ADMISSION & EXAMINATION BYE-LAWS

FOR

MASTER OF PHARMACY IN PHARMACEUTICAL CHEMISTRY

Program Code: MPC

SCHOOL OF PHARMACEUTICAL EDUCATION AND RESEARCH
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CONTENTS

BOS MEETING DETAILS

- **Approval date of the BOS/School Board meeting for the present syllabus:**

Name of the program	Department	Board of School (BOS) Approval Date
M. Pharm	Pharmaceutical Chemistry	21.04.2017

- **Approval date of the Academic Council meeting for the present syllabus**

Name of the program	Program Code	Dates of Revision
M. Pharm	MPC	31.05.2017

VISION AND MISSION STATEMETS

Vision Statement: To be the exemplary learning centre of excellence in pursuit of newer heights in higher education, research and innovation in Pharmaceutical Chemistry.

Mission Statements:

MS-1: To impart professional education through structured program in tune with the needs of the Industry.

MS-2: To provide research facilities and environment to generate new knowledge and develop new strategies in the various spheres of Pharmaceutical chemistry.

MS-3: To promote application of CADD tools in the designing and synthesis of small molecules through various synthetic routes.

MS-4: To develop collaborations at national and international levels to facilitate Industry–Academia relationships.

PROGRAM EDUCATIONAL OBJECTIVES (PEO`S)

After completing this course the student should be able to:

PEO-1: Apply domain knowledge and skills of Pharmaceutical Chemistry and organic synthesis to develop new synthetic strategies for new drug candidates.

PEO-2: Acquire focussed learning in the field of medicinal chemistry at molecular level, rational drug design and computer assisted drug design and apply the acquired knowledge in drug discovery process.

PEO-3: Acquire expertise in analysis of drugs in dosage form using chemical and instrumental method of analysis.

PEO-4: Develop skills for interpretation of NMR, Mass and IR spectra of various compounds.

PEO-5: Promote continuous update of knowledge and skills in the field of Pharmaceutical Chemistry with proficiency in drug synthesis and analysis for employment opportunities in various organisations.

PEO-6: Develop leadership skills to be applied in R&D, production and other facets of the profession

Mapping Program Educational Objectives (PEOs) with Mission Statements (MS)

	MS-1	MS-2	MS-3	MS-4
PEO-1	3	2	3	3
PEO-2	3	3	3	2
PEO-3	3	3	3	3
PEO-4	2	2	3	3
PEO-5	3	3	3	2
PEO-6	3	3	3	3

Level of Mapping: '3' is for 'high-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping.

PROGRAM OUTCOME (PO`s)

After the completion of M. Pharm (Pharmaceutical Chemistry), the student should become competent enough to:

PO-1 **Pharmacy Knowledge**: Apply comprehensive knowledge and skills associated with pharmaceutical chemistry in design and development of new drug like molecules for biological targets.

PO-2 **Planning abilities**: Identify, formulate and test research problems, analyse, interpret and draw conclusions from data; plan, execute and report the results of an experiment or investigation effectively within time frame.

PO-3 **Problem analysis**: Demonstrate efficiency in problem solving skills, based on scientific and analytical approach. Analysis and solving problem related to synthesis, purification, physicochemical properties and toxicity of designed compounds.

PO-4 **Modern tool usage**: Acquire and apply latest scientific methods and computing tools related to synthesis, analysis and characterization of compounds with thorough understanding of limitations.

PO-5 **Leadership skills**: Demonstrate capability to build and lead team that can help to achieve the vision, inspire and motivate team members to engage with that vision and use leadership skills to guide the team for fulfilment of professional and societal responsibilities.

PO-6 **Professional identity**: Demonstrate attitude, values, knowledge and skills that are keys to fulfil professional competence. Understand analyse and communicate the value of their professional role in society as health care professionals.

PO-7 **Pharmaceutical ethics**: Apply ethical principals while making decisions and take responsibility for outcome associated with the decisions. Demonstrate behaviour that respects cultural and personal variability in values, communication and lifestyles.

PO-8 **Communication**: Communicate effectively with scientific community and with society at large, in writing and orally; express views, thoughts and ideas in a clear and concise manner. Write scientific reports, create effectual presentations and documentation and provide and obtain clear instructions.

PO-9 **The Pharmacist and society**: Demonstrate responsible behaviour and ability to assess community, health, safety and legal issues and consequent responsibilities relevant to professional practice.

PO-10 **Environment and sustainability**: Understand the effect of chemicals and materials used in pharmaceutical chemistry on environment, apply contextual knowledge to minimise negative impact on environment and provide sustainable solutions.

PO-11 **Life-long learning**: Promote lifelong learning activities through self motivation focussed at personal and professional development; to fulfil these needs attend and participate in scientific seminars / conferences / workshop on an ongoing basis.

PROGRAM SPECIFIC OUTCOME (PSO)

After the completion of M. Pharm. (Pharmaceutical Chemistry), the student should become competent enough to:

PSO-1: Design, synthesize and develop drug like molecules for biological targets and its structural characterisation.

PSO-2: Acquire expertise in analysis of various drugs in single and combination dosage form using analytical instrumental techniques.

PSO-3: Apply the knowledge of CADD techniques, molecular modelling software, *in silico* virtual screening to design new drug molecules.

PSO-4: Apply knowledge of green chemistry, organic reactions and their mechanisms, retrosynthesis and heterocyclic chemistry to develop synthetic routes for small target molecules.

Mapping of Program Outcomes (POs) and Program Specific Outcomes (PSOs) with Program Educational Objectives (PEOs)

	PEO-1	**PEO-2**	**PEO-3**	**PEO-4**	**PEO-5**	**PEO-6**
PO-1	3	3	3	2	3	3
PO-2	2	2	3	3	2	3
PO-3	2	3	3	3	2	1
PO-4	3	3	3	2	1	2
PO-5	2	3	3	3	3	3
PO-6	2	3	3	2	3	3
PO-7	2	2	2	3	2	1
PO-8	2	2	3	3	3	3
PO-9	2	2	3	3	3	3
PO-10	3	2	3	3	2	1
PO-11	3	3	3	3	3	3
PSO-1	3	3	3	2	2	3
PSO-2	3	3	3	2	2	3
PSO-3	3	3	3	2	2	3
PSO-4	3	3	2	2	3	3

Level of Mapping: ‘3’ is for ‘high-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping.

