IEC UNIVERSITY

DEPARTMENT OF CHEMISTRY

SYLLABUS

MASTER OF SCIENCES

IN

PHARMACEUTICAL CHEMISTRY

SCHOOL OF APPLIED AND BASIC SCIENCES

I.E.C UNIVERSITY, BADDI, SOLAN

HIMACHAL PRADESH,

PIN-174103, INDIA

Table of Content

Section 1

Program Outcomes and Program Specific Outcomes

Program Outcomes

PO1: ***Professional Knowledge:*** Students will able to use and apply professional software's relevant to chemistry.

PO2: ***Research/Project Orientation:*** Students will develop the ability to present pharmaceutical chemistry research by means of an oral presentation, a scientific poster or a written report.

PO3: ***Entrepreneurship Capability:*** Students can establish their own pharmaceutical company (bulk & formulation) or can work as medical representative.

PO4: ***Conformist:*** This course enable the students to carrying out and designing the scientific experiments as well as accurately record and analyze the results of experiments.

PO5: ***Critical Thinking Mindset:*** Critical thinking as an attribute of this course which enables students to analyze, assess, reconstruct and solve a problem.

PO6: ***Leadership and Teamwork:*** Students will be able to demonstrate knowledge to develop Pharmaceutically important molecules, new drug delivery systems etc.

PO7: ***Professional Ethics:*** The employment areas of M.Sc. Pharmaceutical chemistry include Chemicals Manufacturing Companies, manufacturing and Processing Firms, Hospitals, Industrial Laboratories, Medical Research, Oil Industry etc.

PO8: Professional ***Empowerment:*** The present course content will build confidence in students and the students will improve their competencies on par with their counterparts in premier institutions across the nation.

PO9: ***Communication:*** Present scientific and technical information resulting from laboratory as well as Industrial/pharmaceutical experimentation in both written and oral formats, would make them perfect.

PO10: ***Social Responsibility and Environmental Conservation:*** In this Programme Candidates learn Environmental Management and Understanding of safe handling of chemicals, environmental issues and key issues facing our society in energy, health and medicine.

PO11: ***Modern Analytical Knowledge:*** Students will demonstrate an ability to analyze and interpret data of analytical experiments in production, quality control & assurance of pharmaceutical synthesis and formulation.

PO12: ***Life Long Skills:*** Having a strong conceptual framework in the subject along with the skills of analytical reasoning, problem solving, critical thinking etc. make the students lifelong learners.

Programme Specific Outcome

PSO-1 Students will be able to understand the basic concepts of bio-inorganic, bioorganic, physical chemistry, analytical chemistry, Modern pharmaceutical analytical techniques, drug formulation, drug design and development and Environmental Biotechnology.

PSO-2. Students will develop the ability to present pharmaceutical chemistry research by means of an oral presentation, a scientific poster or a written report.

PSO-3. Students will be able to use and apply professional software's relevant to chemistry.

PSO-4. Students will demonstrate an ability to analyze and interpret data of analytical experiments in production, quality control & assurance of pharmaceutical synthesis and formulation.

Section 2

Semester wise Scheme

1st sem

Course Code	Course Title	L	T	P	CH	CP	Int. A	ESE	Total
MPCH-101	Organometallics and Nuclear Chemistry	4	1	0	4	4.5	60	40	100
MPCH-102	Basic Pharmacology	4	1	0	4	4.5	60	40	100
MPCH -103	Chemical Bonding	4	1	0	4	4.5	60	40	100
MPCH-104	Biostatistics and computers	4	1	0	4	4.5	60	40	100
MPCH-151- P	Chemistry Lab-I	0	0	4	4	2	30	20	50
MPCH-152- P	Chemistry Lab-II	0	0	4	4	2	30	20	50
MPCH-153- P	Biostatistics and computers-Lab	0	0	4	4	2	30	20	50

2nd sem

Course Code	Course Title	L	T	P	CH	CP	Int. A	ESE	Total
MPCH-201	Biochemistry	4	1	0	4	4.5	60	40	100
MPCH-202	Advanced organic chemistry	4	1	0	4	4.5	60	40	100
MPCH -203	Coordination Chemistry	4	1	0	4	4.5	60	40	100
MPCH-204	Stereochemistry and Thermo -analytical Methods	4	0	0	4	4	60	40	100
MPCH-251- P	Chemistry lab-III	0	0	4	4	2	30	20	50
MPCH-252- P	Advanced organic chemistry lab	0	0	4	4	2	30	20	50
MPCH-253- P	Coordination Chemistry-Lab	0	0	4	4	2	30	20	50
Seminar	Seminar	0	0	0		1	100	0	100

