Syllabus for Multi-Disciplinary Minor Degree
in
Pharmaceutical Chemistry & Technology

Under the National Education Policy (NEP 2020)
in
(2023-2024)

Offered by

DEPARTMENT OF PHARMACEUTICAL SCIENCES AND TECHNOLOGY

INSTITUTE OF CHEMICAL TECHNOLOGY
(University Under Section-3 of UGC Act, 1956)
Elite Status and Center for Excellence
Government of Maharashtra

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A. Preamble

The pharmaceutical industry is a complex and dynamic field, constantly evolving to meet the demands of patients worldwide. In recent years, technology has played an increasingly significant role in this industry, transforming the way drugs are discovered, developed, and delivered to patients. The development and contribution in the field of pharmaceutical sciences and technology has been a multifaceted and dynamic process, mirroring the broader changes in society. The transformation from localized, small-scale pharmaceutical products to a globalized, industrialized pharmaceutical system has been influenced by numerous factors such as technological advancements, population growth, need for medicines and changes in consumer preferences. Pharmaceutical science and technology have played a crucial role in this evolution, shaping the manufacturing/ preparations/ formulations /extractions, and distributed of drug substances, drug products biological, phytoconstituents, fermented bioactive molecules. The commitment of professionals in these fields has been instrumental in ensuring a safe, abundant, and diverse pharmaceutical products supply for an increasingly global population. Department of Pharmaceutical Sciences and Technology has vision to provide demand-driven, value-based and quality technical education to make India a developed country through socio-economic transformation.

In tune of this, the minor degree course in "Pharmaceutical Science and Technology" has been designed to encompass different domains of pharmaceutical science and technology from fundamental knowledge to scientific and technological advancement. According to National Education policy guidelines, the course has been designed for a total of 14 credits as per the requirements of a minor degree.

B. Programme Specific Outcomes:

Programme Specific Outcomes (PSOs) for MDM in Pharmaceutical Sciences and Technology

PSO1	Drug substance/Drug Products/ Herbal products Analysis: Able to apply analytical techniques for pharmaceuticals safety, quality assurance and regulations
PSO2	Innovations in Pharmaceutical Products Development: Able to translate emerging sciences in developing innovative pharmaceutical products.
PSO3	Pharmaceutical Technology Knowledge: Apply the knowledge of mathematics, science, chemical engineering and pharmaceutical technology fundamentals, and pharmaceutical technology specialization to the solution of complex problems in pharmaceutical formulation technology, Pharmaceutical Chemistry and phytochemical extraction or Herbal technology.
PSO4	Design and Development of innovative Solutions: Design solutions for complex pharmaceutical technology problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PSO5	Fermentation Technology: Able to translate emerging science in developing innovative fermentation products

C. **Intake:** Minimum **15**; Maximum **35**

D. Eligibility criteria:

a. CGPA of the first two semesters.
b. In case the results of the 2nd semester are not available, eligibility will be based on CGPA of the 1st Semester (50% weightage) and CET/JEE score (converted into percentile based on admitted students, 50% weightage).
c. The allotment to the minor degree programme will be as per the policy of the Institute.

E. **Prerequisites:** 12th Standard Biology and Chemistry and Physics of First year B. Tech/B.Chem course.

F. **PEDAGOGY/TEACHING METHODS:**

Lecture/Discussions: These sessions will discuss the subject matters of the course
Experiential Learning: The sessions will involve hands on training.
Tutorials: Problem solving / case studies / relevant real-life applications / student presentations / home assignments / individual or group projects

G. Structure of the MDM course Minor Degree in Pharmaceutical Chemistry & Technology

Semester	Course Code	Subjects	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	CA	MS	ES	Total
III	PHT1456	Introduction to Technology of Pharmaceuticals and Fine chemicals	2	1	1	0	20	30	50	100
IV	PHT1457	Pharmaceutical Analysis	2	1	1	0	20	30	50	100