CONSOLIDATED SEMESTER WISE PROGRAMME DETAILS

Tables-I: Schemes for internal assessments and end semester examinations semester wise

Semester I

Course code	Name of the course	Internal Assessment				End Semester Exams		Total Marks	Credit points
		Continuous mode	Sessional Exams		Total	Marks	Duration		
			Marks	Duration					
MPC101T	Modern Pharmaceutical Analytical Techniques	10	15	1 Hr	25	75	3 Hrs	100	4
MPC102T	Advanced Pharmacology-I	10	15	1 Hr	25	75	3 Hrs	100	4
MPC103T	Pharmacological and Toxicological Screening Methods-I	10	15	1 Hr	25	75	3 Hrs	100	4
MPC104T	Cellular and Molecular Pharmacology	10	15	1 Hr	25	75	3 Hrs	100	4
MPC105P	Experimental Pharmacology – I	20	30	6 Hrs	50	100	6 Hrs	150	6
-	Seminar/Assignment	-	-	-	-			100	4
	Total							**650**	**26**

Semester II

Course code	Name of the course	Internal Assessment				End Semester Exams		Total Marks	Credit points
		Continuous Mode	Sessional Exams		Total	Marks	Duration		
			Marks	Duration					
MPC201T	Advanced Spectral Analysis	10	15	1 Hr	25	75	3 Hrs	100	4
MPC 202T	Advanced Organic Chemistry-II	10	15	1 Hr	25	75	3 Hrs	100	4
MPC 203T	Computer Aided Drug Design	10	15	1 Hr	25	75	3 Hrs	100	4
MPC 204T	Pharmaceutical Process Chemistry	10	15	1 Hr	25	75	3 Hrs	100	4
MPC 205P	Pharmaceutical Chemistry Practical II	20	30	6 Hrs	50	100	6 Hrs	150	6
-	Seminar/Assignment							100	4
	Total							**650**	**26**

Semester III

Course code	Name of the course	Internal Assessment				End Semester Exams		Total Marks	Credit points
		Continuous Mode	Sessional Exams		Total	Marks	Duration		
			Marks	Duration					
MRM 301T	Research Methodology and Biostatistics*	10	15	1 Hr	25	75	3 Hrs	100	4
-	Journal club	-	-	-	25		3 Hrs	25	1
-	Discussion / Presentation (Proposal Presentation)	-	-	-	50		3 Hrs	50	2
-	Research Work	-	-	-	-	350	1 Hrs	350	14
Total								**525**	**21**

* Non-University Exam

Semester IV

Course code	Name of the course	Internal Assessment				End Semester Exams		Total Marks	Credit points
		Continuous Mode	Sessional Exams		Total	Marks	Duration		
			Marks	Duration					
-	Journal club	-	-	-	25	-	-	25	1
-	Discussion / Presentation (Proposal Presentation	-	-	-	75	-	-	75	16
-	Research work and Colloquium	-	-	-	-	400	1 Hr	400	3
Total								**500**	**20**

RULES AND REGULATIONS

1. Short Title and Commencement

These regulations shall be called as "The Revised Regulations for the Master of Pharmacy (M. Pharm.) Degree Program - Credit Based Semester System (CBSS) of the Pharmacy Council of India, New Delhi". They shall come into effect from the Academic Year 2016-17. The regulations framed are subject to modifications from time to time by the authorities of the university.

2. Minimum qualification for admission

A Pass in the following examinations

a) 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.)

b) 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. Duration of the program

The program of study for M. Pharm. 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. Medium of instruction and examinations

Medium of instruction and examination shall be in English.

5. 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.

6. Attendance and progress

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.

7. Program/Course credit 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/extracurricular activities is dependent upon the quantum of work expected to be put in for each of these activities per week/per activity.

8 Credit assignment

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.

9. Minimum credit requirements

The minimum credit points required for the award of M. Pharm. degree is 95. However based on the credit points earned by the students under the head of co-curricular activities, a student shall earn a maximum of 100 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 3 are distributed semester-wise as shown in Table 14. 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.

10. 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.

11. Course of study

The course of study for M. Pharm shall include Semester Wise Theory & Practical as given in Table– II-III. 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 –II-III

Table II-: Course of study for Semester I

Course code	Name of the course	No. of hours	Tutorial	Credit Points
MPC101T	Modern Pharmaceutical Analytical Techniques	4	-----	4
MPC102T	Advanced Organic Chemistry- I	4	-----	4
MPC 103T	Advanced Medicinal chemistry	4	----	4
MPC 104T	Chemistry of Natural Products	4	----	4
MPC 105P	Pharmaceutical Chemistry Practical I	12	----	6
-	Seminar/Assignment	7	----	4
	Total	**35**		**26**

Table III-: Course of study for Semester II

Course code	Name of the course	No. of hours	Tutorial	Credit Points
MPC201T	Advanced Spectral Analysis	4	-	4
MPC 202T	Advanced Organic Chemistry -II	4		4
MPC 203T	Computer Aided Drug Design	4	-	4
MPC 204T	Pharmaceutical Process Chemistry	4	-	4
MPC 205P	Pharmaceutical Chemistry Practical II	12	-	6
	Seminar/Assignment	7	-	4
	Total	**35**		**26**

Table-IV: Semester wise credits distribution

Semester	Credit Points
I	**26**
II	26
III	21
IV	20
Co-curricular Activities (Attending Conference, Scientific Presentations and Other Scholarly Activities)	Minimum=02 Maximum=07*
Total credit points	Minimum=95 Maximum=10*

* Credit Points for Co-curricular Activities

12. Program Committee

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

2. The composition of the Programme Committee shall be as follows: A teacher at the cadre of Professor shall be the Chairperson; One Teacher from each M. Pharm specialization and four student representatives (two from each academic year), nominated by the Head of the institution.

3. Duties of the Programme Committee:
   i. Periodically reviewing the progress of the classes.
   ii. Discussing the problems concerning curriculum, syllabus and the conduct of classes.
   iii. 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.
   iv. Communicating its recommendation to the Head of the institution on academic matters.
   v. The Programme Committee shall meet at least twice in a semester preferably at the end of each sessional exam and before the end semester exam.

