



आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

**SCHOOL OF PHARMACEUTICAL SCIENCES
IFTM UNIVERSITY, MORADABAD.**

www.iftmuniversity.ac.in

Study & Evaluation Scheme of Master of Pharmacy

<i>Programme</i>	:	<i>Master of Pharmacy (Pharmaceutical Chemistry)</i>
<i>Course Level</i>	:	<i>Post Graduate Degree</i>
<i>Duration</i>	:	<i>Four Semester (two academic year) Full Time</i>
<i>Medium of instruction</i>	:	<i>English</i>
<i>Minimum Required Attendance</i>	:	<i>80%</i>
<i>Total Credit Points</i>	:	<i>Minimum=95, Maximum=100</i>

Programme Outcomes (POs):

On completion of the M. Pharm. program, a student will be able to:

PO1: Explain the knowledge of the basics and advanced pharmaceutical sciences and the ability to acquire, manage and use current information with problem solving approach.

PO2: Perform the synthesis, development of analytical techniques for identification, characterization and quantification of drugs, formulation, pharmacological, pharmacognostical, biotechnological and regulatory aspects of drugs and biomolecules.

PO3: Undergo the applied and interdisciplinary research for betterment of society at national and international level.

PO4: Comply and work on rules and regulations involved in the drug discovery & development, manufacture and other allied area of the field.

PO5: Develop problem-based learning approach and analytical thinking in his/her academic and professional life.

PO6: Apply critical thinking skills, including investigation, application, analysis, creativity, evaluation of information, data and documents related to research at local, regional and global platform.

PO7: Tackle professional challenges through lifelong learning attitude.

PO8: Demonstrate the ability to plan and implement professional activities.

PO9: Act efficiently as a leader in the diverse areas of the profession including writing research papers and articles of contemporary trends.

PO10: Apply the knowledge and skills to gain recognition in professional circle as well as society.

PO11: Make initiatives to create awareness in society about the effective and safe use of medicines.

PO12: Exercise ethical practices and moral values in personal and professional endeavors.

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Dean

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Sanjeev Bora
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2016

THE MASTER OF PHARMACY (M. PHARM.) COURSE REGULATION 2014

(BASED ON NOTIFICATION IN THE GAZETTE OF INDIA No. 362, DATED DECEMBER 11, 2014)

SCHEME AND SYLLABUS



PHARMACY COUNCIL OF INDIA
Combined Council's Building, Kotla Road,
Aiwan-E-Ghalib Marg, New Delhi-110 002.
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भारत का राजपत्र The Gazette of India

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NEW DELHI, THURSDAY, DECEMBER 11, 2014/AGRAHAYANA 20, 1936

PHARMACY COUNCIL OF INDIA

NOTIFICATION

New Delhi, the 10th December, 2014

The Master of Pharmacy (M.Pharm) Course Regulations, 2014

No. 14-136/ 2014-PCI.—In exercise of the powers conferred by Sections 10 and 18 of the Pharmacy Act, 1948 (8 of 1948), the Pharmacy Council of India, with the approval of the Central Government hereby makes the following regulations: namely—

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CHAPTER –I: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.


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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/extra-curricular activities is dependent upon the quantum of work expected to be put in for each of these activities per week/per activity.


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.

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.

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


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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.

8. 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.

9. Course of study

The specializations in M.Pharm program is given in Table 1.

Table – 1: M.Pharm. Pharmaceutical Chemistry with Code

S. No.	Specialization	Code
1.	Pharmaceutical Chemistry	MPC

The course of study for M.Pharm specializations shall include Semester wise Theory & Practical as given in Table – 2. 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 – 2.

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Table – 2: Course of study for M. Pharm. (Pharmaceutical Chemistry)

Course Code	Course	Credit Hours	Credit Points	Hrs./week	Marks
Semester I					
MPC101T	Modern Pharmaceutical Analytical Techniques	4	44		100
MPC102T	Advanced Organic Chemistry –I	4	44		100
MPC103T	Advanced Medicinal chemistry	4	44		100
MPC104T	Chemistry of Natural Products	4	44		100
MPC105P	Pharmaceutical Chemistry Practical I	12	612		150
MPC111P	Seminar/Assignment	7	47		100
Total		35	2635		650
Semester II					
MPC201T	Advanced Spectral Analysis	4	44		100
MPC202T	Advanced Organic Chemistry –II	4	44		100
MPC203T	Computer Aided Drug Design	4	44		100
MPC204T	Pharmaceutical Process Chemistry	4	44		100
MPC205P	Pharmaceutical Chemistry Practical II	12	612		150
MPC222P	Seminar/Assignment	7	47		100
Total		35	2635		650

