Re-Accredited 'B++' 2.86 CGPA by NAAC
VEER NARMAD SOUTH GUJARAT UNIVERSITY
University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
Tel : +91 - 261 - 2227141 to 2227146, Toll Free : 1800 2333 011, Digital Helpline No.- 0261 2388888
E-mail : info@vnsgu.ac.in, Website : www.vnsgu.ac.in

–: પરિપત્ર :–

વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન તમામ અનુસ્નાતક અભ્યાસક્રમ ચલાવતી કોલેજોનાં આચાર્યશ્રીઓને તથા વિભાગીય વડાશ્રીને જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૨૩–૨૪ થી અમલમાં આવનાર M.Sc. Pharmaceutical Chemistry Sem-III નો અભ્યાસક્રમ અભ્યાસ સમિતિ વતી ચેરમેનશ્રીએ મંજૂર કરવા વિજ્ઞાન વિદ્યાશાખાને કરેલ ભલામણ સ્વીકારી વિજ્ઞાન વિદ્યાશાખાની તા.૧૯/૦૬/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંકઃ ૩૦ અન્વયે કરેલ ભલામણ એકેડેમિક કાઉન્સિલની તા.૨૩/૦૬/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંકઃ ૫૦ થી મંજૂર કરેલ છે. જેનો અમલ કરવા આથી જાણ કરવામાં આવે છે.

વિજ્ઞાન વિદ્યાશાખાની તા.૧૯/૦૬/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંકઃ૩૦

:: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૩–૨૪ થી અમલમાં આવનાર M.Sc. Pharmaceutical Chemistry Sem-III નો અભ્યાસક્રમ અભ્યાસ સમિતિ વતી ચેરમેનશ્રીએ મંજૂર કરવા કરેલ ભલામણ સ્વીકારી M.Sc.Pharmaceutical Chemistry Sem-III નો અભ્યાસક્રમ સુધારા–વધારા સાથે મંજૂર કરવા એકેડેમિક કાઉન્સિલને ભલામણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલની તા.૨૩/૦૬/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંકઃ ૫૦

:: આથી ઠરાવવામાં આવે છે કે, વિજ્ઞાન વિદ્યાશાખાની તા.૧૯/૦૬/૨૦૨૩ ની સભાની ઠરાવ ક્રમાંકઃ૩૦ અન્વયે કરેલ ભલામણ સ્વીકારી મંજૂર કરવામાં આવે છે.

(બિડાણઃ ઉપર મુજબ)

ક્રમાંક : એસ./સાયન્સ/પરિપત્ર/૧૬૨૩૮/૨૦૨૩
તા.૨૮–૦૬–૨૦૨૩

કુલસચિવ

પ્રતિ,
૧) વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન તમામ અનુસ્નાતક અભ્યાસક્રમ ચલાવતી કોલેજોનાં આચાર્યશ્રીઓ.
તથા વિભાગીય વડાશ્રી.
..... આપશ્રીની કોલેજના સંબંધિત શિક્ષકોને જાણ કરી અમલ કરવા સારૂ.
૨) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
૩) પરીક્ષા નિયામકશ્રી, પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.
.....તરફ જાણ તેમજ અમલ સારૂ.

Veer Narmad South Gujarat University, Surat.

M. Sc. Chemistry Programme

Syllabus
M.Sc. Pharmaceutical Chemistry
Semester-III

To Be Effective From June-2023
NEP 2020

Name of Program	**Master of Science(Chemistry)**
Abbreviation	**M.Sc.**
Duration	**2 Years**
Eligibility Criteria	**Course- M. Sc. Pharmaceutical Chemistry** ELIGIBILITY: Graduation in Science with Chemistry or any subject equivalent to or allied to Chemistry.
Objective of the Course	The core objective of the M. Sc. Pharmaceutical Chemistry course is to prepare the students for dynamic career in industry and academia by providing an excellent environment of teaching and research in the core and emerging areas of the discipline.
Course Outcome	1. Students will have a solid theoretical foundation as well as the requisite abilities in pharmaceutical sciences, as well as the capacity to use them in research and development. 2. Students will have a strong theoretical basis in pharmaceutical chemistry, as well as the necessary skills to use them in research and development. 3. Students who have been trained in analytical methods in drug and formulation development, new drug application, and quality assurance in all parts of drug research will be able to use what they have learned to produce new products that will help people. 4. Through creative teaching approaches that encourage students to self-learn and expand their knowledge, students will be equipped to thrive in pharmaceutical research as well as prosper in the pharmaceutical sector or academia. 5. Professional values, excellent research communication abilities, problem-solving prioritization, and the capacity to understand pharmaceutical concerns in a larger perspective will be instilled in students. 6. The ability to evaluate important aspects of the matter they have studied, weigh the pros and cons of the ideology they adhere to in the field of pharmaceutical chemistry.
Course Specific Outcomes	Students need to build up foundation in the fundamentals & application of current chemical and scientific theories in the concerned branches of Inorganic, Organic, Analytical, Physical, Environmental and Pharmaceutical Chemistry. 1. Graduates will be able to exhibit pharmaceutical quality assurance expertise. As well as recognize, formulate, and solve quality problems in the pharmaceutical business. 2. Graduates will be able to assess and comprehend data from analytical studies in pharmaceutical manufacturing, quality control, and assurance, as well as address regulatory difficulties in formulation design while satisfying pharmaceutical industry expectations and standards. 3. Graduates will be able to create validation protocols for all pharmaceutical processes, from drug discovery through formulation as well as analyse and solve issues using current pharmaceutical techniques, software, and equipment.