13. Examinations/Assessments

The scheme for internal assessment and end semester examinations is given in Table V- VIII

End semester examinations

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

Internal assessment: Continuous mode

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

Table V: Scheme for awarding internal assessment: Continuous mode

Theory	
Criteria	**Maximum Marks**
Attendance (Refer Table – VI)	8
Student – Teacher interaction	2
Total	10
Practical	
Attendance (Refer Table – VI)	10
Based on Practical Records, Regular viva voce, etc.	10
Total	20

Table VI: 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

Sessional Exams

Two sessional exams shall be conducted for each theory / practical course as per the schedule fixed by the college(s). The scheme of question paper for theory and practical sessional examinations is given in the table. The average marks of two sessional exams shall be computed for internal assessment as per the requirements given in tables.

Promotion and award of grades

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 courseincluding internal assessment.

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.

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.

Reexamination of end semester examinations

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

Table VII: Tentative 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

Allowed to keep terms (ATKT):

No student shall be admitted to any examination unless he/she fulfills the norms given in 6. ATKT rules are applicable as follows:

A student shall be eligible to carry forward all the courses of I and IIsemesters till the III semester examinations. However, he/she shall not be eligible to attend the courses of IV semester until all the courses of I, II and III semesters are successfully completed.

A student shall be eligible to get his/her CGPA upon successful completion of the courses of I to IV semesters within the stipulated time period as per the norms.

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.

Grading of performances

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 – VIII.

Table VIII: 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.

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 obtainedin 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, theSGPA shall then be computed as:

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

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 statusin case of F grade(s), till the course(s) is/are passed. When the course(s) is/are passedby obtaining a pass grade on subsequent examination(s) theCGPAshall 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 C1, C2, C3,…. is the total number of credits for semester I,II,III,…. and S1,S2, S3,….is the SGPA of semester I,II,III,…. .

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

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

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, thecandidates should have completed the M. Pharm program in minimum prescribed number of years, (two years) for the award of Ranks.

Award of degree

Candidates who fulfill the requirements mentioned above shall be eligible for award of degree during the ensuing convocation.

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 freshRegistration.

Revaluation I Re-totaling of answer papers

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

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 condonationfee.

SYLLABUS

M.PHARM. SEMESTER I

Course Code MPC 101T	**Title of the course: Modern Pharmaceutical Analytical Techniques (MAT)**
Course Code: MPC 102T	**Title of the Course: Advanced Organic Chemistry-I (Theory)**
Course Code: MPC 103T	**Title of the Course: Advanced Medicinal Chemistry (Theory)**
Course Code: MPC 104T	**Title of the Course: Chemistry of Natural Products (Theory)**
Course Code: MPC 105P	**Title of the Course: Pharmaceutical Chemistry Practical -I**

Name of the Academic Program: M. Pharm. (Pharmaceutical Chemistry)

Course Code: MPC101T

Title of the Course: Modern Pharmaceutical Analytical Techniques (Theory)

L-T 4 **Credits: 4**

(L=Lecture hours, T=Tutorial hours)

COURSE OUTCOMES (COs)

After completing this Course, the students should be able to:

CO1: Recognize the principle, instrumentation and applications of different chromatographic techniques **(Cognitive level: Understand)**

CO2: Investigate the pharmaceutical substance by Nuclear Magnetic spectroscopy techniques. **(Cognitive level: Apply)**

CO3: Investigate the pharmaceutical substance by Mass spectroscopy Techniques. **(Cognitive level: Apply)**

CO4: The analysis of various drugs in single and combination dosage forms **(Cognitive level: Create)**

CO5: Recognize the principle, instrumentation and applications of electrophoresis and X ray crystallography. **(Cognitive level: Apply)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2	3							1		2		
CO2	1	2	2	3							1		2		
CO3	1	2	2	3							1		2		
CO4	1	2	2	3							1		2		
CO5	1	2	2	3							1		2		

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level'mapping, 2 for 'Medium-level'mapping, 1 for 'Low'-level'mapping.

Syllabus: **THEORY** **60 Hrs**

1. **UV-Visible spectroscopy**: Introduction, Theory, Laws, 1Instrumentation associated with UV-Visible spectroscopy, Choice of solvents and solvent effect and Applications of UV-Visible spectroscopy, Difference/ Derivative spectroscopy.

   IR spectroscopy: Theory, Modes of Molecular vibrations, Sample handling, Instrumentation of Dispersive and Fourier - Transform IR Spectrometer, Factors affecting vibrational frequencies and Applications of IR spectroscopy, Data Interpretation.

Spectroflourimetry: Theory of Fluorescence, Factors affecting fluorescence (Characterestics of drugs that can be analysed by flourimetry), Quenchers, Instrumentation and Applications of fluorescence spectrophotometer.
Flame emission spectroscopy and Atomic absorption spectroscopy: Principle, Instrumentation, Interferences and Applications. (10Hrs)

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 Hrs)

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 Hrs)

4. **Chromatography:** Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution, isolation of drug from excipients, data interpretation and applications of the following: (10 Hrs)
   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

5. **Electrophoresis:** Principle, Instrumentation, Working conditions, factors affecting separation and applications of the following: (10 Hrs)
a) Paper electrophoresis b) Gel electrophoresis c) Capillary electrophoresis d) Zone electrophoresis e) Moving boundary electrophoresis f) Isoelectric focusing
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.

6. **a. Potentiometry:** Principle, working, Ion selective Electrodes and Application of potentiometry.
b. Thermal Techniques: Principle, thermal transitions and Instrumentation (Heat flux and power-compensation and designs), Modulated DSC, Hyper DSC, experimental parameters (sample preparation, experimental conditions, calibration, heating and cooling rates, resolution, source of errors) and their influence, advantage and disadvantages, pharmaceutical applications. Differential Thermal Analysis (DTA):

Principle, instrumentation and advantage and disadvantages, pharmaceutical applications, derivative differential thermal analysis (DDTA). TGA: Principle, instrumentation, factors affecting results, advantage and disadvantages, pharmaceutical applications. (10 Hrs)

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7. Pharmaceutical Analysis - Modern Methods – Part B - J W Munson, Vol 11, Marcel. Dekker Series
8. Spectroscopy of Organic Compounds, 2nd edn., P.S/Kalsi, Wiley estern Ltd., Delhi.
9. Textbook of Pharmaceutical Analysis, KA.Connors, 3rd Edition, John Wiley & Sons, 1982.