V	PHT1452	Phytochemicals-Extraction and Isolation	4	2	0	4	20	30	50	100
VI	PHT1453	Introduction to Formulation Technology	2	1	1	0	20	30	50	100
VII	PHT1454	Introduction to Fermentative Biotechnology	2	1	1	0	20	30	50	100
VIII	PHT1455	Pharmaceutical Chemistry and Technology	2	1	1	0	20	30	50	100
		TOTAL:	**14**	**7**	**5**	**4**				

H. Evaluation:

Subject Code	Semester	Course	Method of Evaluation	Methods of Delivery
PHT1456	III	Introduction to Technology of Pharmaceuticals and Fine chemicals	• Minimum two class test • Assignments • Seminar/ Presentation • Report submission	• Lectures/Face to face training • Tutorials • Case studies • Presentation • Projects (Individual and/or group) • Tutorials
PHT1457	IV	Pharmaceutical Analysis	• Continuous evaluation on assigned Job. • Skill based end exam	• Lectures/Face to face training • Hands on Training and • Demonstration • Tutorials
PHT1452	V	Phytochemicals-Extraction and Isolation	• Continuous evaluation on assigned Job. • Skill based end exam	• Lectures/Face to face training • Case studies • Presentation • Projects (Individual and/or group) • Demonstration • Hands on Training
PHT1453	VI	Introduction to Formulation Technology	• Minimum two class tests • Assignments • Seminar/ Presentation • Report submission	• Lectures/Face to face training • Tutorials • Case studies • Presentation • Projects (Individual and/or group)
PHT1454	VII	Introduction to Fermentative Biotechnology	• Continuous evaluation on assigned Job. • Skill based end exam	• face training • Tutorials • Case studies • Presentation • Projects (Individual and/or group)

PHT1455	VIII	Pharmaceutical Chemistry and Technology	• Minimum two class tests • Assignments • Seminar/ Presentation • Report submission	• Lectures/Face to face training • Tutorials • Case studies • Presentation • Projects (Individual and/or group)

I. Instructors: (Tentative)

Semester	Course Code	Subjects	Faculty
III	PHT1456	Introduction to Technology of Pharmaceuticals and Fine chemicals	SVJ/NDA
IV	PHT1457	Pharmaceutical Analysis	GUC/NDA
V	PHT1452	Phytochemicals-Extraction and Isolation	KSL/GP
VI	PHT1453	Introduction to Formulation Technology	PDA/SD
VII	PHT1454	Introduction to Fermentative Biotechnology	PDJ/VF
VIII	PHT1455	Pharmaceutical Chemistry and Technology	NDA/SVJ

J. Detailed syllabus:

MDM	Course Code: PHT1456	Course Title: Introduction to Technology of Pharmaceuticals and Fine chemicals	Credits = 2		
			L	T	P
	Semester: III	Total Contact Hours:	1	1	0
List of Prerequisite Courses					
Organic Chemistry (CHT1407) and Applied Physics (PYT1205)					
List of Courses where this course will be prerequisite					
None					
Description of relevance of this course in the B. Tech. /B.Chem. Engg Program					
Students are required to know various aspects of the Technology of Pharmaceuticals and Fine Chemicals. This subject will fulfill the need to build the professional career additional in Pharmaceutical Sectors.					
	Course Contents (Topics and Subtopics)				Hours
1	**General Aspects:** Definition of a drug. Various drug categories such as Prescription and OTC drugs Drug nomenclature: Chemical name, Generic name, Prototype Brief history of pharmaceutical industry (From Dyes to Small Molecules to Biologicals) Introduction about core subjects of Pharmaceutical Technology: Pharmaceutics (including Biopharmaceutics and Pharmacokinetics), Pharmaceutical and analytical chemistry, Pharmacognosy. Laws governing the drugs and various compendia (official and non-official)				5
2	**Medicinal Chemistry and Process Chemistry:** Discovery of Hits and Leads Lead optimization Introduction to Process chemistry industry and its brief overview				6