	4. Graduates will be able to analyse and understand the results of analytical studies in pharmaceutical manufacturing, quality control, and assurance as well as solve regulatory concerns in formulation design in accordance with the pharmaceutical industry's demands and standards. 5. Graduates will be able to create validation protocols for all pharmaceutical processes, from drug discovery through formulation. 6. Graduates will be able to show that they are aware of their professional and ethical responsibilities under pharmaceutical legislation. 7. Graduates will have the confidence to study on their own and the capacity to learn for the rest of their lives. 8. Graduates will be able to explore chances for research and development in all areas of Pharmaceutical Quality Assurance, as well as work as part of a team and lead when necessary.
Medium of Instruction English	

Master of Science, Chemistry

M.Sc. Pharmaceutical Chemistry, Semester-III

Theory Paper /Practical	Teaching schedule Hrs/week	Exam Schedule			Total marks	Credit
		Duration Hrs	Internal marks	External marks		
Theory papers:						
1) Core-1 (PhCC-301) *Fundamentals of Pharmaceutical chemistry*	4	3	30	70	100	4
2) Core-2 (PhCC-302) *Pharmaceutical Organic chemistry-I*	4	3	30	70	100	4
3) Core-3 (PhCC-303) *Instrumental & separation techniques*	4	3	30	70	100	4
Inter/Multidisciplinary(AECC) 4) Elective Paper-1 (PhEC-301) *Selected topics in pharmaceutical chemistry* **Or** Elective Paper- 2 (PhEC-302) *Formulations, Validations and Impurities*	4	3	30	70	100	4
5) Skill Based Elective paper/Swayam/MOOC courses (OSEC-301) *Industrial Safety & Water Analysis Techniques*	2	2	15	35	50	2
6) Practical (PhP-301)	12	12	60	140	200	6
Total	30	26	195	455	650	24

Teaching-Learning Methodology	To meet the effective teaching and the learning requirements, teaching-learning methodology comprise classroom teaching, use of e-resources, library, IT tools, encourages students to participate in seminars/ workshops, presentations by students, assignments etc.

Evaluation Pattern		
No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	30%
3.	University Examination 2 Days, 6 h each days	70%

Master of Science, Chemistry

M.Sc. Pharmaceutical Chemistry, Semester-III

NEP-2020

SYLLABUS TO BE EFFECTIVE FROM JUNE-2023

Course Code- PhCC -301

Fundamentals of Pharmaceutical Chemistry

Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To understand about pharmacognosy and pharmacopeia. To learn about various types of nomenclature of drugs, Classification of drugs of nature origin distribution, chemical constitution and therapeutic efficiency of different classes of drugs. • To understand drug design, drug targets, different parameters for drug design, pro-drug and soft drug concept. Various physicochemical properties of drug action. • To learn Pharmacokinetics and pharmacodynamics, route of administration, pathway of drug metabolism biotransformation and drug excretion, drug receptor interactions and theory of drug action. • To learn about IPR, rules of pharmacopeia like IP, BP, USP, GLP. Good manufacturing practice-GMP, TQM, ISO & other knowledge regarding pharmaceutical quality controls. Knowledge of quantification and qualification of molecules.

Unit	Description (4- Credit)
1.	**NOMENCLATURE OF DRUGS, PHARMACOGNOSY AND PHARMACOPEIA** (15 Periods) (i) Nomenclature of drugs: Code number, Chemical Name, Proprietary and non-proprietary (Generic) name, Synonyms.

	(ii) Definition and scope of pharmacognosy, various system of classification of drugs of nature origin, occurrence, distribution, organoleptic evaluation, chemical constitution including tests, therapeutic efficiency of following category of drugs: Laxatives: Castor oil, Senna, Isapaghula Carminatives and GI regulator: Asafoetida, Clove, Cinnamon Antihypertensive: Rauwolfia Antitussives: Tulsi Anti-diabetics: Stevia Diuretics: Gokhru, Punarnava Antirheumatics: Guggul, Colchicum (iii) General introduction of pharmacopeia.
2.	**DRUG DESIGN** (15 Periods) Introduction of drugs and drug design, drug targets, procedure of drug design, Pro-drug, soft drug, concepts of lead compounds, lead modification, LD_{50}, ED_{50}, MIC-anti-infective, Therapeutic index. Theories of drug action: Occupancy theory, Rate theory and Induced fit theory, Biological and chemical defence, factors affecting on absorption. SAR and QSAR approaches for drug design: Biological effects of specific types of structural changes. Physicochemical properties: Solubility, Partition coefficient, Ionization constant, Steric effect, Stereochemical consideration, Isosterism and Bio-Isosterism.
3.	**PHARMACOKINETICS AND PHARMACODYNAMICS** (15 Periods) Introduction to Phramacokinetics and Pharmacodynamic, routes of administration, drug absorption, drug distribution, drug metabolism (general pathway of drug metabolism: Phase-I and Phase-II), elementary treatment of enzyme stimulation, drug excretion, Xenobiotics, Membrane active drugs. Receptor: Classification, Chemical nature of binding of ligands to receptor, Concepts of drug receptors, Elementary treatment of drug receptor interactions, Receptor complex and Allosteric modulation, Second and Third messenger system.
4.	**INTELLECTUAL PROPERTIES AND GOOD MANUFACTURING PRACTICES** (15 Periods) IPR: Patents, Conditions for patentable inventions, patentable inventions under the patent Act 1970, Indian patent system, essential patent documents to be submitted, provisional and complete specification, criteria for naming inventors patent, copyright policies, recent changes in IPR laws impacting pharmaceutical industry, intellectual cooperation in the pharmaceutical industry, Some case studies. Geographical indication, BP, IP, USP, Limit Tests, GLP, GMP, quality audit, SOP, ICH, ISO-9000, regulatory aspects of pharmaceuticals validation of Personnel, In-process quality control on various dosage forms, Quality control of finished products, factor affecting stability of formulations.