Teaching-Learning Strategies in Brief

The teaching learning strategies, followed are board and chalk teaching, Learning through discussion among the peer group, classroom interaction, discussion of research papers of Journals related to topics, power point presentation, Q & A session and reflective learning.

Assessment methods and weightages in brief

There are two components of assessment: Internal assessment (25 marks) and End semester examination (75 marks). Internal assessment consists of continuous mode (10 marks) and sessional examinations (15 marks). There are two Sessional exams (each conducted for 30 marks and computed for 15 marks) and one improvement exam. The average marks of two best sessional exams are computed out of 15 marks. Continuous mode evaluation is of 10 marks comprising of attendance- 8 marks (calculated as: Percentage of Attendance: Allotment of marks- Less than 80: 0 marks; 80-84: 2 marks; 85-89: 4 marks; 90-94: 6 marks and 95-100: 8 marks) and Student- Teacher interaction: 2 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 marks and End Semester Examination: 75 Marks).

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Name of the Academic Program: M. Pharm (Pharmaceutical Chemistry)

Course Code: MPC 102T

Title of the Course: Advanced Organic Chemistry-I (Theory)

L- P: 4-0 Credits: 4

(L=Lecture hours, P=Practical hours)

COURSE OUTCOMES (COs)

After completing this Course, the students should be able to:

CO-1: Understand the basic concept of organic chemistry, method of formation and stability of organic intermediates. (**Cognitive level: Understand)**

CO-2: Apply the concept of mechanism and name reaction to synthesize small molecules for various pharmacological effects. **(Cognitive level: Apply)**

CO-3: Explain the concept of protecting groups and synthetic reagents required during drug synthesis. (**Cognitive level: Create)**

CO-4: Demonstrate the **c**oncept of disconnection/ Retrosynthesis to develop synthetic routes for small target molecule. (**Cognitive level: Apply)**

CO-5: Explain synthetic strategies involved in the synthesis of drugs containing five, six membered and fused heterocyclics systems. **(Cognitive level: Apply)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3		3	2	1		1	2		2		3		2	1
CO2	3		2	2	2		2	1	2	2	3	3		3	3
CO3	3	2	3	2	2		2	2	2	3	3	3	2		
CO4	3		3	2	2	2	2	2	2	2	3	3	2		3
CO5	3	3	2	3	2	2	2	2	2	2	3	3	2		2

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level'mapping, 2 for 'Medium-level'mapping, 1 for 'Low'-level'mapping.

Detailed Syllabus **60 Hrs**

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

Organic intermediates: Carbocations, carbanions, free radicals, carbenes and nitrenes. Their method of formation, stability and synthetic applications. Types of reaction mechanisms and

methods of determining them, Detailed knowledge regarding the reactions, mechanisms and their relative reactivity and orientations.

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, 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, 5th 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, NelsonThorns.
11. Organic Synthesis - Special Techniques. VK Ahluwalia and R Agarwal, Narosa Publishers.
12. Organic Reaction Mechanisms IVth Edtn, VK Ahluwalia and RK Parashar, Narosa Publishers.

Teaching-Learning Strategies in Brief

The teaching learning strategies, followed are board and chalk teaching, Learning through discussion among the peer group, classroom interaction, discussion of research papers of Journals related to topics, power point presentation, Q & A session and reflective learning.

Assessment methods and weightages in brief

There are two components of assessment: Internal assessment (25 marks) and End semester examination (75 marks). Internal assessment consists of continuous mode (10 marks) and sessional examinations (15 marks). There are two Sessional exams (each conducted for 30 marks and computed for 15 marks) and one improvement exam. The average marks of two best sessional exams are computed out of 15 marks. Continuous mode evaluation is of 10 marks comprising of attendance- 8 marks (calculated as: Percentage of Attendance: Allotment of

marks- Less than 80: 0 marks; 80-84: 2 marks; 85-89: 4 marks; 90-94: 6 marks and 95-100: 8 marks) and Student- Teacher interaction: 2 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 marks and End Semester Examination: 75 Marks).

…….

Name of the Academic Program: M. Pharm. (Pharmaceutical Chemistry)

Course Code: MPC-103T

Title of the Course: Advanced Medicinal Chemistry (Theory)

L-T-P: 4-0-12 Credits: 4

(L=Lecture hours, T=Tutorial hours, P=Practical hours)

COURSE OUTCOMES (COs)

After the course has been completed students should be able to:

CO-1: Know how does medicinal chemistry relate to drug discovery (**Cognitive level: Understand)**

CO-2: The need of peptidomimetics for drug discovery (**Cognitive level: Apply)**

CO-3: Understand the basic concepts of prodrugs (**Cognitive level: Understand)**

CO-4: Explain the chemistry and pharmacology of therapeutic agents studied (**Cognitive level: Analyse)**

CO-5: Know the strategies to compact antimicrobial resistance (**Cognitive level: Apply)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1		2	2	2	2	2	2	3	1	2	1
CO2	2	1	1	1		2	2	2		1		2	1		
CO3	2	2	1	1		2	2	2				3	3	2	1
CO4	3	3	3	2	2		3	2	2	3	2	2	3	2	1
CO5	1	2	2	1	2		2	2	2	3	2	1	1		

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level'mapping, 2 for 'Medium-level'mapping, 1 for 'Low'-level'mapping.

Detailed Syllabus **60 Hrs**

Unit-I **12 Hrs**

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.

Unit-II **12 Hrs**

Prodrug Design and Analog design:

a) **Prodrug design**: Basic concept, Carrier linked prodrugs/ Bio precursors, 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) Combating drug resistance: Causes for drug resistance, strategies to combat drug resistance in antibiotics and anticancer therapy, Genetic principles of drug resistance.
c) Analog Design: Introduction, Classical & Non classical, Bioisosteric replacement strategies, rigid analogs, alteration of chain branching, changes in ring size, ring position isomers, design of stereo isomers and geometric isomers, fragments of a lead molecule, variation in inter atomic distance.

Unit-III **12 Hrs**

Medicinal chemistry aspects of the following class of drugs:

Systematic study, SAR, Mechanism of action and synthesis of new generation molecules of following class of drugs:

a) Anti-hypertensive drugs, Psychoactive drugs, Anticonvulsant drugs, H1 & H2 receptor antagonist, COX1 & COX2 inhibitors, Adrenergic & Cholinergic agents, Antineoplastic and Antiviral agents.
b) Stereochemistry and Drug action: Realization that stereo selectivity is a pre-requisite for evolution. Role of chirality in selective and specific therapeutic agents. Case studies, Enantio selectivity in drug adsorption, metabolism, distribution and elimination.