3	**Pharmacology and Pharmacognosy:** Brief overview of Pharmacokinetic principles Brief overview of mechanism of action of drugs Brief overview of Adverse Drug Reactions Introduction to Pharmacognosy Extraction and isolation of Phyto-constituents.	6
4	**Dosage forms of the drugs:** Various definitions such as Formulation, Dosage form, API, Excipient, Vehicles Brief overview of following dosage forms Solid dosage forms Liquid dosage forms for internal and external use Inhalations, Aerosols, and suppositories Targeted Drug Delivery systems	6
5	**Drug administration:** Brief overview of following routes of administration with their advantage and disadvantage Enteral: Oral, Sublingual and Rectal Parenteral: Injections, Inhalation, Transdermal Topical routes: Ophthalmic, Nasal, Auditory	2
6	**Overview of drug development:** Various aspects of preclinical studies in brief Clinical trials and its phases in brief	2
7	**Introduction to biological therapeutics:** Peptides and proteins as drugs and their synthesis in brief Introduction of rDNA technology Monoclonal antibodies	3
	Total	**30**

List of Textbooks/Reference Books	
1	Principles of Pharmacology, HL Sharma, KK Sharma, Paras Medical Publisher
2	An introduction to pharmaceutical sciences: Production, chemistry, techniques, and technology, Jiben Roy, Woodhead Publishing Series in Biomedicine
3	Real World Drug Discovery: A Chemist's Guide to Biotech and Pharmaceutical Research, Robert M. Rydzewski, Elsevier Science (2008)
4	Dewick P.M., Medicinal Natural Products- A Biosynthetic Approach, 2nd edition/2002, John Wiley & Sons Ltd
5	Pharmaceutical Dosage Form And Drug Delivery Systems, Howard C. Ansel, Nicholas G. Popovich, Lord V. Alien, 6th edition, 1995,
6	Remington - The Science And Practice Of Pharmacy (Vol.1& 2), David B. Troy, 21st edition, 2006, Lippincott Williams &Wilkins
7	PK Gupta, Elements of biotechnology, 2nd ed, Rastogi Publications (2015)

Course Outcomes (Students will be able to…..)	
CO1	Explain overview of pharmaceutical Industry (K3)
CO2	Explain Perspectives of Medicinal and Pharmaceutical Chemistry Describe role of biotechnology in Pharmaceutical Industry (K2)
CO3	Understand ole of Pharmacology in Pharmaceutical Industry (K1)
CO4	Explain importance of Phyto-constituents Pharmaceutical Industry (K3)
CO5	Describe aspects of various dosage forms(K2)

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	3	3	1

CO2	3	2	2	3	2
CO3	3	3	2	2	1
CO4	3	2	2	2	1
CO5	3	2	2	2	1
Course	3	3	2	2	1

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution

MDM	**Course Code:** PHT1457	**Course Title:** Pharmaceutical Analysis	**Credits = 2**		
			L	**T**	**P**
	Semester: IV	**Total Contact Hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses

Organic Chemistry (CHT1407) analytical Chemistry (CHT1406) and Applied Physics (PYT1207)

List of Courses where this course will be prerequisite

Formulation, Natural Products and Pharmaceutical process Chemistry and Technology.

Description of relevance of this course in the B. Tech./B.chem Program

The course is designed to acquaint the students with the basics of Pharmaceutical Analysis including Pharmacopeial monographs, analytical method validation, spectroscopic and spectrometric techniques, chromatographic separations, structural elucidation and thermal analysis.