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Table – 3: Course of study for M. Pharm. (Pharmaceutical Chemistry). IIISemester

Course Code	Course	CreditHours	CreditPoints
MRM 301T	Research Methodology and Biostatistics*	4	4
MPC302	Journal club	1	1
MPC303	Discussion / Presentation (Proposal Presentation)	2	2
MPC304	Research Work	28	14
Total		35	21

* Non University Exam

Table – 4: Course of study for M. Pharm. (Pharmaceutical Chemistry) IVSemester

Course Code	Course	CreditHours	CreditPoints
MPC 401	Journal Club	1	1
MPC 402	Discussion / Presentation (Proposal Presentation)	3	3
MPC 403	Research Work and Colloquium	31	16
Total		35	20

Table – 5: 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=100*

*Credit Points for Co-curricular Activities MPC– Pharmaceutical Chemistry

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

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

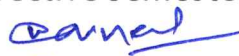
Note: International Conference: Held Outside India International Journal: The Editorial

Board Outside India

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

10. 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.


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- 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.

11. Examinations/Assessments

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

End semester examinations

The End Semester Examinations for each theory and practical course through semesters I to IV shall be conducted by the respective university except for the subject with asterix symbol (*) in table 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.


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Table - 7: Schemes for internal assessments and end semester
(Pharmaceutical Chemistry- MPC)

CourseCode	Course	Internal Assessment				End semester Exams		Total Marks
		Continuous Mode	Sessional Exams		Total	Marks	Duration	
			Marks	Duration				
SEMESTER I								
MPC101T	Modern Pharmaceutical Analytical Techniques	10	15	1 Hr	25	75	3 Hrs	100
MPC102T	Advanced Organic Chemistry –I	10	15	1 Hr	25	75	3 Hrs	100
MPC103T	Advanced Medicinal chemistry	10	15	1 Hr	25	75	3 Hrs	100
MPC104T	Chemistry of Natural Products	10	15	1 Hr	25	75	3 Hrs	100
MPC105P	Pharmaceutical Chemistry Practical I	20	30	6 Hrs	50	100	6 Hrs	150
MPC111P	Seminar /Assignment	-	-	-	-	-	-	100
Total								650
SEMESTER II								
MPC201T	Advanced Spectral Analysis	10	15	1 Hr	25	75	3 Hrs	100
MPC202T	Advanced Organic Chemistry –II	10	15	1 Hr	25	75	3 Hrs	100
MPC203T	Computer Aided Drug Design	10	15	1 Hr	25	75	3 Hrs	100
MPC204T	Pharmaceutical Process Chemistry	10	15	1 Hr	25	75	3 Hrs	100
MPC205P	Pharmaceutic	20	30	6 Hrs	50	100	6	150

	al Chemistry Practical II						Hrs	
MPC222P	Seminar /Assignment	-	-	-	-	-	-	100
Total								650

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

Course Code	Course	Internal Assessment				End Semester Exams		Total Mark s
		Continu ous Mode	Sessional Exams		Tot al	Mark s	Duration	
			Marks	Duration				
SEMESTER III								
MRM301T	Research Methodology Biostatistics*	10	15	1 Hr	25	75	3 Hrs	100
MPC 302	Journal club	-	-	-	25	-	-	25
MPC 303	Discussion / Presentation (Proposal Presentation)	-	-	-	50	-	-	50
MPC 304	Research work*	-	-	-	-	350	1 Hr	350
Total								525
SEMESTER IV								
MPC 401	Journal club	-	-	-	25	-	-	25
MPC 402	Discussion / Presentation (Proposal Presentation)	-	-	-	75	-	-	75
MPC 403	Research work and Colloquium	-	-	-	-	400	1 Hr	400
Total								500

*Non University Examination

MPC-

Pharm.chemistry

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Internal assessment: Continuous mode

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

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

Theory	
Criteria	Maximum Marks
Attendance (Refer Table – 28)	8
Student – Teacher interaction	2
Total	10
Practical	
Attendance (Refer Table – 28)	10
Based on Practical Records, Regular viva voce, etc.	10
Total	20

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

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

Sessional Exams

Two sessional exams shall be conducted for each theory / practical courses 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.

12. 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 course including internal assessment.

13. 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

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shall be carried over and he/she shall be entitled for grade obtained by him/her on passing.

14. 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.