Course Outcomes: Having completed this course, the learner will be able to	
1.	To understand pharmacognosy, nomenclature of drug and general idea about pharmacopeia. Occurrence, distribution, organoleptic evaluation, chemical constitution of individual and their therapeutic efficiency.
2.	Understand drug design, procedure of drug design, preparation of library of compounds-leads to identification and optimization. Various concept like pro drug, soft drug. SAR and QSAR approach.
3.	Understanding of pharmacokinetics and pharmacodynamics, drug metabolism, phase-I phase-II clinical trials, enzyme stimulation, biotransformation and membrane active drugs. MOA, ADMET and receptor, drug administration.
4.	Understanding of IPR, filing of patents, clinical trials, quality control measurement by different pharmacopeia like BP, IP, USP, GLP, Manufacturing practice like GMP, ISO-9000 & related terms.

Reference Books Recommended:

1. Burger's Medicinal Chemistry and Drug Discovery (5/e), 1997, Vol.1, 2, 3, 4,5, Ed. ManFred E. Wolff (John Wiley & Sons, inc., New York).
2. Principles of Medicinal Chemistry, Vol. I & II (5/e), by S. S. Kadam, K. R. Mahadik, K. G. Bothra (Nirali Prakashan).
3. Principles of Medicinal Chemistry by William O. Foye (ed.), Lea and Febiyer, Philadelphia.
4. Wilson and Gisvold's Text-book of Organic Medicinal and Pharmaceutical Chemistry (5/e, 1982) by Robert F. Doerge (J. B. Lippincott Co., Philadelphia/Toppan Co. Ltd., Tokyo).
5. Essential of Medicinal Chemistry (2/e) by Andrejus Korolkovas (A Wiley Interscience Publication, 1988, John Wiley & Sons; Canada).
6. Medicinal Chemistry by Ashutoshkar (Wiley Eastern Ltd., 1993).
7. Fundamentals of Medicinal Chemistry by G Thomas.
8. Textbook of pharmacognosy by Trease and Evans
9. Textbook of pharmacognosy by T.E. Wallis
10. Textbook of pharmacognosy & phytochemistry, Biren Shah, A.K. Seth
11. Introduction of medicinal chemistry, A Gringuage, wiley-VCH.
12. The organic chemistry of drug design and drug action, R.B. Silverman, academic press
13. Topics in Medicinal Chemistry, Vol. I & II by Rabinowitz and Myerson (Ed.) (Interscience, 1968)
14. Biochemistry by U. Satyanarayana & U. Chakrapani, 4th Ed.
15. The Pharmaceutical Basis of Therapeutics by Goodman and Gilman (The Macmillan Co.).
16. Intellectual Property Law (Covering Copyright, Trademark, Design, Patent - Aditya Son.
17. Law Relating To Intellectual Property, 2011 by B.L. Wadehra
18. Writing Chemistry Patents and Intellectual Property: A Practical guide by Francis J. Waller

On-line resources to be used if available as reference material

Master of Science, Chemistry
M.Sc. Pharmaceutical Chemistry, Semester-III
NEP-2020
SYLLABUS TO BE EFFECTIVE FROM JUNE-2023
Course Code- PhCC -302
Pharmaceutical Organic Chemistry-I

Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To understand the concept of biomolecules, enzymes, nucleic acids and natural products, structural elucidation of natural alkaloids of different class, their interrelation to each other, synthesis of intermediates and their confirmation through synthetic pathways. • To learn multicomponent reaction, alkene formation, asymmetric synthesis, amide formation, role of intermediate in synthesis, transformation and study their mechanism. • To provide basic theoretical understanding of heterocyclic chemistry, improving general methodology for different kind of ring synthesis which implies the new heterocyclic systems by changing the functionality with respective positions in skeleton. • To understand green chemistry, selection of reagents, solvents, synthetic route, types of green reagents and selection of techniques to synthesize various molecules.

Unit	Description (4- Credit)
1.	**ALKALOIDS, ENZYMES AND NUCLEIC ACIDS** (15 Periods) (a) Alkaloids: Nature, occurrence, extraction, general properties, test and physiological importance of following alkaloids: Adrenaline, Nicotine and Reserpine. (b) Enzymes: Classification, nomenclature and inhibition, factors affecting catalytic activity and specificity in action, regulation of enzyme activity. (c) Nucleic Acids: Purine and pyrimidine bases of nucleic acids, base pairing via H-bonding, chemical and enzymatic hydrolysis of nucleic acids, nucleosides and nucleotides, DNA replication, Transcription, Translation.