Unit-IV **12 Hrs**

Rational Design of Enzyme Inhibitors

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.

Unit-V **12 Hrs**

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 thromboxane.

Reference Books

1. Medicinal Chemistry by Burger, Vol I –VI.
2. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, 12th 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
5. Introduction to Quantitative Drug Design by Y.C. Martin.
6. Principles of Medicinal Chemistry by William Foye, 7th 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, Vallabh Prakashan, New Delhi.
12. Peptidomimetics in Organic and Medicinal Chemistry by Antonio Guarna and Andrea Trabocchi, First edition, Wiley publishers.

Teaching-Learning Strategies in Brief

The teaching learning strategies, followed are board and chalk teaching, Learning through discussion among the peer group, classroom interaction, discussion of research papers of Journals related to topics, power point presentation, Q & A session and reflective learning.

Assessment methods and weightages in brief

There are two components of assessment: Internal assessment (25 marks) and End semester examination (75 marks). Internal assessment consists of continuous mode (10 marks) and sessional examinations (15 marks). There are two Sessional exams (each conducted for 30 marks and computed for 15 marks) and one improvement exam. The average marks of two best sessional exams are computed out of 15 marks. Continuous mode evaluation is of 10 marks comprising of attendance- 8 marks (calculated as: Percentage of Attendance: Allotment of marks- Less than 80: 0 marks; 80-84: 2 marks; 85-89: 4 marks; 90-94: 6 marks and 95-100: 8 marks) and Student- Teacher interaction: 2 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 marks and End Semester Examination: 75 Marks).

…….

Name of the Academic Program: M. Pharm. (Pharmaceutical Chemistry)

Course Code: MPC-104T

Title of the Course: Chemistry of Natural Products (Theory)

L-T-P: 4-0-0 Credits: 4

(L=Lecture hours, T=Tutorial hours, P=Practical hours)

COURSE OUTCOMES (COs)

Upon course completion, students should be able to:

CO-1: Understand different types of natural compounds with their chemistry and medicinal importance. (**Cognitive level: Understand)**

CO-2: Understand the general methods of structural elucidation of compounds of natural origin (**Cognitive level: Understand)**

CO-3: understand the Isolation, purification and characterization of simple chemical constituents from natural source (**Cognitive level: Apply)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	1	1	1	1	1	1	3	3	1	1	1
CO2	3	2	1	1	1	1	1	1	1	1	1	3	1		
CO3	3	3	1	1	1	1	1	1	1	2	1	3	1	1	1

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level'mapping, 2 for 'Medium-level'mapping, 1 for 'Low'-level'mapping.

Detailed Syllabus **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** 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 agents male & female sex hormones (Testosterone, Estradiol, Progesterone), adrenocorticoids (Cortisone), contraceptive agents and steroids (Vit – D). **12 Hrs**

3. a) 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).

b) Vitamins Chemistry and Physiological significance of Vitamin A, B1, B2, B12, C, E, Folic acid and Niacin. **12 Hrs**

4. a) Recombinant DNA technology and drug discovery 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. **12 Hrs**

5 Structural Characterization of natural compounds 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. **12 Hrs**

RECOMMENDED BOOKS

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

Teaching-Learning Strategies in Brief

The teaching learning strategies, followed are board and chalk teaching, Learning through discussion among the peer group, classroom interaction, discussion of research papers of Journals related to topics, power point presentation, Q & A session and reflective learning.

Assessment methods and weightages in brief

There are two components of assessment: Internal assessment (25 marks) and End semester examination (75 marks). Internal assessment consists of continuous mode (10 marks) and sessional examinations (15 marks). There are two Sessional exams (each conducted for 30 marks and computed for 15 marks) and one improvement exam. The average marks of two best sessional exams are computed out of 15 marks. Continuous mode evaluation is of 10 marks comprising of attendance- 8 marks (calculated as: Percentage of Attendance: Allotment of marks- Less than 80: 0 marks; 80-84: 2 marks; 85-89: 4 marks; 90-94: 6 marks and 95-100: 8 marks) and Student- Teacher interaction: 2 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 marks and End Semester Examination: 75 Marks).

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Name of the Academic Program: M. Pharm. (Pharmaceutical Chemistry)

Course Code: MPC-105T

Title of the Course: Pharmaceutical Chemistry Practical- I

L-T-P: 0-0-12 **Credits: 6**

(L=Lecture hours, T=Tutorial hours, P=Practical hours)

COURSE OUTCOMES (COs)

Upon course completion, students should be able to:

CO-1: Analyze Pharmacopeial compounds and their formulations by various spectroscopic techniques **(Cognitive Level: Analyze)**

CO-2: Use analytical tools and instruments in the estimation of multi component containing formulations **(Cognitive Level: Apply)**

CO-3: Purify organic solvents and chemical compounds **(Cognitive Level: Apply)**

CO-4: Understand the mechanism of chemical reactions to be used in the synthesis of compounds. **(Cognitive Level: Understand)**

CO-5: Understand and apply isolation, purification and characterization of medicinally important compounds. **(Cognitive Level: Apply)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2
CO2	3	2	3	3	2	2	1	1		2	1	2	2	2	2
CO3	3	2	3	2	2		1		1	2		1	1	1	
CO4	3	3	3	2	2	2		1	1	1	1	1		1	1
CO5	3	3	3	2	2	2	1	1	1	1	1	1	1	1	1

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level'mapping, 2 for 'Medium-level'mapping, 1 for 'Low'-level'mapping.

Detailed Syllabus **60 Hrs**

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

References:

1. Practical Organic Chemistry- Vogel, 5th Edition/ Rev by Brian S. Furniss.
2. Principles of Medicinal Chemistry by William Foye, 7th Edition, Lippincott Williams & Wilkins, Wolters Kluwer (India) Pvt. Ltd, New Delhi.
3. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, 12th Edition, Lippincott Williams & Wilkins, Wolters Kluwer (India) Pvt. Ltd, New Delhi.
4. Strategies for Organic drug synthesis and design. Daniel Lednicer, A Wiley Interscience Publication.
5. Experimental Organic chemistry. Principles and Practice, /Laurence M. Harwood & Christopher J. Moody. Blackwell Scientific Publications.
6. Heterocyclic Chemistry- Thomas L. Gilchrist. John Wiley & Sons Inc.
7. Morrison and Bond's Organic Chemistry 6th Edition.
8. Heterocyclic Chemistry in Drug Discovery, Wiley Publication Edited by Jie Jack Li.
9. Top Drugs and top synthetic routes- John Saunder, Oxford University Press.
10. Mann and Saunders practical organic chemistry 4th Edition.