3rd sem

Course Code	Course Title	L	T	P	CH	CP	Int. A	ESE	Total
MPCH-301	Modern pharmaceutical analytical techniques	4	1	0	4	4.5	60	40	100
MPCH-302	Medicinal chemistry	4	1	0	4	4.5	60	40	100
MPCH -303	Environmental Biotechnology	4	1	0	4	4.5	60	40	100
MPCH-304	drug delivery system & bio pharmaceutics	4	0	0	4	4	60	40	100
MPCH-351- P	Modern pharmaceutical analytical techniques-Lab	0	0	4	4	2	30	20	50
MPCH-352- P	Medicinal chemistry-Lab	0	0	4	4	2	30	20	50
MPCH-353- P	Pharmacokinetics Practical-Lab	0	0	4	4	2	30	20	50

4th sem

Course Code	Course Title	L	T	P	CH	CP	Int. A	ESE	Total
MPCH-401	Pharmaceutical process chemistry	4	1	0	4	4.5	60	40	100
MPCH-402	Chemistry of natural products	4	1	0	4	4.5	60	40	100
MPCH-403	Dissertation	0	0	15	40	12	50	50	100

L – Lecture; **T** – Tutorial; **P** – Practical; **CH** – Contact hour; **CP** – Credits points; **Int. A** – Internal assessment; **ESE** – End-semester exam

Section 3

Semester wise Syllabus

Program: M.Sc. Pharmaceutical Chemistry	**Semester: I**
Course Title: ORGANOMETALLICS AND NUCLEAR CHEMISTRY	**Course Code: MPCH-101**

Course Description: The special feature of M. Sc. (Organometallics and nuclear chemistry) Sem.-I is a good foundation of basics and research component through practical and theoretical knowledge, which in turn will provide excellent job prospects in Academics, Industries and other fields of interest. This programme intended to offer a balanced combination of core and applied courses of pharmaceutical Chemistry. This course will provide competence to tackle frontier area in Organometallic Compounds, their Synthesis, Structure and Bonding, nuclear chemistry, catalysis of organometallic compounds, organometallic polymers etc.

Course Outcomes

CO1: The course content would help students to learn about organometallic compounds, their synthesis, structure & bonding with specific examples.

CO2: The nuclear chemistry chapter would make the student aware of nuclear processes like nuclear fission, fusion, radio analysis and synthesis of transuranic elements etc.

CO3: Chapter of Catalysis by Organometallic Compounds gives insight about alkene hydrogenation using Wilkinson catalyst, Tolman catalytic loops, Ziegler Natta catalysts, Carbonylation reactions-Monsanto acetic acid process etc.

CO4: The chapter on organic polymers gives emphasis on Polymers with organometallic moieties as pendant groups, polymers with organometallic moieties in the main chain, Bioinorganic Compounds, Essential and trace elements in biological systems etc.

Theory: **65 hr./Sem**

Unit	**Topic**	**Hours**
1	**Organometallic Compounds- Synthesis, Structure and Bonding** Organometallic compounds with linear pi donor ligands-olefins, acetylenes, dienes and allyl complexes-synthesis, structure and bonding, Complexes with cyclic pi donors-metallocenes and cyclic arene complexesstructure and bonding. Hapto nomenclature, three electron donor (π-allyl complexes of transition metals). Carbene and carbyne complexes, Preparation, properties, structure and bonding of simple mono and binuclear metal carbonyls, metal nitrosyls, metal cyanides and dinitrogen complexes. Polynuclear metal carbonyls with and without bridging. Carbonyl clusters-LNCCS and HNCCS, Isoelectronic and isolobal analogy, Wade-Mingos rules, cluster valence electrons.	17