	Course Contents (Topics and Subtopics)	**Hours**
1	**Introduction to Pharmacopoeial Monographs**, Documentation and record-keeping	4
3	**Introduction to Sample Preparation Methods** Solvent Extraction: Basic principles, classification, mechanism of extraction, equilibria, techniques and applications; Solid-Phase Extraction	3
4	**Polarimetry:** Theory, instrumentation and applications	2
5	**Fourier Transform Infra-Red (FT-IR) and Raman Spectroscopy:** Basics, Theory, Instrumentation Applications in - Structural elucidation of organic compounds, qualitative and quantitative analyses, atmospheric chemistry, forensic sciences, pharmaceutical and material sciences, earth sciences (geology)	6
7	**Nuclear Magnetic Resonance (NMR) Spectroscopy:** ^{1}H-NMR: Principle, Precessional frequency, Chemical shift, Spin-spin coupling, Coupling constant, Instrumentation (continuous wave (CW) versus pulsed FT instruments); Introduction to ^{13}C NMR; Applications of NMR	5
8	**Mass Spectrometry:** Principle, methods of ionization - chemical ionization, fast-atom bombardment (FAB), thermospray, electrospray; Fragmentation patterns – α-fission, βfission, McLaffarty rearrangement, Retro Diels-Alder; Introduction to quadrupole mass analyzers; applications of mass spectrometry	5
9	**Hyphenated Techniques:** GC-MS, LC-MS, LC-MS/MS, interfaces, advantages and limitations	3
10	**Examples** encompassing structural elucidation of simple organic compounds using ^{1}H-NMR, Mass, UV-Vis and FT-IR techniques	2
	Total	**30**

List of Textbooks/Reference Books

1	Practical Pharmaceutical Chemistry; 4th ed. - Part 2; Beckett, A. H., Stenlake, J. B., Eds.; The Athlone Press, London, UK (1988)
2	Pharmaceutical Analysis; Lee, D. C., Webb, M., Eds.; Blackwell Publishing Ltd., Oxford, UK (2003)
3	Analytical Chemistry; 6th ed.; Christian, G. D., Ed.; Wiley India (P.) Ltd., New Delhi, India (2008)

4	Vogel's Textbook of Quantitative Chemical Analysis; 6th ed.; Mendham, J., Denney, R. C., Barnes, J. D., Thomas, M., Sivasankar, B., Eds.; Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.), New Delhi, India (2000)
5	Vogel's Textbook of Quantitative Chemical Analysis; 5th ed.; Jeffery, G. H., Basset, J., Mendham, J., Denney, R. C., Eds.; Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.), New Delhi, India (2000)
6	Introduction to Spectroscopy; Pavia, D. L., Lampman, G. M., Kriz, G. S., Vyvyan, J. R., Eds.; Cengage Learning, Stamford, USA (2015)
7	Fundamentals of Analytical Chemistry; 9th ed.; Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R., Eds.; Cengage Learning, Boston, USA (2014)
8	William Kemp, Organic Spectroscopy; 3rd ed.; Macmillan Education, UK (1991)
9	Indian Pharmacopoeia 2018, Vol. I-IV; 8th ed.; The Indian Pharmacopoeia Commission, Gaziabad, India (2018)
10	USP 2019 – United States Pharmacopoeia 42 – National Formulary 37 (USP 42 – NF 37), Vol. 1-5; The United States Pharmacopeial Convention, USA (2019)
11	BP 2020 – British Pharmacopoeia 2020, Vol. 1-5; British Pharmacopoeia Convention, UK (2019)
Course Outcomes	
CO1	Describe various analytical method validation criteria as per USP and ICH along with other relevant guidelines (K2)
CO2	Understand and follow identification and quantitative analytical aspects of Active Pharmaceutical Ingredients (APIs), related substances and impurities. (K1)
CO3	Suggest suitable analytic method(s) for the analysis of sample under investigation. (K3)
CO4	Follow structural elucidation of simple organic molecules in stepwise manner. (K1)

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	2	2	1
CO2	2	3	2	3	1
CO3	3	2	2	2	1
CO4	2	2	2	3	2
Course	3	2	2	2	1

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution

MDM	**Course Code:** **PHT1452**	**Course Title:** **Phytochemicals-Extraction and Isolation**	**Credits = 4**		
			L	**T**	**P**
	Semester: V	**Total Contact Hours: 90**	**2**	**0**	**4**
List of Prerequisite Courses					
Organic Chemistry (CHT1407)					
List of Courses where this course will be prerequisite					
None					
Description of relevance of this course in the B. Tech./B.Chem Program (MDM Degree)					