Teaching-Learning Strategies in brief

The teaching learning strategies, followed are chalk-board teaching, learning through discussion among the peer group, classroom interaction, quiz, presentations, Q & A session and reflective learning.

Assessment methods and weightages in brief

Practical

There are two components of assessment: Internal assessment (50 marks) and End semester examination (100 marks). Internal assessment consists of continuous mode (20 marks) and sessional examinations (30 marks). Continuous mode evaluation is of 10 marks comprising of Attendance- 10 marks (calculated as: Percentage of Attendance: Allotment of marks- Less than 80: 0 marks; 80-84: 2.5 mark; 85-89:5 mark; 90-94: 7.5 marks and 95-100: 10 marks) and based on practical records, regular viva voce, etc. -10 marks. There are two Sessional exams (each conducted for 40 marks and computed for 30 marks) and one improvement exam (40 marks and computed for 30 marks). The average marks of two best sessional exams are computed out of 30 marks.

Total Marks are 150 for the subject (Internal Assessment: 50 marks and End Semester Examination: 100 Marks)

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M.PHARM. SEMESTER II

Course Code MPC 201T	**Title of the course: Advanced Spectral Analysis**
Course Code: MPC 202T	**Title of the Course: Advanced Organic Chemistry-II**
Course Code: MPC 203T	**Title of the Course: Computer Aided Drug Design**
Course Code: MPC 204T	**Title of the Course: Pharmaceutical Process Chemistry**
Course Code: MPC 205P	**Title of the Course: Pharmaceutical Chemistry Practical-II**

Name of the Academic Program: M. Pharm. (Pharmaceutical Chemistry)

Course Code: MPC-201T

Title of the Course: Advanced Spectral Analysis (Theory)

L-T-P: 4-0-12 **Credits: 4**

(L=Lecture hours, T=Tutorial hours, P=Practical hours)

COURSE OUTCOMES (COs)

After completing this Course, the students should be able to understand:

CO-1: How to identify organic compounds (**Cognitive level: Analyse)**

CO-2: The principle, instrumentation and applications of hyphenated instruments (**Cognitive level: Understand)**

CO-3: Identification of compounds using instrumental techniques **(Cognitive level: Analyse)**

CO-4: About the theory and practical of the instruments used in analysis (**Cognitive level: Understand)**

CO-5: Spectral interpretation of organic compounds (UV, IR, NMR and Mass) **(Cognitive level: Apply)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3		1		1	2	1		3	3	2	2
CO2	1	2	2	3						3		3	3	3	3
CO3	3	2	2	3	2	2	3	3		5		3	3	3	2
CO4	1	2	3	3	2	2			3		2	1	1	1	2
CO5	2	2	3	3	3	2	3				3	3	3	1	1

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level'mapping, 2 for 'Medium-level'mapping, 1 for 'Low'-level'mapping.

Detailed Syllabus **60 Hrs**

Unit-I **12 Hrs**

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.

Unit-II **12 Hrs**

NMR spectroscopy: 1-D and 2-D NMR, NOESY and COSY, HECTOR, INADEQUATE techniques, Interpretation of organic compounds

Unit-III **12 Hrs**

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.

Unit-IV **12 Hrs**

Chromatography: Principle, Instrumentation and Applications of the following:

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

Unit-V **12 Hrs**

a) **Thermal methods of analysis:** 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.

Reference Books:

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

Teaching-Learning Strategies in brief

The teaching learning strategies, followed are chalk-board teaching, learning through discussion among the peer group, classroom interaction, quiz, presentations, Q & A session and reflective learning.

Assessment methods and weightages in brief

There are two components of assessment: Internal assessment (25 marks) and End semester examination (75 marks). Internal assessment consists of continuous mode (10 marks) and sessional examinations (15 marks). Continuous mode evaluation is of 10 marks comprising of Attendance -8 marks (calculated as: Percentage of Attendance: Allotment of marks- Less than 80: 0 marks; 80-84: 2 mark; 85-89: 4 marks; 90-94: 6 marks and 95-100: 8 marks), Academic activities

Student teacher interaction-2 marks. There are two Sessional exams (each conducted for 30 marks and computed for 15 marks) and one improvement exam (30 marks and computed for 15 marks). The average marks of two best sessional exams are computed out of 15 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 marks and End Semester Examination: 75 Marks)

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Name of the Academic Program: M. Pharm (Pharmaceutical Chemistry)

Course Code: MPC 202T

Title of the Course: Advanced Organic Chemistry-II

L-T-P: 4-0-0 **Credits: 4**

(L=Lecture hours, T=Tutorial hours, P=Practical hours)

COURSE OUTCOMES (COs)

After completing this Course, the students should be able to:

CO-1: Discuss the principles and applications of Green chemistry. **(Cognitive level: Understand)**

CO-2: Discuss the concept of peptide chemistry**. (Cognitive level: Understand)**

CO-3: Explain the concept of catalysts and various catalysts used in organic reactions **(Cognitive level: Understand)**

CO-4: Explain the photochemical and pericyclic reactions. **(Cognitive level: Understand)**

CO-5: Explain the concept of stereochemistry and asymmetric synthesis. **(Cognitive level: Understand)**

CO-6: Use microwave irradiated reactions of synthetic importance**. (Cognitive level: Create)**

CO-7: Discuss the synthesis of organic compounds by adapting different approaches. **(Cognitive level: Apply)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	3	1	3	1	2	3	3	3				3
CO2	3	2	2	1	1	3	1	2	3	2	3				3
CO3	3	2	3	3	1	3	1	2	3	3	3	1			3
CO4	3	2	1	1	1	3	1	2	3	2	3	1	1		3
CO5	3	3	1	1	1	3	1	2	2	2	3		1	1	3
CO6	3	3	3	3	2	3	1	2	3	3	3	2	1		3
CO7	3	3	3	3	2	3	1	2	3	3	3	2	1		3

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low'-level' mapping.