15. Reexamination of end semester examinations

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

Table - 11: 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

16. 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 II semesters 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.

17. 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 - 12.


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

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

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

18. 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:

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

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

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

19. 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:

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

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

20. 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

21. 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
Communications skills	50 Marks
Question and answer skills	100 Marks
Total	250 Marks

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22. Award of Ranks

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

23. Award of degree

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

24. Duration for completion of the program of study

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

25. Revaluation I Retotaling 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.

26. Re-admission after break of study

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

Panel

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PHARMACEUTICAL CHEMISTRY (MPC)
MODERN PHARMACEUTICAL ANALYTICAL TECHNIQUES

Scope (MPC101T)

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

Objectives

After completion of course student is able to know about,

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

THEORY

60 Hrs

1	UV-Visible spectroscopy: Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy, Choice of solvents and solvent effect and Applications of UV-Visible spectroscopy, Difference/ Derivative spectroscopy. IR spectroscopy: Theory, Modes of Molecular vibrations, Sample handling, Instrumentation of Dispersive and Fourier - Transform IR Spectrometer, Factors affecting vibrational frequencies and Applications of IR spectroscopy, Data Interpretation. Spectrofluorimetry: Theory of Fluorescence, Factors affecting fluorescence Flame emission spectroscopy and Atomic absorption spectroscopy: Principle, Instrumentation, Interferences and Applications.	10 Hrs
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 ¹³ C 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	10 Hrs

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	fragmentation and its rules, Meta stable ions, Isotopic peaks and Applications of Mass spectroscopy.	
4	<p>Chromatography: Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution, isolation of drug from excipients, data interpretation and applications of the following:</p> <ul style="list-style-type: none"> j) Thin Layer chromatography k) High Performance Thin Layer Chromatography l) Ion exchange chromatography m) Column chromatography n) Gas chromatography o) High Performance Liquid chromatography p) Ultra High Performance Liquid chromatography q) Affinity chromatography r) Gel Chromatography 	10 Hrs
5	<p>Electrophoresis: Principle, Instrumentation, Working conditions, factors affecting separation and applications of the following:</p> <ul style="list-style-type: none"> a) Paper electrophoresis b) Gel electrophoresis c) Capillary electrophoresis d) Zone electrophoresis e) Moving boundary electrophoresis f) Iso electric focusing <p>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.</p>	10 Hrs
6	<p>Potentiometry: Principle, working, Ion selective Electrodes and Application of potentiometry.</p> <p>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</p>	10 Hrs

	influence, advantage and disadvantages, pharmaceutical applications. Differential Thermal Analysis (DTA): Principle, instrumentation and advantage and disadvantages, pharmaceutical applications, derivativedifferential thermal analysis (DDTA). TGA: Principle, instrumentation, factors affecting results, advantage and disadvantages, pharmaceutical applications.	
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Course Outcomes:

Upon completion of this course, the student should be able to:

CO1: Understand theory, instrumentation and applications of various spectroscopic techniques for skill development, entrepreneurship and employability at national and international level.

CO2: Know about the concept and applications of NMR spectroscopy for skill development, entrepreneurship and employability.

CO3: Learn theory, instrumentation and applications of Mass spectroscopy for skill development, entrepreneurship and employability.

CO4: Understand principle and instrumentation of various chromatographic methods for skill development, entrepreneurship and employability.

CO5: Understand electrophoresis, X-Ray Crystallography, potentiometry, different thermal techniques and/or immunological assay for skill development, entrepreneurship and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	3	3	3	1	1	2	2	1	1
CO2	3	2	1	3	1	1	2	3	1	1	2	2
CO3	3	2	1	3	2	2	3	3	2	1	1	3
CO4	3	2	2	3	1	1	3	3	2	3	2	3
CO5	3	1	2	3	2	2	3	3	2	3	2	2

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)


(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	3	3	2
CO3	3	2	1
CO4	2	3	1
CO5	3	2	2

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3. Instrumental methods of analysis – Willards, 7th edition, CBS publishers.
4. Practical Pharmaceutical Chemistry – Beckett and Stenlake, Vol II, 4th edition, CBS Publishers, New Delhi, 1997.
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ADVANCED ORGANIC CHEMISTRY - I
(MPC102T)

Scope

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

Objectives

Upon completion of the course the student shall be able to:

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

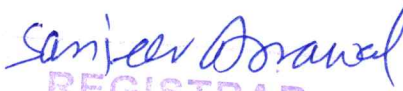
THEORY

60 Hrs

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 Hrs
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 Hrs