The course is designed to train the students with the basics and application of technology in separation and detection of phyto-constituents from drugs of natural origin.		
	Course Contents (Topics and Subtopics)	**Hours**
1	Extraction and Separation of starch from potato	4
2	To carry out particle size Analysis and assessment of starch using microscopic and chemical methods	4
3	Extraction and evaluation of pectin from citrus rind	4
4	Phytochemical Evaluation of Unorganized drugs Carbohydrates: Starch, Agar, Acacia Proteins: Gelatin Lipids: Castor oil Resins: Asafoetida, Myrrh	12
5	Phytochemical Evaluation of Drugs- Tannins, Alkaloids, Flavonoids, Volatile oils, Anthraquinones.	4
6	Separation of Sugars/ Pigments using paper chromatography	4
7	Thin Layer chromatography of Herbs: Alkaloids- Tea, Nux vomica, Volatile oils- Clove, Cinnamon	12
8	Histochemical localization of volatile oil in Clove buds	4
9	Extraction, isolation and evaluation of Clove oil from clove buds.	6
10	Evaluation of effect of solvent and temperature on extraction (curcumin from Curcuma/ Betalains from beetroot)	8
11	Comparative evaluation of different extraction methods (Maceration, Percolation, Digestion and Soxhlet extraction) for extraction of curcumin	4
12	Extraction isolation and purification of Curcuminoids using column chromatography.	12
13	Extraction, isolation and evaluation of caffeine from tea.	4
14	Preparation, Isolation and Evaluation of Aloe -emodin from Barbaloin.	4
15	Extraction of piperine from *Piper nigrum*	4
	Total	**90**
List of Textbooks/Reference Books		
1	Wagner H. , Bladt S. , Zgainski E, Plant Drug Analysis- A Thin Layer Chromatography Atlas, Springerlink Publications	
2	Harborne J. B. Phytochemical Methods - A Guide to modern techniques of Plant analysis	
3	Ikan R., Natural Products- A Laboratory Guide	
4	Trease & Evans, Textbook of Pharmacognosy	
5	Tyler V.E., Pharmacognosy	
6	Wallis, Textbook of Pharmacognosy 8 Wagner H., Plant Drug Analysis- A Thin Layer Chromatography Atlas 1984, Springer-Verlag Publishers	
Course Outcomes (Students will be able to…..)		
CO1	Understand and undertake systematic identification of different plant/herbal material. (K1)	
CO2	Understand and undertake steps involved in the preparation of herbal drugs for commerce (K2)	
CO3	Understand and undertake Extraction of plant materials and thereafter separation of phytoconstituents and also undertake separation of constituents by column chromatography. (K1)	
CO4	Standardize the medicinal plants using morphological and microscopic analyses(K3)	
CO5	Isolate phytoconstituents from the natural materials using chromatographic analyses and further characterize using spectroscopic and spectrometric techniques. (K3)	

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	1	1
CO2	3	2	2	2	1
CO3	3	2	2	1	1
CO4	3	2	2	1	1
CO5	3	2	2	1	1
Course	3	2	2	1	1

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution

MDM	**Course Code:** **PHT1453**	**Course Title:** **Introduction to Formulation Technology**	**Credits = 2**		
			L	**T**	**P**
	Semester: VI	**Total Contact Hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses

Industrial Chemistry (CHT1408), Introduction to Technology of Pharmaceuticals and Fine chemicals (PHT1456)

List of Courses where this course will be prerequisite

None

Description of relevance of this course in the B. Tech. / B. Chem Program (MDM Degree)

To train the students with respect to basics of monophasics, biphasics, topical formulation,