Detailed Syllabus **Theory** **60 Hrs**

1. Green Chemistry: **12 Hrs**

a. Introduction, principles of green chemistry

b. 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 heterocycles synthesis

c. Ultrasound assisted reactions: Types of sonochemical reactions, homogenous, heterogeneous liquid-liquid and liquid-solid reactions, synthetic applications

d. Continuous flow reactors: Working principle, advantages and 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 12 Hrs

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 sigmatrophic rearrangement reactions with examples

4 Catalysis: 12 Hrs

a. Types of catalysis, heterogeneous and homogenous catalysis, advantages and disadvantages

b. Heterogeneous catalysis – preparation, characterization, kinetics, supported catalysts, catalyst deactivation and regeneration, some examples of heterogeneous catalysis used in synthesis of drugs.

c. Homogenous catalysis, hydrogenation, hydroformylation, hydrocyanation, Wilkinson catalysts, chiral ligands and chiral induction, Ziegler-Natta catalysts, some examples of homogenous catalysis used in synthesis of drugs

d. Transition-metal and Organo-catalysis in organic synthesis: Metal-catalyzed reactions

e. Biocatalysis: Use of enzymes in organic synthesis, immobilized enzymes/cells in organic reaction.

f. Phase transfer catalysis - theory and applications

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. "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, Sixth ed., 1995.
5. Carey, Organic chemistry, 5th edition (Viva Books Pvt. Ltd.)
6. Organic synthesis-the disconnection approach, S. Warren, Wily India
7. Principles of organic synthesis, ROC Norman and JM Coxan, Nelson thorns
8. Organic synthesis- Special techniques VK Ahluwalia and R Aggarwal, Narosa Publishers.
9. Organic reaction mechanisms IV edtn, VK Ahluwalia and RK Parashar, Narosa Publishers.
10. Ahluwalia VK, Kidwai M. New trends in green chemistry. Springer Science & Business Media; 2004 Feb 29.
11. Green Chemistry: Theory and Practice by Paul Anastas and John Warner
12. Sanghi R, Singh V, editors. Green chemistry for environmental remediation. John Wiley & Sons; 2012 Jan 20.

Teaching-Learning Strategies in brief

The teaching learning strategies, followed are chalk-board teaching, learning through discussion among the peer group, classroom interaction, quiz, presentations, Q & A session and reflective learning.

Assessment methods and weightages in brief

There are two components of assessment: Internal assessment (25 marks) and End semester examination (75 marks). Internal assessment consists of continuous mode (10 marks) and sessional examinations (15 marks). Continuous mode evaluation is of 10 marks comprising of Attendance -8 marks (calculated as: Percentage of Attendance: Allotment of marks- Less than 80: 0 marks; 80-84: 2 mark; 85-89: 4 marks; 90-94: 6 marks and 95-100: 8 marks), Academic activities

Student teacher interaction-2 marks. There are two Sessional exams (each conducted for 30 marks and computed for 15 marks) and one improvement exam (30 marks and computed for 15 marks). The average marks of two best sessional exams are computed out of 15 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 marks and End Semester Examination: 75 Marks)

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Name of the Academic Program: M. Pharm (Pharmaceutical Chemistry)

Course Code: MPC203T

Title of the Course: Computer Aided Drug Design

L-T-P: 4-0-0 **Credits**: **04**

(L=Lecture hours, T=Tutorial hours, P=Practical hours)

COURSE OUTCOMES (COs)

After completing this Course, the students should be able to

CO-1: Explain the role of CADD in the drug development pipeline (**Cognitive level: Understand**)

CO-2: Understanding the concept of rational approach of to lead discovery from various sources. (**Cognitive level: Understand**)

CO-3: Evaluates the different CADD techniques and their application in drug design (**Cognitive level: Evaluate**)

CO-4: Explain various structure based drug design methods (**Cognitive level: Apply**)

CO-5: Explain various Ligand based drug design methods (**Cognitive level**: **Apply**)

CO-6: Compare the various CADD techniques and justify the use of particular CADD technique (**Cognitive level: Evaluate**)

CO-7: Employ the knowledge to design the ligand molecule (**Cognitive level: Create**)

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3			3		2		1		1		3		3	1
CO2	3	3		3		2				1		3		3	1
CO3	3	3		3		2				1		3		3	1
CO4	3			3		2		1		1		3		3	1
CO5	3			3		2		1		1		3		3	1
CO6	3		3	3		2				1		3		3	1
CO7	3		3	3		2		1		1		3		3	1

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level'mapping, 2 for 'Medium-level'mapping, 1 for 'Low'-level'mapping.

Detailed Syllabus: **Theory** **60 Hrs**

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 (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. **12 Hrs**

2. Quantitative Structure Activity Relationships: 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. **12 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

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**

4. 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. **12 Hrs**

5. Pharmacophore Mapping and Virtual Screening 12 Hrs

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.

Reference Books:

1. R M Stroud and J F Moore, Computational and structural approaches to drug design, 2nd Edn. 2007, RSC
2. Y.C. Martin. Quantitative Drug Design A Critical Introduction, 2nd Edition, 2019 CRC Press
3. Abraham DJ, Burger's Medicinal Chemistry, Drug Discovery and Development, Volumes 1, 8th Edition, Wiley, New York
4. Smith and Williams, Introduction to the Principles of Drug Design 2005, Harwood Academic Publisher.
5. Silverman R.B. "The organic Chemistry of Drug Design and Drug Action"Academic Press New York

6. Patrick Graham, L., An Introduction to Medicinal Chemistry, 3rd edn Oxford University Press.
7. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry.
8. S. Chackalamannil, D. Rotella, S. Ward Comprehensive Medicinal Chemistry 3rd Edn Elsevier
9. C. G. Wermuth, The Practice of Medicinal Chemistry, 4th edition, Academic Press;
10. Robert GCK, ed., "Drug Action at the Molecular Level" University Prak Press Baltimore.
11. Delgado JN, Remers WA eds "Wilson & Gisvolds's Text Book of Organic Medicinal & Pharmaceutical Chemistry" Lippincott, New York.

Teaching-Learning Strategies in brief

The teaching learning strategies, followed are chalk-board teaching, learning through discussion among the peer group, classroom interaction, quiz, presentations, Q & A session and reflective learning.