2.	**NAME REACTIONS** (15 Periods) General nature, method, mechanism and synthetic applications of the following reactions; 1. Ene reaction 2. Noyori reaction 3. Mcmurry reaction 4. Stork enamine reaction 5. Stille coupling reaction 6. Peterson olefination reaction 7. Nef reaction 8. Robinson annulations reaction 9. Negishi coupling Reaction
3.	**HETEROCYCLIC CHEMISTRY-1** (15 Periods) (A)Nomenclature of Monocyclic, Fused and Bridged heterocyclic compounds (B) Synthesis, reactivity, aromatic character and importance of the following: (I) Five member heterocycles: Oxazole, Pyrazole, Imidazole, 1,2,3- triazole (II) Six member heterocycles: Pyridazine, Pyrimidine, Pyrazine, Triazine.
4.	**GREEN SYNTHESIS** (15 Periods) Green Reagents: Dimethylcarbonate, Polymer supported reagents Green Catalysts: Acid Catalyst, Oxidation Catalyst, Polymer Supported catalyst, Basic Catalyst, Phase Transfer Catalyst Green Solvent: Ionic liquids Green Synthesis: Williamson's synthesis, Wittig reaction Microwave assisted Synthesis: Microwave reactions in various solvents, applications. Photo assisted Synthesis: Photo reactions in various solvents, applications Ultrasound assisted Synthesis: Ultrasound reactions in various solvents, applications

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the nature of alkaloids, classification, structural elucidation of given alkaloid. To learn the role and classification of enzymes. Structure of nucleic acid, types of purine and pyrimidine bases. Their classification and determination of catalytic activities with different theories. Structures of nucleosides and nucleotides, DNA replication, Transcription, Translation.
2.	To learn multicomponent reaction, alkene formation, asymmetric synthesis, amide formation, role of intermediate in synthesis, transformation and study their mechanism.
3.	To provide basic theoretical understanding of heterocyclic chemistry, improving general methodology for different kind of ring synthesis which implies the new

	heterocyclic systems by changing the functionality with respective positions in skeleton.
4.	To learn about green chemistry, selection of solvents, catalyst, devices of synthesis like microwave, ultrasound, photochemistry etc. Development of synthetic pathways to synthesize target molecule including intermediates.

Suggested References:

1. Organic synthesis using transition metals-Roderick Bates (Wiley)
2. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
3. Some modern methods of organic synthesis – W. Carruthers (Cambridge)
4. Organic synthesis – Michael B. Smith
5. Advanced organic chemistry, Part B – F. A Carey and R. J. Sundberg, 5th edition (2007)
6. Guidebook to organic synthesis-R K Meckie, D M Smith and R A Atken
7. Organic synthesis- Robert E Ireland
8. Strategic Applications of named reactions in organic synthesis-Laszlo Kurti and Barbara Czako
9. Organic Synthesis, Jagdamba Singh & L.D.S. Yadav, 6th edition, Pragati Prakashan (2010).
10. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976)
11. Advance Organic Chemistry, Reaction Mechanism and Structure by Jerry March, 4th ed. John Wiley & Sons, 19927.
12. Heterocyclic Chemistry- J A Joule and Smith
13. Heterocyclic Chemistry-II- R R Gupta, M Kumar, V Gupta, Springer (India) pvt
14. Heterocyclic Chemistry, 4th Edition by J. A. Joule & K. Mills, Pub. Chapman & Hall (1995)
15. Principles of modern heterocyclic chemistry, Edited by Leo A. Paquette, Pub. Pearson Benjamin Cummings (1968)
16. Heterocyclic Chemistry, 3rd Edition by Thomas L. Gilchrist, Pub. Prentice Hall (1997)
17. The Structure & Reactions of Heterocyclic Compounds, Edited by Michael Henry Palmer, Published by Edward Arnold (1967)
18. Heterocyclic chemistry by V. K. Ahluwalia, Narosa publishing house.
19. New trends in Green Chemistry, 2nd edition, V.K. Ahluwalia and M. Kidwai, Anamaya publishers, New Delhi
20. Green Chemistry, theory and practice, Paul T. Anastas and John C. Warner, Oxford University Press, 2003, New York USA
21. Green Chemistry: an introductory text, Mike Lancaster, Green Chemistry network, University of New York, RSC, 2002
22. Handbook of Green chemistry and Technology, edited by James Clark and Duncan Macquarrie, blackwell publishing
23. Green Chemical synthesis and processes, Paul T. Anastas, Luren G. Heine, Tracy C. Williamsons, ACS Publication, 2000
24. Foye's principle of medicinal chemistry, 5th ed. David A. Williams and Thomas L. Lenke.
25. Organic Chemistry, Vol. I & II (Sixth edition), I. L. Finar.
26. S.W. Pelletier, Chemistry of the Alkaloids, Van Nostrand Reinhold Co., New York (1970).

27. K.W. Bentley, The Alkaloids, Vol. I., Interscience Publishers, New York (1957).
28. Chemistry of Organic Natural Products, Vol. I & II, O. P. Agrawal.
29. Organic Chemistry of Natural Products, Vol. I & II, Chatwal.
30. Organic Chemistry (5/e) by Morrison & Boyd.
31. Biochemistry by U. Satyanarayana & U. Chakrapani, 4th Ed.

On-line resources to be used if available as reference material

Master of Science, Chemistry
M.Sc. Pharmaceutical Chemistry, Semester-III
NEP-2020
SYLLABUS TO BE EFFECTIVE FROM JUNE-2023
Course Code- PhCC -303
Instrumental and Separation Techniques

Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To understand and familiarize with the basic properties, theory & interpretation of ^{1}H NMR, ^{13}C NMR spectrometry, to impart knowledge in the theory & principles of spectroscopic techniques for characterization & differentiation of various molecules. • To understand and familiarize the basic principles, theory and instrumentation of mass spectrometry, low and high resolution mass spectra, to impart knowledge in theory and principles of spectroscopy, spectroscopic technique for characterization and differentiation of various nucleus. • To learn various separation techniques and solvent extraction. Understanding of their principal, classification, different methods, mechanism and selection of reagents. To understand theory of dissolution, dissolution model. Dissolution-Testing Solid phase extraction, factors affecting on dissolution rates, different dosage form. • To understand various chromatographic separation methods, classification and theory with principle. Study of GC-MS, GC-TLC, LC-MS etc. and their applications General idea of XRD, SEM.