	Course Contents (Topics and Subtopics)	**Required Hours**
1	**Overview of Pharmaceutical Industry** with introduction and classification of pharmaceutical dosage forms and routes of drug administration	2
2	**Origin and Development of the Pharmacopoeia** – IP/BP/USP, Introduction to monographs, Parts of monograph, Introduction to Biopharmaceutics	2
3	Solubilization techniques	2
4	**Monophasic** (Oral and Topicals) Preformulation, Formulation, Quality Control	5
5	**Large-scale Manufacturing of Monophasics** • Large scale manufacture and packaging with focus on equipment • Layout design and unit operations	3
6	**Biphasic – Suspensions** Preformulation, Principles and Stabilization techniques, Formulation Development, Evaluation, Large scale manufacture, and packaging with focus on equipment, Layout design, and unit operations	4
7	**Biphasic – Emulsions** Preformulation, Theories of emulsions, Formulation, Evaluation including stress testing, Large scale manufacture, and packaging with focus on equipment, Layout design, and unit operations	4
8	**Topical Dosage Forms -Ointments, Creams, Gels, and Suppositories**	8

	• Preformulation • Formulation • Evaluation • Large scale manufacture and packaging with focus on equipment • Layout design and Unit operations	
	Total	**30**
List of Textbooks/Reference Books		
1	Pharmaceutical Dosage Form And Drug Delivery Systems, Howard C. Ansel, Nicholas G. Popovich, Lord V. Alien, 6th edition, 1995,	
2	Remington - The Science And Practice Of Pharmacy (Vol.1& 2), David B. Troy, 21st edition, 2006, Lippincott Williams &Wilkins	
3	Tutorial Pharmacy J.W. Cooper, Colin Gunn, 4th edition, 1950, Sir Isaac Pitman & Sons Ltd., London	
4	Pharmaceutics: The Science of Dosage Form Design, Michael E. Aulton, 1998, Churchill-Livingstone Dermatological Formulations, B. W. Barry, 198, New York, Marcel Dekker	
5	Pharmaceutical Production Facilities: Design & Applications, Graham C. Cole,1st Edition, 1990, Ellis Horwood	
6	Theory & Practice Of Industrial Pharmacy, Leon Lachman, Herbert A. Lieberman& Joseph Kanig, 3rd edition, 1987, Lea &Febiger, Philadelphia	
8	Introduction of Pharmaceutical Dosage Forms, Howard Ansel, 3rd edition, 1981, Lea & Febiger	
9	Pharmacopoeias: Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia, all editions	
Course Outcomes (Students will be able to….)		
CO1	Explain principles of preformulations and basic formulation considerations for monophasic liquid orals and emulsions. (K3)	
CO2	Conceptualize and develop monophasic liquid oral and topical formulations. (K1)	
CO3	Conceptualize and develop biphasic oral products and semisolid formulations. (K2)	

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	3	2	2	2
CO2	1	3	2	1	1
CO3	1	3	2	1	1
Course	1	3	2	1	1

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution

MDM	**Course Code:** PHT1454	**Course Title:** Introduction to Fermentative Biotechnology	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total Contact Hours: 30**	**1**	**1**	**0**
List of Prerequisite Courses					
Introduction to Technology of Pharmaceuticals and Fine Chemical (PHT1456)					
List of Courses where this course will be prerequisite					