3	<p>Synthetic Reagents & Applications:</p> <p>Aluminium isopropoxide, N-bromosuccinamide, diazomethane, dicyclohexylcarbodiimide, Wilkinson reagent, Witting reagent. Osmium tetroxide, titanium chloride, diazopropane, diethyl azodicarboxylate, Triphenylphosphine, Benzotriazol-1-yloxy) tris (dimethylamino) phosphonium hexafluoro-phosphate (BOP).</p> <p>Protecting groups</p> <ol style="list-style-type: none"> Role of protection in organic synthesis Protection for the hydroxyl group, including 1,2-and 1,3-diols: ethers, esters, carbonates, cyclic acetals & ketals Protection for the Carbonyl Group: Acetals and Ketals Protection for the Carboxyl Group: amides and hydrazides, esters Protection for the Amino Group and Amino acids: carbamates and amides 	12 Hrs
4	<p>Heterocyclic Chemistry:</p> <p>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.</p> <p>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.</p>	12 Hrs
5	<p>Synthon approach and retrosynthesis applications</p> <ol style="list-style-type: none"> Basic principles, terminologies and advantages of retrosynthesis; guidelines for dissection of molecules. Functional group interconversion and addition (FGI and FGA) 	12 Hrs


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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.	

Course Outcomes:

Upon completion of this course, the student should be able to:

CO1: Understand the basic aspects of organic chemistry, addition reactions, elimination and rearrangement reactions for skill development and employability.

CO2: Describe the mechanism and synthetic applications of various name reactions for skill development and employability.

CO3: Learn about various synthetic reagents and protecting groups for skill development and employability at national and international level.

CO4: Describe the mechanism and applications of various organic name reactions and synthesis of heterocyclic compounds for skill development and employability.

CO5: Learn the synthon approach and retero synthesis for skill development and employability at local, regional and global platform.

PO-CO Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1	1	1	2	2	1	1	1
CO2	2	2	2	3	2	2	2	1	1	2	2	1
CO3	3	3	2	1	3	1	3	2	2	2	1	3
CO4	3	3	2	2	2	3	3	3	1	3	1	3
CO5	3	3	3	2	2	2	3	1	3	1	3	3


CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)


(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	1
CO2	2	3	2
CO3	3	2	1
CO4	3	3	2
CO5	3	2	2

REFERENCES

1. "Advanced Organic chemistry, Reaction, Mechanisms and Structure", J March, John Wiley and Sons, New York.
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12. Organic Reaction Mechanisms IVth Edtn, VK Ahluwalia and RK Parashar, Narosa Publishers.


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ADVANCED MEDICINAL CHEMISTRY
(MPC103T)

Scope

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

Objectives

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

- ❖ Different stages of drug discovery
- ❖ Role of medicinal chemistry in drug research Different techniques for drug discovery
- ❖ Various strategies to design and develop new drug like molecules for biological targets
- ❖ Peptidomimetics

THEORY

60 Hrs

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 Hrs
2	Prodrug Design and Analog design: a. Prodrug design: Basic concept, Carrier linked prodrugs/ Bioprecursors, Prodrugs of functional group, Prodrugs to improve patient acceptability, Drug solubility, Drug absorption and distribution, site specific drug delivery and sustained drug action. Rationale of prodrug design and practical consideration of prodrug design. b. 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.	12 Hrs

3	<p>a. Medicinal chemistry aspects of the following class of drugs</p> <p>Systematic study, SAR, Mechanism of action and synthesis of new generation molecules of following class of drugs:</p> <p>a. Anti-hypertensive drugs, Psychoactive drugs, Anticonvulsant drugs, H1 & H2 receptor antagonist, COX1 & COX2 inhibitors, Adrenergic & Cholinergic agents, Antineoplastic and Antiviral agents.</p> <p>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.</p>	12 Hrs
4	<p>Rational Design of Enzyme Inhibitors</p> <p>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.</p>	12 Hrs
5	<p>Peptidomimetics</p> <p>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.</p>	12 Hrs

Course Outcomes:

Upon completion of this course, the student should be able to:

CO1: Understand the concept of drug discovery and biological drug targets for skill development and employability.

CO2: Attain knowledge about prodrug design, analogue design and drug resistance for skill development and employability.

CO3: Describe the chemistry, SAR, Mechanism of Action and synthesis of new generation molecules of different classes of drugs for skill development and employability.

CO4: Understand the rational design of enzyme inhibitors for skill development and employability at local, regional and global platform.