Unit	Description (4- Credit)
1.	**NMR SPECTROSCOPY** (15 Periods) Theory and principles of NMR spectroscopy, Theory of Fourier Transform (i) ^{1}H NMR Spectroscopy: Proton resonance condition, nuclear spin, aspects of PMR spectra – number of signals, chemical shift, factors influencing chemical shift, deshielding, magnetic anisotropy, interpretation of protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other

	nuclei (alcohols, phenols, enols, acids, amines, amides and mercaptans), effect of deuteration, spin-spin coupling, (n+1) rule, long range coupling, factors effecting coupling constant. (ii) ^{13}C NMR spectroscopy: Types of ^{13}C NMR Spectra, proton coupled and decoupled spectra, chemical shift, calculations of chemical shifts of aliphatic, olefinic, aromatic and hetero aromatic, factors affecting chemical shifts.
2.	**MASS SPECTROMETRY** (15 Periods) Theory and principles of mass spectrometry; Instrumentation; low and high resolution mass spectra; Ionization techniques – Electron Impact (EI) ionization, Chemical Ionization (CI), Fast Atom Bombardment (FAB), Determination of molecular weight and molecular formula, nitrogen rule, detection of molecular ion peak, metastable ion peak; Fragmentations – rules governing the fragmentations, McLafferty rearrangement; Interpretation of mass spectra of different class of compounds, To write possible fragmentation for given compound; To identify structure from combined spectral data.
3.	**ANALYTICAL SEPARATION** (15 Periods) Introduction of various separation techniques: Membrane separation, Precipitation, Electro deposition, distillation and miscellaneous methods. Theory of dissolution, dissolution model, factors affecting on dissolution rates, dissolution of different dosage form: solids, suspension; controlled drug release system. Solvent Extraction: Principles, classification, mechanism, factors approaching solvent extraction, quantitative treatment of solvent extraction, applications, synergistic extraction, reagents, Numericals.
4.	**CHROMATOGRAPHIC SEPARATION** (15 Periods) Hyphenated Techniques: GC-MS, GC-TLC, LC-MS etc. Principle and Application Adsorption Chromatography: Classification, definition of terms, principle and basic theory. column absorption chromatography: technique and application Partition chromatography: column, paper, TLC. Selection of stationary and mobile phase, detection technique, elementary idea of HPTLC. Characterization: General idea of XRD, SEM, TEM

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand fundamental & basic terms involved in ^{1}H NMR, ^{13}C NMR spectroscopy, know effects of various factors on the spectra, interpretation from spectral data, identify structure of organic compounds by using combined spectral data, distinguish isomers and other closely related compounds by using spectral techniques.

2.	Understand the theory, instrumentation and important terms of mass spectrometry, fragmentation pattern, to set valuable insight into the types of molecular interaction and interpreting from obtained data.
3.	Learning of types of separation techniques, selection of solvents and development of methodology. To understand their principle, classification, different methods, mechanism and selection of reagents. To understand theory of dissolution, dissolution model, sample preparation, selecting and handling reagents. Dissolution-Testing Solid phase extraction, factors affecting on dissolution rates, different dosage form.
4.	Understanding of various chromatographic separation methods, classification and theory with principle. Study of GC-MS, GC-TLC, LC-MS etc. and their applications. General idea of XRD, SEM, TEM.

Suggested References:

1. R.M. Silverstein and F.X. Webster, Spectroscopic Identification of Organic Compounds, 6th Edition (2003) John Wiley, New York.
2. D.H. Williams and I.F. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Edition(1988), Tata-McGraw Hill, New Delhi.
3. P.Y Bruice, Organic Chemistry, 2nd Edition (1998) Prentice – Hall, New Delhi.
4. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer- Verlag (1986).
5. One and Two dimensional NMR Spectroscopy – Atta-Ur-Rehman, Elsevier (1989).
6. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998).
7. Holler, Skoog, principle of instrumental analysis, 6th edition, Crounch, India edition reprint, 2007
8. Douglas A. Skoog, F. James Holler, Timothy A. Nieman, principle of instrumental analysis, Brooks Cole Publisher.
9. Willard, marritt, Dean, Settle, Instrumental methods of analysis, CBS publisher and distributor.
10. Separation Process Principles-chemical and biochemical operations by Seader, Henley & Roper, 3rd ed.

On-line resources to be used if available as reference material

Master of Science, Chemistry
M.Sc. Pharmaceutical Chemistry, Semester-III
NEP-2020
SYLLABUS TO BE EFFECTIVE FROM JUNE-2023
ELECTIVE PAPER -1 (EC-1)
Course Code- PhEC-301
Selected topics in Pharmaceutical chemistry

Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To understand cardiovascular and Antilipidaemic agents, learn about Anti-coagulant, Antihypertensive and Antilipidaemic agents. Synthesis, introduction, general classification, mode of action, mechanism and uses of selected class of drug compounds with SAR. • To understand Diuretics, classification and drug belong to that class, structural variation, synthesis and uses. Learn about Immune system, cellular humoral immunity, antigen & haptens, antigen & antibody reactions and their application. • To learn about overview, classification and mode of action of autocoids and anti-allergic drugs. To grab knowledge about usage of autocoids and allergic drugs. • To understand Radio Pharmaceuticals their applications in diagnosis and treatment, diagnostics techniques- ELISA, RIA, PET, SPET, isotopes, and metal complex with their general roles of metal complexes in biological processes.