	Polyhedral electron pair theory.	
2	**Nuclear Chemistry** Fission products and fission yield. Neutron capture cross section and critical size, Nuclear fusion reactions and their applications. Chemical effects of nuclear transformations. Positron annihilation and autoradiography. Principles of counting technique such as G.M. counter, proportional, ionization and scintillation counters. Cloud chamber and working of cloud chamber, Synthesis of transuranic elements such as Neptunium, Plutonium, Curium, Berkelium, Einsteinium, Mendelevium, Nobelium, Uses of transuranic elements. Lawrencium and elements with atomic numbers 104 to 109, Analytical applications of radioisotopes-radiometric titrations, kinetics of exchange reactions, measurement of physical constants including diffusion constants, Radioanalysis, Neutron Activation Analysis, Prompt Gama Neutron, Activation Analysis and Neutron Absorptiometry, Applications of radio isotopes in industry, food preservation, medicine, audiography , radio pharmacology, radiation safety precaution, nuclear waste disposal, Radiation chemistry of water and aqueous solutions, Measurement of radiation doses. Relevance of radiation chemistry in biology, organic compounds and radiation polymerization.	20
3	**Catalysis by Organometallic Compounds** Homogeneous and heterogeneous organometallic catalysis-alkene hydrogenation using Wilkinson catalyst, Tolman catalytic loops, Reactions of carbon monoxide and hydrogen-the water gas shift reaction, the Fischer-Tropsch reaction(synthesis of gasoline), Hydroformylation of olefins using cobalt or rhodium catalyst, Polymerization by organometallic initiators and templates for chain propagation- Ziegler Natta catalysts, Phase transfer catalysis. Carbonylation reactions-Monsanto acetic acid process, carbonylation of butadiene using Co2(CO)8 catalyst in adipic ester synthesis, Olefin methathesis-synthesis gas based reactions, photo dehydrogenation catalyst (“Platinum Pop”). Palladium catalysed oxidation of ethylene-the Wacker process, proximity interaction.	16
4	**Organometallic Polymers** Polymers with organometallic moieties as pendant groups, polymers with organometallic moieties in the main chain, based condensation polymers, condensation polymers based on ferrocene and on rigid rod polyynes, polymers prepared by ring opening polymerization, organometallic dendrimers, General properties of bioinorganic Compounds, Essential and trace elements in biological systems, structure and functions, application of biological membranes, mechanism of ion transport across membranes, sodium pump, ionophores, valinomycin and crown ether complexes of Na+ and K+, ATP and ADP.	12

Textbooks

- Organometallic Chemistry-R.C.Mehrotra
- Organometallic compounds of Transition Metal-Crabtree
- Chemistry of the Elements – Greenwood and Earnshaw
- Inorganic Chemistry – J.E.Huheey

Reference Books

- Principles of organometallic compounds – Powell
- Organometallic chemistry (an Introduction) – Perkin and Pollar
- Organometallic chemistry – Parison
- Advanced Inorganic Chemistry – Cotton and Wilkinson
- Homogeneous transition metal catalysis – Christopher Masters
- Homogeneous Catalysis – Parshall

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	**Marks**
Below 75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO 1	**3**	**3**	**1**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	1	**3**	**1**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 3	3	3	1	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 4	3	3	2	**3**	**1**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: I
Course Title: Chemistry Lab-I	Course Code: MPCH-151 P

Course Description: The major goals of the practical courses are to acquire basic chemical laboratory skills and learn the safe manipulation of chemicals and chemical reactions, become skilled in precisely observing and documenting experiments, learn and practice basic chemical principles by performing experiments in inorganic, Organic, and Physical Chemistry by yourself. Students will also acquire knowledge pertaining the disposal and recovery of chemicals as well as to gain awareness of environmental protection from a chemical point of view. In this course students will perform various experiments like volumetric analysis, EDTA titrations, determination of cell constant, viscosity etc.

Course Outcomes

CO1: Students will be able to determine antimony (III), arsenic (III), aluminium, cobalt and zinc by titrating against KBrO3.

CO2: Students will able to perform EDTA titrations for the determination of copper, nickel, magnesium, Back titration and hardness of water

CO3: Students will become familiar that how to determine cell constant, limiting molar conductance of simple electrolytes in water, verification of Ostwald and dilution law for week acetic acid.