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CO5: Learn about the autacoids, peptidomimetics and design of peptodomimetics for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	2	3	1	3	3	2	2	1
CO2	3	3	1	3	1	2	3	2	1	3	2	2
CO3	3	3	2	2	3	2	3	1	3	1	3	2
CO4	3	2	3	2	1	3	3	3	2	3	2	3
CO5	3	2	3	2	1	2	3	1	3	2	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	3	3	2
CO3	3	2	1
CO4	2	3	1
CO5	3	2	2

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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, Lippincott Williams & Wilkins, Wolters 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.

CHEMISTRY OF NATURAL PRODUCTS
(MPC104T)

Scope

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

Objectives

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

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

THEORY

60 Hrs

1	Study of Natural products as leads for new pharmaceuticals for the following class 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. 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)	12 Hrs
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.	12 Hrs

	<p>b) Flavonoids</p> <p>Introduction, isolation and purification of flavonoids, General methods of structural determination of flavonoids; Structural elucidation of quercetin.</p> <p>c) Steroids</p> <p>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).</p>	
3	<p>a) Terpenoids</p> <p>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).</p> <p>b) Vitamins</p> <p>Chemistry and Physiological significance of Vitamin A, B1, B2, B12, C, E, Folic acid and Niacin.</p>	12 Hrs
4	<p>a). Recombinant DNA technology and drug discovery</p> <p>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</p> <p>b). Active constituent of certain crude drugs used in Indigenous system Diabetic therapy – <i>Gymnema sylvestre</i>, <i>Salacia reticulata</i>, <i>Pterocarpus marsupium</i>, <i>Swertia chirata</i>, <i>Trigonella foenum graecum</i>; Liver dysfunction – <i>Phyllanthus niruri</i>; Antitumor – <i>Curcuma longa</i> Linn.</p>	12 Hrs
5	<p>Structural Characterization of natural compounds</p> <p>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.</p>	12 Hrs

Course Outcomes:

Upon completion of this course, the student should be able to:

CO1: Attain detailed knowledge about chemistry of medicinal compounds from natural origin as lead molecule for drug discovery for skill development, entrepreneurship and employability.

CO2: Understand classification, isolation, general methods of structural elucidation of natural compounds like alkaloids, flavonoids and steroids for skill development, entrepreneurship and employability.

CO3: Understand isolation, purification and characterization of terpenoids and learn chemistry and importance of vitamins for skill development, entrepreneurship and employability at national and international level.

CO4: Understand the concept of rDNA technology for drug discovery and to identify the active constituent of crude drugs used in indigenous system for skill development, entrepreneurship and employability.

CO5: Understand structural characterization of natural compounds by spectroscopic methods for skill development, entrepreneurship and employability at local, regional and global platform.

PO-CO Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	2	2	2	3	3	1
CO2	3	3	2	3	2	3	2	1	3	1	1	1
CO3	3	2	2	1	3	2	3	3	3	2	3	2
CO4	3	3	3	2	2	3	3	3	2	2	2	2
CO5	3	3	3	3	3	2	1	1	3	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	2
CO2	3	3	2
CO3	3	3	1
CO4	3	3	1
CO5	3	3	2

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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.
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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 multicomponent containing formulations by UV
3. spectrophotometry
4. Experiments based on Column chromatography
5. Experiments based on HPLC
6. Experiments based on Gas Chromatography
7. Estimation of riboflavin/quinine sulphate by fluorimetry
8. Estimation of sodium/potassium by flame photometry

To perform the following reactions of synthetic importance

1. Purification of organic solvents, column chromatography
2. Claisen-schmidt reaction.
3. Benzylic 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


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ADVANCED SPECTRAL ANALYSIS (MPC201T)

Scope

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

Objectives

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

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

THEORY

60 Hrs

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 Hrs
2	NMR spectroscopy: 1-D and 2-D NMR, NOESY and COSY, HECTOR, INADEQUATE techniques, Interpretation of organic compounds.	12 Hrs
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 Hrs
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) 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	12 Hrs
5	a) Thermal methods of analysis	12 Hrs

Introduction, principle, instrumentation and application of DSC, DTA and TGA.	
b) Raman Spectroscopy Introduction, Principle, Instrumentation and Applications.	
c) Radio immuno assay Biological standardization , bioassay, ELISA, Radioimmuno assay of digitalis and insulin.	

Course Outcomes:

Upon completion of this course, the student should be able to:

CO1: Acquire the knowledge about theoretical principles of UV, IR Spectroscopy and Woodward-Fieser rule for skill development, entrepreneurship and employability at national and international level.