Unit	Description (4- Credit)
1.	**CARDIOVASCULAR AND ANTILIPIDAEMIC AGENTS** (15 Periods) General introduction of Anti-coagulants and Antihypertensive drugs, classification, structure variation in ß-adrenergic blockers and Dihydropyridines, Structure activity relationship of ACE Inhibitors, mode of action. Antilipidaemic agents: Introduction, general classification, mode of action, disease and disorder caused by it. Synthesis and therapeutic uses of the following: Verapamil, Lisinopril, Losartan, Hydralazine, Warfarin, Fluvastatin.
2.	**DIURETICS AND IMMUNOLOGY** (15 Periods) (I) Diuretics: General classification, Structural variation and SAR of Thiazide Diuretics Synthesis and therapeutic uses of only the following: Chlorothiazide, Furosemide, Ethacrynic acid, Triamterene. (II) Immune system, cellular humoral immunity, antigen and haptens, antigen and antibody reactions and their applications, hypersensitivity, active and passive immunization; Vaccines and their preparation, sterilization and storage.
3.	**AUTOCOIDS AND ANTI-ALLERGIC DRUGS** (15 Periods) General Introduction, classification, SAR of Histamine antagonists, mode of action of Antihistamines, structure variation in Aminoalkylethers, Ethylenediamines and Piperazine derivatives. Eicosanoids and their synthesis inhibitors. Synthesis and therapeutic uses of only the following: Diphenhydramine (Benadryl), Antazoline, Chlorpheniramine, Primethazine, Clemastine, Cetirizine
4.	**PHARMACEUTICAL INORGANIC CHEMISTRY** (15 Periods)

	(I) Radio Pharmaceuticals and their applications in diagnosis and treatment, Diagnostics techniques- ELISA, RIA, PET, SPET. Radiopharmaceuticals & their diagnostic & therapeutic applications in pharmacy & medicine such as ^{125}I, ^{32}P, ^{59}Fe. (II) Metal complex: General Roles of metal complexes in biological processes, Therapeutic uses as Anti arthritics, Antimicrobial Complexes, Photo activated metal complex, Metal Poisoning, Drug action and metal chelation, medicinal significance of complex stability.

Course Outcomes: Having completed this course, the learner will be able to	
1.	To learn about anti-coagulants and anti-hypertensive drugs. Learner should able to understand synthesis and uses of selected class of drug compounds. SAR and MOA of the studied class of compounds. To understand concept of Antilipidaemic agents.
2.	General classification of diuretics, general structure of each class of drugs with substituent, their SAR and trivial/generic name, synthesis and uses of selective drug of class.
3.	To comprehend classification and usage of autocoids and anti-allergic drugs. To learn about synthesis and therapeutic uses of drug molecules.
4.	To understand the concept of radio pharmaceuticals, their applications in diagnosis and treatment, Diagnostics techniques- ELISA, RIA, PET, SPET. Learn about Isotopes: Isotope, types & measurement of radioactivity. To understand radiopharmaceuticals & their diagnostic & therapeutic applications in pharmacy & medicine. Dentifrices, desensitizing agents, & anticaries agents. To learn Metal complex:, General role in biological processes

Suggested References:

1. Burger's Medicinal Chemistry and Drug Discovery (5/e), 1997, Vol. 1, 2, 3, 4,5, Edited by ManFred E. Wolff (John Wiley & Sons, inc., New York).
2. Principles of Medicinal Chemistry, Vol. I & II (5/e), by S. S. Kadam, K. R. Mahadik, K. G. Bothra (Nirali Prakashan).
3. Principles of Medicinal Chemistry by William O. Foye (ed.), Lea and Febiyer, Philadelphia.
4. Wilson and Gisvold's Text-book of Organic Medicinal and Pharmaceutical Chemistry (5/e, 1982) by Robert F. Doerge (J. B. Lippincott Company, Philadelphia/Toppan Co. Ltd., Tokyo).
5. Essential of Medicinal Chemistry (2/e) by Andrejus Korolkovas (A Wiley Interscience Publication, 1988, John Wiley & Sons, Canada).
6. Medicinal Chemistry by Ashutoshkar (Wiley Eastern Ltd., 1993).
7. The Pharmaceutical Basis of Therapeutics by Goodman and Gilman (The Macmillan Co.).
8. The Organic Chemistry of Drug Synthesis, Vol. I, II & III (1980), Ed. By D. Lednicer and L. A. Mitscher (John Wiley and Sons, New York).

9. Topics in Medicinal Chemistry, Vol. I & II by Rabinowitz and Myerson (Editor) (Interscience, 1968).
10. Adhunik Sanshleshit Aushodhonu Rasayanvighyan, Dr. Anamik Shah, University Granth Nirman Board, Ahmedabad.
11. Medicinal Chemistry, D. Sriram and P. Yogeeswari, 1st edi., Pearson Education, 2007.
12. Handbook of pharmaceutical chemicals by Dr. A. R. Shenoy and Dr. V. R. Shenoy Multitech Publishing Co., 15-Yogesh, Hingwala Lane, Ghatkopar (East) Mumbai.
13. Fundamentals of Medicinal Chemistry by G Thomas.
14. Textbook of Medicinal Chemistry, Volume I & II, Alagarsamy, 2010, Elsevier Publication.

On-line resources to be used if available as reference material

Master of Science, Chemistry
M.Sc. Pharmaceutical Chemistry, Semester-III
NEP-2020
SYLLABUS TO BE EFFECTIVE FROM JUNE-2023
ELECTIVE PAPER -2 (EC-2)
Course Code- PhEC-302
Formulations, Validations and Impurities

Total Credits of the Course	4	Hours per Week	4 hrs

Course Objectives:	• To learn about Types of Capsule and Tablet. Learner should able to understand formulation methods of drugs. • To understand Manufacturing process of known drugs with flowchart • To learn general classification validation process. To understand government regulations, scope and advantage of validation. • To understand the concept of impurities in pharmaceutical industries. Learner should be able to understand pure and impure chemical compound. to learn impurity commonly found in medicinal preparation
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1	■	■	■	■	■				■	■		
CO2	■	■		■	■	■				■	■	■
CO3	■	■	■		■	■			■	■	■	
CO4	■	■			■	■				■	■	■

Unit	Description (4- Credit)
1.	**CAPSULE AND TABLET** (15 Periods) Definition, Types of Capsule and Tablet, Formulation and coating of tablet **Hard Gelatin capsule**: Ideal requirement, size of capsule, capsule shell, preparation of empty capsule shell, method for capsule filling, quality control for hard gelatin capsule **Soft Gelatin capsule**: Nature of soft gelatin capsule shell, nature of capsule content, manufacturing of soft gelatin capsule, quality control for soft gelatin capsule, capsule storage and packaging.
2.	**MANUFACTURING PROCESS OF PHARMACEUTICAL AGENT WITH FLOWCHART** (15 Periods) Darvon, hexylresorcinol, Riboflavin, Ascorbic acid, Salol, antibiotics by fermentation, purification, extraction and crystallization, Insulin , Morphin Sulfate
3.	**INTRODUCTION TO VALIDATION** (15 Periods) General concept and importance **Pharmaceutical Validation**: Introduction, definition, process model, Government regulations, Scope and advantage of validation. **Analytical method validation and Process validation**: General principles of analytical method validation, validation of following analytical instruments (HPLC, dissolution test apparatus, UV/Visible spectrophotometer), Case studies. **Process validation:** Prospective, concurrent, retrospective and revalidation, process validation of various formulations viz. tablets, capsules, ampoules & vials, ointments, Liquid orals. **Cleaning validations**: Cleaning of equipments, Clean room technology.
4.	**IMPURITY IN PHARMACEUTICAL SUBSTANCE AND THEIR LIMIT TEST** (15 Periods) Pure and impure chemical compound, impurity commonly found in medicinal preparation, source of impurity in pharmaceutical chemicals, contamination and cross contamination, effect of impurity on pharmaceutical substance, permissible impurity in pharmaceutical substance, Common methods use for purification. Limit test for chloride, sulphate, iron and heavy metals, Method of determination of volatile and non- volatile impurities in pharmaceutical.

Course Outcomes: Having completed this course, the learner will be able to	
1.	To learn about Types of Capsule and Tablet. Learner should able to understand formulation methods of drugs.
2.	To understand Manufacturing process of known drugs with flowchart
3.	To learn general classification validation process. To understand government regulations, scope and advantage of validation.
4.	To understand the concept of impurities in pharmaceutical industries. Learner should be able to understand pure and impure chemical compound. to learn impurity commonly found in medicinal preparation

Suggested Reference Books:

1. Pharmaceutical Process Validation, Author: Ira R. Berry and Robert Nash, Publisher: Marcel Decker Inc.(2nd edition).
2. Validation of Pharmaceutical Processes: Sterile Products, Second Edition, Revised and Expanded; Auhtor: James P. Agalloco; Publisher: Informa HealthCare; 2nd edition; ISBN-10: 0824793846, ISBN-13: 978-0824793845..
3. Pharmaceutical Process Validation, Author: Ira R. Berry and Robert Nash, Publisher: Marcel Decker Inc.(2nd edition).
4. Validation of Pharmaceutical Processes: Sterile Products, Second Edition, Revised and Expanded; Auhtor: James P. Agalloco; Publisher: Informa HealthCare; 2nd edition; ISBN-10: 0824793846, ISBN-13: 978-0824793845
5. Shreve's Chemical Process Industries by G. T. Austin
6. Biocontamination control for pharmaceutical and healthcare by Tim Sandle
7. Risk management and risk asseement for pharmaceutical manufacturing by Tim Sandle
8. Hazard study and risk assessment in the pharmaceutical chemistry by John EGillett

On-line resources to be used if available as reference material

Master of Science, Chemistry
M.Sc. Pharmaceutical Chemistry, Semester-III
NEP-2020
SYLLABUS TO BE EFFECTIVE FROM JUNE-2023
Course Code- OSEC-301
Paper-V: Industrial Safety & Water Analysis Techniques
(Skill Enhancement Course)

Total Credits of the Course	2	Hours per Week	2 hrs

Course Objectives:	• To teach safety parameters, health & welfare to the students. • To create awareness among students regarding Industrial and laboratory accident, its causes & its prevention. • To learn about various water analysis techniques. • To develop advance analytical skills for Quality Checking and Assurance in Laboratories.

Unit	Description (2- Credit)
1.	**INDUSTRIAL SAFETY (15 Periods)** **Risk Assessment:** Process Risk Assessment, Industrial Hygiene Risk Assessment, Environmental Risk Assessment, Fire & Explosive Risk Management **Chemical Storage Safety:** Bulk storage, Solvent storage, Explosive chemical storage, Transportation storage **Static electricity, its hazards, and control measures**

	Hazard Identification, Communication and Symbol
2.	**WATER ANALYSIS TECHNIQUES** **(15 Periods)** 1. Total Dissolved Solids (TDS) & Total Suspended Solids (TSS) determination 2. Fixed & Total Volatile Solids 3. Fixed Dissolved Solids 4. Mother Liquor Suspended Solids (MSS) & Mother Liquor Volatile suspended Solids (MLVSS) 5. Oil, Grease and phenol determination 6. Chloride and Fluoride determination 7. Kjeldahl's method for ammoniacal nitrogen determination 8. Nitrite and Nitrate determination 9. Phosphate Determination 10. Sulphide and sulphate determination 11. Sodium and Potassium determination 12. Chromium determination 13. Fanton process 14. Hydrodynamic Cultivation 15. Microorganism purification

Evaluation Pattern		
No.	Details of the Evaluation	Weightage
1.	Internal Written	15 Marks
2.	University External Written Examination	35 Marks

Course Outcome: Having Completed this course, the learner will be able to	
1.	To get skilled to measure risk assessment for hazardous chemical reaction, its monitoring and preventive actions to avoid accidents.
2.	To get skilled for proper chemical segregation and Industrial hygiene management to maintain safety.
3.	To get skilled for analysis of water quality, its sampling, operational techniques, and to produce results.
4.	Students will be able to use the techniques and get skilled necessary for water resource management.

Suggested Reference Books:

1. Fundamentals of Industrial safety and health by Dr. K.U. Mistry, Vol-1&2.
2. Industrial accidental prevention, H. W. Heinrich
3. Encyclopedia of Occupational Health & Safety, ILO, Geneva, Switzerland
4. Accident, Prevention Manual for Industrial Operation, NSC, USA.

5. Analytical methods for drinking water, Advances in sampling and Analysis by Phillippe Quevauviller, K. Clive Thompson.
6. Industrial Water Analysis Handbook by Natrajan Manivasakan.

Master of Science, Pharmaceutical Chemistry
PRACTICALS
NEP-2020
SYLLABUS TO BE EFFECTIVE FROM JUNE-2023
Semester- III
Course Code- PhP-301

Total Credits of the Course	**6**	**Hours per Week**	**12 hrs.**

Course Objectives:	• To impart basic knowledge for the separation of organic ternary mixture. • To identify nature of mixture i.e., solid-solid, solid-liquid, liquid-liquid etc. • To impart knowledge of different purification techniques including distillation • Separation and identification of component with their functional group test and M.P. /B.P. • To confirm the structure and prepare the relevant derivative. • To impart basic knowledge for carrying out multistep synthesis based on some name reactions. • Understand nature of reaction and establishment of reaction condition with mechanism • To learn about the calculation of mole ratio for each reaction. • Preparation of reagent to carry out estimation. • To understand the purpose of estimation and establishment of respective condition.

Course Content		
1	Analysis of Ternary mixture	6- Credit
2	Preparation of drugs and drug intermediates	
3	Estimation of drugs and drug intermediates	
4	Spectral Interpretation - 1	

1. Analysis of Ternary mixture (Minimum Six)
Types, separation and identification by physical and chemical methods.
(S+S+S), (S+S+L), Semisolids or (L+L+L) mixture.

2. Preparation of drugs and drug intermediates by following: (Minimum five)
i. Quinoline from aniline by Skraup synthesis
ii. 1,2,3,4-tetrahydrocarbazole from cyclohexanone and phenylhydrazine

iii. β-Resorcyclic acid from resorcinol.
iv. Benzimidazole from o-phenelenediamine.
v. Benztriazole from o-phenylenediamine.
vi. Aspirin from phenol via salicylic acid
vii. 5,5′-diphenylhydantoin from benzil and urea
viii. Synthesis of Paracetamol

3. Estimation of Drugs and Drug Intermediates: (Minimum Five)

i. Determination of Sulphonamides with silver nitrate solution by volumetrically.
ii. Determination of aromatic primary amines by either diazotization or indirect diazotization.
iii. Estimation of Benzyl Penicillin.
iv. Non-aqueous titration of Sodium benzoate.
v. Estimation of Isonazid.
vi. Determination of amount of Analgin in given solution.
vii. Determination of amount of Glucose in given solution.
viii. Determination of amount of drug in given sample by colorimetric method.

4. Spectral Interpretation - 1 (Minimum 10 from syllabus)

Structure interpretation of drugs intermediate from spectra (functional groups and low molecular weight compounds determination only from UV, IR, NMR and Mass)

Teaching-Learning Methodology	Introduction, interaction with students in calculation of mole ratios, carrying out experiments at each step according to the respective practical.

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the basics to carry out reactions, nature of reaction and calculation of mole ratio.
2.	Establish mechanism of reaction and monitoring specified reaction condition.
3.	Learn to work-up after the completion of reaction, purification.
4.	Confirm the product through the references.
6.	Learn to set up reaction condition for individual estimation of compound.
7.	Understand the calculation with reference to respective factors.
8.	Appreciate good laboratory practices.

Suggested References:

1. Vogel's Textbook of practical organic chemistry, 5th edition, B. S. Furniss, A. J. , P. W. G. Smith, A. R. Tatchell (Pearson Ed.).
2. Comprehensive practical organic chemistry: Preparation and Quantitative analysis, V. K. Ahluwalia, Renu Agarwal (Universities Press).
3. Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST
4. L. D. Field, S. Sternhell, J. R. Kalman - Organic Structures from Spectra-Wiley(2013)
3. Quantitative analysis by Arther I.Vogel
4. Quantitative analysis by V.K.Ahluwalia
5. Quantitative analysis by Mann and sanders

On-line resources to be used if available as reference material