Assessment methods and weightages in brief

There are two components of assessment: Internal assessment (25 marks) and End semester examination (75 marks). Internal assessment consists of continuous mode (10 marks) and sessional examinations (15 marks). Continuous mode evaluation is of 10 marks comprising of Attendance -8 marks (calculated as: Percentage of Attendance: Allotment of marks- Less than 80: 0 marks; 80-84: 2 mark; 85-89: 4 marks; 90-94: 6 marks and 95-100: 8 marks), Academic activities

Student teacher interaction-2 marks. There are two Sessional exams (each conducted for 30 marks and computed for 15 marks) and one improvement exam (30 marks and computed for 15 marks). The average marks of two best sessional exams are computed out of 15 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 marks and End Semester Examination: 75 Marks)

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Name of the Academic Program: M. Pharm (Pharmaceutical Chemistry)

Course Code: MPC 204T

Title of the Course: Pharmaceutical Process Chemistry

L-T-P: 4-0-0 Credits: 4

(L=Lecture hours, T=Tutorial hours, P=Practical hours)

COURSE OUTCOMES (COs)

After completing this Course, the students should be able to:

CO-1: Explain the criteria for the various unit operations in process chemistry (**Cognitive level: Understand**)

CO-2: Understand Extraction, Filtration, Distillation, Evaporation and Crystallization required for process chemistry. **(Cognitive level: Understand**)

CO-3: Learn about Unit processes like nitration, halogenation, reduction etc required for industrial application. **(Cognitive level: Understand**)

CO-4: Have knowledge regarding food industrial safety management **(Cognitive level: Understand)**

CO-5: Use the concept in developing strategies of scale up process of APIs and intermediates (**Cognitive level: Apply**)

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	1	3	1	1	1	2	1	1	2	3		3		
CO2	3	1	3	1	1	1	2	1	1	2	2		3		
CO3	3	1	3	2	1	1	2	1	1	2	2		3		
CO4	3	1	3	2	1	1	2	1	1	2	2		3		
CO5	3	1	3	3	1	1	2	1	1	2	2		3		

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level'mapping, 2 for 'Medium-level'mapping, 1 for 'Low'-level'mapping.

Detailed Syllabus **60 Hrs**

Unit-I **12 Hrs**

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

Unit-II **12 Hrs**

Unit operations

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, non-aqueous solutions factors affecting crystallization, nucleation. Principle and general methods of Preparation of polymorphs, hydrates, solvates and amorphous APIs

Unit-III **12 Hrs**

Unit Processes - I

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.

Unit-IV **12 Hrs**

Unit Processes - II

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.

Unit-V **12 Hrs**

Industrial Safety

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(Environmentaal Management System), Effluents and its management

Reference Books

1. Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever- Changing Climate-An Overview; K. Gadamasetti, CRC Press.
2. Pharmaceutical Manufacturing Encyclopedia, 3 rd edition, Volume 2.

3. Medicinal Chemistry by Burger, 6 th 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 text book 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

Teaching-Learning Strategies in brief

The teaching learning strategies, followed are chalk-board teaching, learning through discussion among the peer group, classroom interaction, quiz, presentations, Q & A session and reflective learning.

Assessment methods and weightages in brief

There are two components of assessment: Internal assessment (25 marks) and End semester examination (75 marks). Internal assessment consists of continuous mode (10 marks) and sessional examinations (15 marks). Continuous mode evaluation is of 10 marks comprising of Attendance -8 marks (calculated as: Percentage of Attendance: Allotment of marks- Less than 80: 0 marks; 80-84: 2 mark; 85-89: 4 marks; 90-94: 6 marks and 95-100: 8 marks), Academic activities

Student teacher interaction-2 marks. There are two Sessional exams (each conducted for 30 marks and computed for 15 marks) and one improvement exam (30 marks and computed for 15 marks). The average marks of two best sessional exams are computed out of 15 marks.

Total Marks are 100 for the subject (Internal Assessment: 25 marks and End Semester Examination: 75 Marks)

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Name of the Academic Program: M. Pharm-II Semester (Pharmaceutical Chemistry)

Course Code: MPC 205T

Title of the Course: Pharmaceutical Chemistry Practical-II

L-T-P: 0-0-12 **Credits: 6**

(L=Lecture hours, T=Tutorial hours, P=Practical hours)

COURSE OUTCOMES (COs)

After completing this Course, the students should be able to:

CO-1: To develop synthetic route for small molecules. **(Cognitive Level: Understand and Apply)**

CO-2: To apply the structure and theory to the study of organic reaction mechanisms **(Cognitive Level: Apply)**

CO-3: To apply all the naming reactions in multistep process in manufacturing of drugs and drug intermediates special reactive intermediates including carbenes, carbanions and free radicals **(Cognitive Level: Apply)**

CO-4: A detailed understanding of the processes involved in the design, development and discovery of medicinal compounds **(Cognitive Level: Understand)**

CO-5: Student will deal with different analytical data from different principle instrument **(Cognitive Level: Understand)**

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3			2					3			3		
CO2	3										3	3		
CO3	3	2	3	2					1	2	3	3		
CO4	3		3							2	3	3		
CO5	3	3	2	3					2	2	3	3		

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level'mapping, 2 for 'Medium-level'mapping, 1 for 'Low'-level'mapping.

Detailed Syllabus **12 Hrs/Week**

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 P, MR, 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

References:

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

Teaching-Learning Strategies in brief

The teaching learning strategies, followed are chalk-board teaching, learning through discussion among the peer group, classroom interaction, quiz, presentations, Q & A session and reflective learning.

Assessment methods and weightages in brief

Practical

There are two components of assessment: Internal assessment (50 marks) and End semester examination (100 marks). Internal assessment consists of continuous mode (20 marks) and sessional examinations (30 marks). Continuous mode evaluation is of 10 marks comprising of Attendance- 10 marks (calculated as: Percentage of Attendance: Allotment of marks- Less than 80: 0 marks; 80-84: 2.5 mark; 85-89:5 mark; 90-94: 7.5 marks and 95-100: 10 marks) and based on practical records, regular viva voce, etc. -10 marks. There are two Sessional exams (each conducted for 40 marks and computed for 30 marks) and one improvement exam (40 marks and computed for 30 marks). The average marks of two best sessional exams are computed out of 30 marks.

Total Marks are 150 for the subject (Internal Assessment: 50 marks and End Semester Examination: 100 Marks)

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