CO2: Understand the NMR Spectroscopy 1-D and 2-D NMR, NOESY and COSY, HECTOR, INADEQUATE techniques, and Interpretation of the NMR of various organic compounds for skill development, entrepreneurship and employability.

CO3: Understand the Principle of Mass Spectroscopy Mass fragmentation and its rule, McLafferty rearrangement, Ring rule, Isotopic peaks, Interpretation of organic compounds for skill development, entrepreneurship and employability.

CO4: Understand the Principle, Instrumentation and Applications of Various Chromatography techniques for skill development, entrepreneurship and employability.

CO5: Learn the general theory and principles of thermal analysis, Raman spectroscopy, Bioassay and ELISA and techniques involved in radioimmuno assay for skill development, entrepreneurship and employability at local, regional and global platform.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	3	3	2	1	3	2	3
CO2	3	3	3	3	3	2	1	2	3	3	3	2
CO3	3	3	3	3	3	1	2	3	3	1	3	2
CO4	3	3	2	1	1	2	3	3	2	3	3	2
CO5	3	3	2	2	2	1	3	1	2	1	3	2

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	2
CO2	3	3	2
CO3	3	3	2
CO4	3	3	2
CO5	3	2	2

REFERENCES

1. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.
2. Principles of Instrumental Analysis - Douglas 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

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ADVANCED ORGANIC CHEMISTRY - II
(MPC202T)

Scope

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

Objectives

Upon completion of the course the student shall be able to:

- The principles and applications of Green chemistry
- The concept of peptide chemistry.
- The various catalysts used in organic reactions
- The concept of stereochemistry and asymmetric synthesis.

THEORY

60 Hrs

1	Green Chemistry: 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.	12 Hrs
2	Chemistry of peptides 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,	12 Hrs

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	<p>purification and case studies, site-specific chemical modifications of peptides</p> <p>c. Segment and sequential strategies for solution phase peptide synthesis with any two case studies</p> <p>d. Side reactions in peptide synthesis: Deletion peptides, side reactions initiated by proton abstraction, protonation, over- activation and side reactions of individual amino acids.</p>	
3	<p>Photochemical Reactions</p> <p>Basic principles of photochemical reactions. Photo-oxidation, photo-addition and photo-fragmentation.</p> <p>Pericyclic reactions</p> <p>Mechanism, Types of pericyclic reactions such as cyclo addition, electrocyclic reaction and sigma trophic rearrangement reactions with examples</p>	12 Hrs
4	<p>Catalysis:</p> <p>a. Types of catalysis, heterogeneous and homogenous catalysis, advantages and disadvantages</p> <p>b. Heterogeneous catalysis – preparation, characterization, kinetics, supported catalysts, catalyst deactivation and regeneration, some examples of heterogeneous catalysis used in synthesis of drugs.</p> <p>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</p> <p>d. Transition-metal and Organo-catalysis in organic synthesis:</p> <p>Metal-catalyzed reactions</p> <p>e. Biocatalysis: Use of enzymes in organic synthesis, immobilized enzymes/cells in organic reaction.</p> <p>f. Phase transfer catalysis- theory and applications</p>	12 Hrs
5	<p>Stereochemistry & Asymmetric Synthesis</p> <p>a. Basic concepts in stereochemistry – optical activity, specific rotation, racemates and resolution of racemates, the Cahn, Ingold, Prelog (CIP)</p>	12 Hrs

	<p>sequence rule, meso compounds, pseudo asymmetric centres, axes of symmetry, Fischers D and L notation, cis-trans isomerism, E and Z notation.</p> <p>b. Methods of asymmetric synthesis using chiral pool, chiral auxiliaries and catalytic asymmetric synthesis, enantiopure separation and Stereoselective synthesis with examples.</p>	
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Course Outcomes:

Upon completion of this course, the student should be able to:

CO1: Learn about the concept of green chemistry, microwave assisted reactions, ultrasound assisted reactions and continuous flow reactors for skill development and employability.

CO2: Gain knowledge about peptide chemistry for skill development and employability at national and international level.

CO3: Know about the photochemical reactions and pericyclic reactions for skill development and employability.

CO4: Understand heterogeneous catalysis, homogeneous catalysis, transition-metal and organo-catalysis in organic synthesis, metal-catalyzed reactions, biocatalysis and phase transfer catalysis for skill development and employability.

CO5: Know about the concept of stereochemistry and asymmetric synthesis for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	2	3	1	3	2	3	2
CO2	2	3	2	3	3	3	1	1	2	2	2	3
CO3	2	3	3	3	2	3	1	2	1	3	3	3
CO4	3	3	3	2	2	3	3	3	2	3	3	3
CO5	3	3	3	3	2	1	3	1	2	1	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	3	3	2
CO3	3	3	2
CO4	3	3	2
CO5	3	3	2

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 Wothers., 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, Wiley India
7. Principles of organic synthesis, R.C. Norman and J.M. 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.

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COMPUTER AIDED DRUG DESIGN
(MPC203T)

Scope

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

Objectives

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

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

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	12 Hrs

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	c) Molecular docking and drug receptor interactions: Rigid docking, flexible docking and extra-precision docking. Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AchE & BchE)	
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 Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophore modeling; Conformational search used in pharmacophore mapping. In Silico Drug Design and Virtual Screening Techniques Similarity based methods and Pharmacophore based screening, structure based In-silico virtual screening protocols.	12 Hrs

Course Outcomes:

Upon completion of this course, the student should be able to:

CO1: Attain detailed knowledge about computer aided drug design and quantitative structure activity relationships for skill development, entrepreneurship and employability.

CO2: Understand Hansch analysis, Free Wilson analysis, 2D-QSAR equations, 3D-QSAR approaches, contourmap analysis and Statistical methods used in QSAR for skill development, entrepreneurship and employability at national and international level.

CO3: Understand molecular modeling and docking for skill development, entrepreneurship and employability.

CO4: Understand the concept of molecular properties and drug design for skill development, entrepreneurship and employability.

CO5: Understand pharmacophore mapping and virtual screening for skill development, entrepreneurship and employability.

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PO-CO Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2	2	1	1	3	3	3	2
CO2	3	3	3	3	2	3	2	1	1	3	3	3
CO3	3	3	1	1	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	2	2	3	1	2	2	2
CO5	3	2	3	3	2	1	3	1	3	1	3	3

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	3	3	2
CO3	3	2	1
CO4	3	3	2
CO5	3	2	2

REFERENCES

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

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PHARMACEUTICAL PROCESS CHEMISTRY

(MPC204T)

Scope

Process chemistry is often described as scale up reactions, taking them from small quantities created in the research lab to the larger quantities that are needed for further testing and then to even larger quantities required for commercial production. The goal of a process chemist is to develop synthetic routes that are safe, cost-effective, environmentally friendly, and efficient. The subject is designed to impart knowledge on the development and optimization of a synthetic route/s and the pilot plant procedure for the manufacture of Active Pharmaceutical Ingredients (APIs) and new chemical entities (NCEs) for the drug development phase.

Objectives

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

- The strategies of scale up process of APIs and intermediates
- The various unit operations and various reactions in process chemistry

THEORY

60 Hrs

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 Hrs
2	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	12 Hrs

	methods of Preparation of polymorphs, hydrates, solvates and amorphous APIs.	
3	<p>Unit Processes - I</p> <p>a) Nitration: Nitrating agents, Aromatic nitration, kinetics and mechanism of aromatic nitration, process equipment for technical nitration, mixed acid for nitration,</p> <p>b) Halogenation: Kinetics of halogenations, types of halogenations, catalytic halogenations. Case study on industrial halogenation process.</p> <p>c) Oxidation: Introduction, types of oxidative reactions, Liquid phase oxidation with oxidizing agents. Nonmetallic Oxidizing agents such as H₂O₂, sodium hypochlorite, Oxygen gas, ozonolysis.</p>	12 Hrs
4	<p>Unit Processes - II</p> <p>a) Reduction: Catalytic hydrogenation, Heterogeneous and homogeneous catalyst; Hydrogen transfer reactions, Metal hydrides. Case study on industrial reduction process.</p> <p>b) Fermentation: Aerobic and anaerobic fermentation.</p> <p>Production of</p> <p>I. Antibiotics; Penicillin and Streptomycin,</p> <p>II. Vitamins: B₂ and B₁₂</p> <p>III. Statins: Lovastatin, Simvastatin</p> <p>c) Reaction progress kinetic analysis</p> <p>I. Streamlining reaction steps, route selection,</p> <p>II. Characteristics of expedient routes, characteristics of cost-effective routes, reagent selection, families of reagents useful for scale-up.</p>	12 Hrs
5	<p>Industrial Safety</p> <p>a) MSDS (Material Safety Data Sheet), hazard labels of chemicals and Personal Protection Equipment (PPE)</p> <p>b) Fire hazards, types of fire & fire extinguishers</p> <p>c) Occupational Health & Safety Assessment Series 1800 (OHSAS-1800) and ISO-14001 (Environmental Management System), Effluents and its management</p>	12 Hrs

Course Outcomes:

Upon completion of this course, the student should be able to:

CO1: Learn the process chemistry, stages of scale up process, case studies of some scale up process of APIs and impurities in API for skill development and employability.

CO2: Attain detailed knowledge about extraction, filtration, distillation, evaporation and crystallization for skill development and employability.

CO3: Attain detailed knowledge about nitration, halogenation and oxidation for skill development and employability.

CO4: Understand the reduction, catalyst, metal hydrides, fermentation, production of various pharmaceutically active drugs and reaction progress kinetic analysis for skill development and employability.

CO5: Understand the industrial safety, MSDS, personal protection equipment, firehazards, fireextinguishers, OHSAS-1800, ISO-14001, effluents and its management for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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CO2	2	3	3	3	2	2	1	3	2	2	2	3
CO3	3	2	3	3	3	3	2	3	3	3	3	3
CO4	3	3	2	2	3	3	3	3	3	3	2	2
CO5	2	3	2	1	2	3	3	3	2	2	3	3

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CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	2	2
CO2	2	3	2
CO3	3	3	1
CO4	2	2	1
CO5	3	2	2

REFERENCES

1. Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever- Changing Climate-An Overview; K. Gadamasetti, CRC Press.
2. Pharmaceutical Manufacturing Encyclopedia, 3rd edition, Volume 2.
3. Medicinal Chemistry by Burger, 6th edition, Volume 1-8.
4. W.L. McCabe, J.C Smith, Peter Harriott. Unit operations of chemical engineering, 7th edition, McGraw Hill
5. Polymorphism in Pharmaceutical Solids .Dekker Series Volume 95Ed: 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, VikasPublishing House
14. J.K. Stille: Industrial Organic Chemistry (PH)
15. Shreve: Chemical Process, McGrawhill.
16. B.K.Sharma: Industrial Chemistry, Goel Publishing House
17. ICH Guidelines
18. United States Food and Drug Administration officialwebsite www.fda.gov

PHARMACEUTICAL CHEMISTRY PRACTICALS – II

(MPC205P)

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. Assignment on regulatory requirements in API (2 experiments)
4. Comparison of absorption spectra by UV and Woodward–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-chlorobenzhydryl piperazine. (an intermediate for cetirizine HCl).
12. Preparation of 4-iodotoluene from p-toluidine.
13. NaBH₄ reduction of vanillin to vanillyl alcohol
14. Preparation of umbelliferone by Pechmann 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

Semester III

MRM301T -Research Methodology & Biostatistics

UNIT – I

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.

UNIT – II

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.

UNIT – III

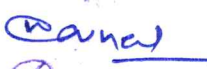
Medical Research: History, values in medical ethics, autonomy, beneficence, non-maleficence, double effect, conflicts between autonomy and beneficence/non-maleficence, euthanasia, informed consent, confidentiality, criticisms of orthodox medical ethics, importance of communication, control resolution,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

UNIT – IV

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.

UNIT – V

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


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Course Outcomes:

Upon completion of this course, the student should be able to:

CO1: Learn the general research methodology for skill development and employability at national and international level.

CO2: Learn the biostatistics, sample size, statistical tests of significance, parametric tests, non-parametric tests, null hypothesis, P values, degree of freedom and interpretation of P values for skill development and employability.

CO3: Attain detailed knowledge about medical Research for skill development and employability at local, regional and global platform.

CO4: Understand the CPCSEA guidelines for laboratory animal facility for skill development and employability.

CO5: Understand the declaration of Helsinki, basic principles for all medical research and additional principles for medical research combined with medical care for skill development and employability.

PO-CO Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3	3	1	1	3	3	3	1
CO2	2	2	2	3	3	3	3	2	2	2	1	1
CO3	3	3	3	3	3	3	2	2	2	2	2	1
CO4	2	2	2	3	2	3	3	3	1	2	2	1
CO5	2	1	2	2	2	3	3	2	2	3	2	1

CO-Curriculum Enrichment Mapping (Please write 3, 2, 1 wherever required)

(Note: 3 for highly mapped, 2 for medium mapped and 1 for low mapped)

	Skill Development	Employability	Entrepreneurship Development
CO1	3	3	2
CO2	2	3	2
CO3	3	2	1
CO4	2	3	1
CO5	3	2	2

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