None		
Description of relevance of this course in the B. Tech./B.Chem Program (MDM Degree)		
To assess the application of biological and engineering principles to problems involving microbial, mammalian, and biological/biochemical systems. To understand the fundamentals of fermentation technology to know the basics in mammalian cell culture and genetic engineering. To understand the current concepts in fermentative biotechnology, with a focus on industrial practices		
	Course Contents (Topics and Subtopics)	**Required Hours**
1	**Basics in mammalian cell culture**	4
2	**Fermentation technology** Introduction to fermentation Types of fermentation, microorganisms in fermentation Fermenters and types; Stages of fermentation; typical fermentation types – batch, continuous, fed-batch; factors affecting fermentation Typical fermenter designs and explanation of design characteristics.	11
3	**Recombinant microorganisms in fermentation** Basics of genetic engineering Examples of industrial products	11
4	**Enzyme fermentation and immobilization**	4
	Total	**30**
List of Textbooks/Reference Books		
1	Elements of biotechnology by PK Gupta (Rastogi Publications)	
2	Biochemistry- Lehninger	
3	Plant cell, Tissue and Organ culture, Gamborg O.L. and Phillips G. C. (Springer)	
4	Food Biotechnology edited by Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto, Robert E. Levin (Taylor and Francis)	
5	Principles of fermentation technology, Stanbury P. F. and Whitaker A.	
6	Bioreactor system design, Asenjo J. A.	
7	Bioreactor immobilized enzymes and cells: fundamentals & applications, Moo-young M.	
Course Outcomes (Students will be able to…..)		
CO1	Explicate and employ various concepts of fermentation and different fermentative strategies as well as design a simple containment system (Bioreactor / fermenter) for producing compounds of industrial importance(K3)	
CO2	Elucidate and apply common mammalian cell culture techniques to produce compounds of industrial, specifically therapeutic importance (K2)	
CO3	Explain and apply basic techniques in genetic engineering for production of recombinant microbes(K3)	
CO4	Explicate and employ various concepts of fermentation and different fermentative strategies as well as design a simple containment system (Bioreactor / fermenter) for producing compounds of industrial importance (K1)	

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	2	2	3
CO2	1	1	2	2	3
CO3	2	1	2	2	3
CO4	1	1	2	2	3
Course	1	1	2	2	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution

MDM	Course Code: PHT1455	Course Title: Pharmaceutical Chemistry and Technology	Credits = 2		
			L	T	P
	Semester: VIII	Total contact hours: 30	1	1	0

List of Prerequisite Courses
Introduction to technology of Pharmaceutical and Fine Chemicals (PHT1456), Organic Chemistry (CHT1407) and Industrial Chemistry (CHT1408)
List of Courses where this course will be prerequisite
None
Description of relevance of this course in the B. Tech. /B.Chem Program (MDM Degree)
To introduce students to synthetic strategies in the pharmaceutical industry.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	**Functional Group Conversions and basic Concepts of retrosynthesis**	
	Functional group conversions common in reactions in retrosynthesis	5
	Basic concepts of retrosynthesis	5
	Application of retrosynthesis to simple molecules	5
2	**Free Radical Reactions** Basic concepts and applications in pharmaceutical chemistry	3
	Free radical reactions in the body and modulation of the same by drugs or supplements	-
3	**Basic introduction (no SAR or MOA) to the following drug classes with emphasis on synthesis** **Minimum 10 drug synthesis with 2-3 steps to be covered.**	-
	NSAIDS	2
	Antidiabetics	2
	Drugs for cardiovascular system	4
	Drugs for central nervous system	4
	Total	**30**

List of Text Books/ Reference Books	
1	J. McMurry, Brooks/Cole, Organic Chemistry
2	T.W.G. Solomons, C.B. Fryhle, Organic Chemistry, John Wiley and Sons Inc.,
3	L.G. Wade Jr, Organic Chemistry, Pearson Education
4	E.L. Eliel, StereoChemistry of Carbon compounds, Mcgraw-Hill
5	Paula Y. Bruice, Organic Chemistry, Pearson Education
6	Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry; Beale, J. M., Jr., Block, J. H., Eds.; 12th ed.; Wolters Kluwer (2011)
7	Staurt Warren, Designing Organic Syntheses A programmed Introduction to the Synthon Approach, John Wiley & Sons, Inc
8	Iyer RP and Degani M.S, Synthesis of Drugs: A synthon Approach Vol-1, 2nd Ed. Sevak publications Pvt. Ltd

Course Outcomes (students will be able to…..)	
CO1	Understand the concepts of functional group transformation and retrosynthesis(K1)
CO2	Grasp concepts of free radical reactions, with relevance to pharmaceutical chemistry(K3)
CO3	Apply retero-synthesis to synthesis of simple organic molecules (K2)
CO4	Elaborate Introduction to various classes of drugs(K1)

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	1	2	3	1
CO2	2	2	2	3	1
CO3	1	1	2	2	1
CO4	2	2	2	3	1
Course	2	2	2	3	1

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution