration, process equipment for technical nitration, mixed acid for nitration. Halogenation: Kinetics of halogenations, types of halogenations, catalytic halogenations. Case study on industrial halogenation process. Oxidation: Introduction, types of oxidative reactions, liquid phase oxidation with oxidizing agents. Non-metallic oxidizing agents such as H_2O_2 , sodium hypochlorite, oxygen gas, ozonolysis. **12 Hours**

Unit 4:

Unit processes - II:

Reduction: Catalytic hydrogenation, heterogeneous and homogeneous catalyst; hydrogen transfer reactions, metal hydrides. Case study on industrial reduction process. Fermentation: Aerobic and anaerobic fermentation. Production of antibiotics (penicillin and streptomycin), vitamins (B_2 and B_{12}), statins (lovastatin, simvastatin). Reaction progress kinetic analysis: streamlining reaction steps, route selection, characteristics of expedient routes, characteristics of cost-effective routes, reagent selection, families of reagents useful for scale-up. **12 Hours**

Unit 5:

Industrial safety: MSDS (Material Safety Data Sheet), hazard labels of chemicals and personal protection equipment (PPE). Fire hazards, types of fire & fire extinguishers. Occupational Health & Safety Assessment Series 1800 (OHSAS-1800) and ISO-14001 (Environmental Management System). Effluents and its management. **12 Hours**

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 ed. Volume 2.
3. Medicinal Chemistry – Burger. Vol. 1–6.
4. Unit Operations of Chemical Engineering - W.L. McCabe, J.C. Smith & Peter Harriott. 7th ed.
5. Polymorphism in Pharmaceutical Solids – H.G. Britain. Vol 95. Dekker Series, 1999.
6. Introduction to Chemical Processes: Principles, Analysis, Synthesis - Regina M Murphy.
7. Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale-Up - Peter J Harrington.

8. Unit Processes in Organic Synthesis (MGH) - P.H. Groggins.
9. Chemical Technology - F.A. Henglein. Pergamon Publishers.
10. Dryden's Outlines of Chemical Technology - M. Gopal. WEP East-West Press.
11. Principle of Industrial Chemistry – Clausen & Mattson. Wiley Publishing Co.
12. Industrial Chemicals - Lowenheim & M.K. Moran.
13. A text book of Chemical Technology - S.D. Shukla & G.N. Pandey. Vol. 2. Vikas Publishing.
14. Industrial Organic Chemistry - J.K. Stille: (Prentice Hall publishers)
15. Chemical Process – Shreve. Mc Graw-Hill.
16. Industrial Chemistry - B.K. Sharma. Goel Publishing House.
17. ICH Guidelines website www.ich.org
18. United States Food and Drug Administration official website www.fda.gov

PHARMACEUTICAL CHEMISTRY PRACTICAL – III (MPC 205P)

1. Synthesis of organic compounds by adapting different approaches involving a) oxidation b) reduction/hydrogenation c) Nitration (3 experiments)
2. Comparative study of synthesis of APIs/intermediates by different synthetic routes (2 experiments)
3. Assignments on regulatory requirements in API (2 experiments)
4. To carry out the preparation of following organic compounds
5. Preparation of 4-chlorobenzhydrylpiperazine. (an intermediate for cetirizine HCl).
6. Preparation of 4-iodotoluene from p-toluidine.
7. NaBH₄ reduction of vanillin to vanillyl alcohol
8. Preparation of umbelliferone by Pechhman reaction
9. Preparation of triphenyl imidazole
10. To perform the microwave irradiated reactions of synthetic importance (Any two)
11. Determination of log P, MR, hydrogen bond donors and acceptors of selected drugs using software
12. Calculation of ADMET properties of drug molecules and its analysis using software Pharmacophore modeling
13. 2D-QSAR based experiments
14. 3D-QSAR based experiments
15. Docking study based experiment
16. Virtual screening based experiment
17. Comparison of absorption spectra by UV and Woodward – Fieser rule
18. Interpretation of organic compounds by FTIR
19. Interpretation of organic compounds by NMR
20. Interpretation of organic compounds by MS
21. Determination of purity by DSC in pharmaceuticals
22. Identification of organic compounds using FTIR, NMR, C13 NMR and Mass spectra

Third Semester

RESEARCH METHODOLOGY & BIOSTATISTICS (MRM 301T)

(Note: Common Paper for all specializations)

Unit 1:

General research methodology: Research, objective, requirements, practical difficulties, review of literature, study design, types of studies, strategies to eliminate errors/bias, controls, randomization, crossover design, placebo, blinding techniques. **12 Hours**

Unit 2:

Biostatistics: Definition, application, sample size, importance of sample size, factors influencing sample size, dropouts, statistical tests of significance, type of significance tests, parametric tests (students "t" test, ANOVA, Correlation coefficient, regression), non-parametric tests (Wilcoxon rank tests, analysis of variance, correlation, Chi-square test), null hypothesis, P values, degree of freedom, interpretation of P values. **12 Hours**

Unit 3:

Medical Research: History, values in medical ethics, autonomy, beneficence, non-maleficence, double effect, conflicts between autonomy and beneficence/non-maleficence, euthanasia, informed consent, confidentiality, criticisms of orthodox medical ethics, importance of communication, control resolution, guidelines, ethics committees, cultural concerns, truth telling, online business practices, conflicts of interest, referral, vendor relationships, treatment of family members, sexual relationships, fatality. **12 Hours**

Unit 4:

CPCSEA guidelines for laboratory animal facility: Goals, veterinary care, quarantine, surveillance, diagnosis, treatment and control of disease, personal hygiene, location of animal facilities to laboratories, anesthesia, euthanasia, physical facilities, environment, animal husbandry, record keeping, SOPs, personnel and training, transport of lab animals. **12 Hours**

Unit 5:

Declaration of Helsinki: History, introduction, basic principles for all medical research, and additional principles for medical research combined with medical care. **12 Hours**

REFERENCES

1. Pharmaceutical Statistics: Practical and Clinical Applications - Stanford Bolton & Charles Bon. 5th ed. CRC Press.
2. Biostatistics: A Foundation for Analysis in the Health Sciences - Wayne W Daniel. 10th ed. John Wiley & Sons.
3. Introduction to Research in the Health Sciences - Stephen Polgar & Shane Thomas. 7th ed. Elsevier.
4. www.cpcsea.nic.in
5. www.wma.net