CO4: Students will be able to understand method of determination of surface tension, Analysis of mixture of two miscible solvents and verification of Gibb's Thomson Rule of surface tension

Practical: 60 hr./Sem

Sr No.	Experiment Title
1.	**Volumetric Analysis:**
	(a) Potassium bromate titrations
	i) Determination of antimony (III) and arsenic (III) Direct Method)
	ii) Determination of aluminium, cobalt and zinc (by oxine method)
2.	**(b) EDTA titrations** i) Determination of copper, nickel, magnesium
	ii) Back titration
	iii) Alkalimetric titration
	iv) Titration of mixtures using masking and demasking agents
	v) Determination of hardness of water
3.	Determination of cell constant, limiting molar conductance of simple electrolytes in water,

	verification of Ostwald, dilution law for week acetic acid.
4.	Determination of Surface tension of pure solvents, analysis of mixtures of two miscible solvents, verification of Gibb's Thomson Rule of surface tension.
5.	Determination of partition – coefficient for I_2 between water and CCl_4 and for benzoic acid between water and benzene.

Textbooks

- Experimental Physical Chemistry: V. Athawale and P. Mathur.
- Practical Physical Chemistry: B. Vishwanathan and P.S. Raghavan.

Reference books

- Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
- Practical in Physical Chemistry: P.S. Sindhu

Assessment Process (Internal)

- **Continuous Assessment (CA)= 30 Marks in the form of:-**

  i) Practical file - 10 marks **ii) Practical Performane-** 10 marks **iii) Viva-**10 marks

Attendance percentage	**Marks**
Below 75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO 1	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 2	3	3	1	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	2	**1**	**1**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**

CO 4	3	3	2	**3**	**1**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: I
Course Title: BASIC PHARMACOLOGY	Course Code: MPCH-102

Course Description: The special feature of M. Sc. (Basic Pharmacology) Sem.-I is a good foundation of basics and research component through practical and theoretical knowledge, which in turn will provide excellent job prospects in Academics, Industries and other fields of interest. This programme intended to offer a balanced combination of core and applied courses of Pharmaceutical chemistry. This course will provide competence to tackle frontier area in pharmacology, pharmacodynamics, drug reactions, interactions etc.

Course Outcomes

CO1: It makes the student aware of absorption, distribution metabolism, excretion of drugs, mechanism of drug structure and the adverse response of drug.

CO2: Students will be familiar with elementary introduction to adverse drug reactions & drug interactions, Drug allergy.

CO3: The chapter on toxicity explain Acute, subacute & chronic toxicity tests, teratogenicity & carcinogenicity, itrogenic diseases, LD50, ED50, tolerance, habituation & addiction

CO4: Screening of drugs chapter describe general principles, screening methods, clinical trial. Screening methods for evaluation of anti-inflammatory, analgesics, antipyretics & antiulcer, anticonvulsants, hepatoprotective, antidiabetic, diuretic and drugs acting on CNS.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	History of development of Pharmacology, introduction & general principles of route of drug administration, Mention of uses of pharmacokinetics pharmacokinetics, (absorption, distribution, metabolism & excreation) a pharmacodynamics (general mechanism of drug action, Development of new drugs.	17
2	Elementary introduction to adverse drug reactions, Local antiinfective drugs & drug interactions, Drug allergy.	12
3	**Toxicity** General concepts of toxicity, Acute, subacute & chronic toxicity tests, teratogenicity & carcinogenicity, itrogenic diseases, LD50, ED50, tolerance, habituation & addiction. Bio-assays: General principles, general methods, biological variations & animal ethics. Bioassays of insulin, heparin, d-tubocurarin, digitalis, acetylcholine, adrenaline, histamine.	20
4	General principles of screening of drugs, general screening methods, clinical trial. Screening methods for evaluation of anti-inflammatory, analgesics, antipyretics & antiulcer, anticonvulsants, hepatoprotective, antidiabetic, diuretic and drugs acting on CNS, SAR and mode of actions, sulfonamide inhibition.	16

Textbooks

- Katzung G. Bertram, Basic and Clinical Pharmacology, 8th ed., McGraw Hill Companies, New York, USA, 2001.
- Rang H.P., Dale M.M., Ritter J.M., Pharmacology, 4th ed., Churchill livingstone, N. Y., 1999.
- R.S. Satoshkar, Pharmacology and Pharmacotherapeutics, vol. I & II: 16th ed., Mumbai Popular Prakashan, 1999.

Reference Books

- Goodman & Gillman, The Pharmacological Basis of Therapeutics 9th ed., McGraw Hill Companies, New York, USA, 1996.
- Munson L. Paul, Principles of Pharmacology, Chapman & Hill, N. Y. 1995.
- S. K. Kulkarni & P.C. Dandiya, Introduction to Pharmacology, 5th ed. Vallabh Prakasha, 1998.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**2**	**3**	**1**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	1	**3**	**1**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 4	3	3	2	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: I
Course Title: Chemistry Lab-II	Course Code: MPCH-152 P

Course Description: This course will impart knowledge about separation & identification of sugar from the mixture of glucose, fructose and sucrose by paper chromatography, determination of DO, COD and BOD etc. The major goals of the practical courses are to acquire basic chemical laboratory skills and learn the safe manipulation of chemicals and chemical reactions, become skilled in precisely observing and documenting experiments, learn and practice basic chemical principles by performing experiments in inorganic, Organic, and Physical Chemistry by yourself. Students will also acquire knowledge pertaining the disposal and recovery of chemicals as well as to gain awareness of environmental protection from a chemical point of view.

Course Outcomes

CO1: Students can separate and identify presence of sugar from the mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values.

CO2: Students can determine the percentage/ number of hydroxyl groups in an organic compound by acetylation method.

CO3: Students can perform the experiment for the determination of iodine and saponification values of an oil sample. Determination of DO, COD and BOD of water sample.

CO4: Students can do estimation of amines/ phenols using bromate – bromide solution/ acetylation method.

Practical: 60 hr./Sem

Sr No.	Experiment Title
1.	**Paper Chromatography:**
	Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values.
2.	**Quantitative Analysis:** Determination of the percentage/ number of hydroxyl groups in an organic compound by acetylation method.
3.	Estimation of amines/ phenols using bromate – bromide solution/ acetylation method.
4.	Determination of iodine and saponification values of an oil sample. Determination of DO, COD and BOD of water sample.

Textbooks

- Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C.Heath.
- Systematic Qualitative Organic Analysis, H.Middleton, Adward Arnold.

Reference books

- Experiments and Techniques in Organic Chemistry, D.Pasto, C. Johnson and M.Miller, Prentice Hall.
- Handbook of Organic Analysis-Qualitative and Quantitative, H.Clark, Adward Arnold.

- Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.

Assessment Process (Internal)

- **Continuous Assessment (CA)= 30 Marks in the form of:-**

  ii) Practical file - 10 marks **ii) PracticalPerformane-** 10 marks **iii) Viva-**10 marks

Attendance percentage	**Marks**
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO 1	**3**	**3**	**1**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	1	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 3	3	3	1	**1**	**1**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 4	3	3	2	**3**	**2**	**2**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester:I
Course Title: CHEMICAL BONDING	Course Code: MPCH-103

Course Description: The special feature of M. Sc. (Chemical Bonding) Sem.-I is a good foundation of basics and research component through practical and theoretical knowledge, which in turn will provide excellent job prospects in Academics, Industries and other fields of interest. This programme intended to offer a balanced combination of core and applied courses of Chemistry. This course will provide competence to tackle frontier area in approximate methods in quantum mechanics, chemical bonding and applications of group theory in chemical bonding etc.

Course Outcomes

CO1: The student is able to apply principles of quantum mechanics to calculate observables on known wave functions, the variational method, time-independent perturbation theory and time-dependent perturbation theory to solve simple problems and gain knowledge about fundamental quantum mechanical processes in nature.

CO2: Chapter chemical bonding explain VB and MO theory with examples for specific molecules, comparison between VB & MO theories, HMO of ethane, allyl systems.

CO3: Students can describe Schrondinger wave equation and Born-Oppenheimer approximation.

CO4: Students should able to construct hybrid orbitals with BF_3, CH_4, PCl_5 and SALC of C_{2v}, C_{2h}, C_3, C_{3v} and D_{3h} and Jahn Teller effect.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	**Approximate Methods in Quantum Mechanics** Many-body problem and the need of approximation methods, independent particle model. Variation method, variation theorem with proof, illustration of variation theorem using the trial function x(a-x) for particle in a 1D-box and using the trial function e-ar for the hydrogen atom, variation treatment for the ground state of helium atom, Graphical presentation of orbitals (s, p and d),Perturbation method, time-independent perturbation method (non-degenerate case only), first order correction to energy and wave function, illustration by application to particle in a 1D-box with slanted bottom, perturbation treatment of the ground state of the helium atom. Qualitative idea of Hellmann-Feynman theorem, Hartree Self-Consistent Field method. Spin orbitals for many electron atomssymmetric and antisymmetric wave functions. Pauli's exclusion principle. Slater determinants, radial and angular probability distribution plots .Qualitative treatment of Hartree-Fock Self-Consistent Field (HFSCF) method. Roothan's concept of basis functions, Slater type orbitals (STO) and Gaussian type orbitals (GTO), sketches of STO and GTO, applications of quantum mechanical principle	28

2	**Chemical Bonding** Schrödinger equation for molecules. Born-Oppenheimer approximation. Valence Bond (VB) theory, VB theory of H2 molecule, singlet and triplet state functions (spin orbitals) of H_2, Molecular Orbital (MO) theory, MO theory of H2+ ion, MO theory of H2 molecule, MO treatment of homonuclear diatomic molecules Li2, Be2, N2, O2 and F2 and hetero nuclear diatomic molecules LiH, CO, NO and HF. Bond order, Correlation diagrams, non-crossing rule. Spectroscopic term symbols for diatomic molecules. Comparison of MO and VB theories, Concept of Hybridization, quantum mechanical treatment of sp, sp2 and sp3 hybridisation, Semi empirical MO treatment of planar conjugated molecules, Hückel Molecular Orbital (HMO) theory of ethene, allyl systems, butadiene and benzene, Calculation of charge distributions, bond orders and free valency.	20
3	**Applications of Group Theory in Chemical Bonding** Application in quantum mechanics, group representation, transition moment integral, vanishing of integrals, Applications in chemical bonding, construction of hybrid orbitals with BF3, CH4, PCl5 as examples. Transformation properties of atomic orbitals. Symmetry adapted linear combinations (SALC) of C2v, C2h, C3, C3v and D3h. Jahn-Teller effect, hybrid orbitals for σ-bonding in different geometries and hybrid orbitals for π-bonding. Woodward Hoffmann rules-correlation diagram, Symmetries of molecular orbitals in BF_3, C_2H_4.	17

Textbooks

- F.A. Cotton, Chemical Applications of Group Theory, 3rd Edn., Wiley Eastern, 1990.
- V. Ramakrishnan, M.S. Gopinathan, Group Theory in Chemistry, Vishal Publications, 1992.
- A.S. Kunju, G. Krishnan, Group Theory and its Applications in Chemistry, PHI Learning, 2010

Reference Books

- N. Levine, Quantum Chemistry, 6th Edn., Pearson Education, 2009.
- D.A. McQuarrie, Quantum Chemistry, University Science Books, 2008.
- R.K. Prasad, Quantum Chemistry, 3rd Edn., New Age International, 2006.
- E.G. Lewars, Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics, 2nd Edn., Springer, 2011.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**
  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	Marks
Below75%	0

75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**1**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 2	3	3	2	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**1**	**3**
CO 4	3	3	1	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	**Semester: I**
Course Title: BIOSTATISTICS AND COMPUTERS	**Course Code: MPCH-104**

Course Description: Biostatistics and computers is a good foundation of basics and critical thinking component through practical and theoretical knowledge which in turn will provide excellent job prospects in Academics, Industries and other fields of interest. This programme intended to offer a balanced combination of core and applied courses of pharmaceutical Chemistry. This course will provide competence to tackle frontier area in scope of biostatistics, testing of hypothesis, computer fundamentals, internet browsing, WWW, MS-Word etc.

Course Outcomes

CO1: Students will acquire knowledge about data presentation**,** classification of data, methods of collection of data, frequency distribution, graphical representation of data by histogram, frequency polygon, frequency curve and cumulative frequency curve, measures of dispersion, mean, median, mode and their properties, partition value, standard deviation, correlation coefficient and regression coefficient, regression lines, tests of significance.

CO2: Chapter testing of hypothesis will introduce types of errors, power of test, T-test, chi-square, test of goodness of fit, independent test, F-test for variance ration, correlation and regression, rank correlation curve fitting and sign test.

CO3: Students will able to explain computer fundamentals, MS-Word, MS-Excel & Power point and microcomputers.

CO4: Students will know about internet, URL, WWW and role of computers in pharmaceutical sciences.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	**Introduction and scope of Biostatistics** Presentation of data**,** classification of data, Methods of collection of data (primary and secondary), frequency distribution, graphical representation of data by histogram, frequency polygon, frequency curve and cumulative frequency curve, Central tendency and measures of dispersion, mean, median, mode and their properties, partition value, standard deviation and coefficient of variation, simple correlation coefficient and regression coefficient, regression lines, tests of significance: t-test, z-test, q-test chi-square tests, F-test, heterogeneity and independence of attributes,4d rule, 2.5d rule.	20
2	**Testing of hypothesis** Types of errors, minimization of errors, power of test, test of significance based on normal distribution T-test for mean of population, difference of means of two normal population, chi-square test of goodness of fit, independent test, test of variance of normal population F-test for variance ration, correlation and regression, latest square methods and its application, significance of coefficient of correlation, rank correlation curve fitting and sign test.	17
3	**Computer fundamentals** Sample model of computer and its working, input-output devices, computer languages and their hierarchy (low level and high level), Introduction to microcomputers, working of microcomputers, concept of operating system, computer networking, Introduction of software (MS-Word, MS-Excel & Power point etc.) Introduction to organization and architecture of mainframe, mini and micro systems.	16
4	Internet and its working, Uniform resource locator (URL), World wide web, HTTP, Internet explorer, LAN, WAN, role of computers in pharmaceutical sciences, use of high level programming Language for the systematic development of programs.	12

Textbooks

- Biostatistics-Arora & Malhan, Himalaya Publishing House, Bombay.
- Statistical Methods in Biology-Baidy, Cambridge University press.

Reference Books

- Information technology-D.P.Curtin, Tata McGraw Hill,New Delhi.
- Guide to Medical Informatics, The Internet & Telemedicine-E Coiera, Amold Publishers, USA.

- P. K. Sinha, B.P.B Publication New Delhi.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**2**	**1**	**0**	**0**	**1**	**1**	**2**	**0**	**0**	**0**	2	√	**0**	**0**	**3**	1
CO 2	2	**1**	**0**	**0**	**2**	**1**	**2**	**0**	**0**	**0**	2	√	**0**	**0**	**3**	1
CO 3	**2**	**1**	**0**	**0**	**1**	**2**	**2**	**0**	**0**	**0**	2	√	**0**	**0**	**3**	1
CO 4	**2**	**1**	**0**	**0**	**1**	**2**	**1**	**0**	**0**	**0**	2	√	**0**	**0**	**3**	2

Program: M.Sc. Pharmaceutical Chemistry	Semester: I
Course Title: Biostatistics and computers Lab	Course Code: MPCH-153P

Course Description: Biostatistics and computers Lab knows the basic IT and biostatistical methods used in medicine, including medical databases, spreadsheets and basics of computer graphics, basic methods of statistical analysis used in population and diagnostic studies, possibilities of modern telemedicine as a tool to support the work of a doctor, uses databases, including websites and searches for the necessary information using the available tools. Students will gain practical skills, performing medical statistics and its analysis.

Course Outcomes

CO1: Students will operate chemdraw, generation of graphs, data sheets creation and tables using Excel Programme.

CO2: Students will perform PowerPoint presentation & their features.

CO3: Students will able to explain and perform MS word, email creation etc.

CO4: Students will acquire knowledge about Internet browsing and benefits.

Practical: 60 hr./Sem

Sr No.	Experiment Title
1.	Exposure to available standard application packages like: Chemdraw, generation of graphs, data sheets creation and tables using Excel Programme.
2.	PowerPoint presentation & features
3.	MS Word
4.	Internet browsing
5	E-mail creation and features

Textbooks

- P. K. Sinha, B.P.B Publication New Delhi.

Reference books

- Biostatistics-Arora & Malhan, Himalaya Publishing House, Bombay.
- P. K. Sinha, B.P.B Publication New Delhi.

Assessment Process (Internal)

- **Continuous Assessment (CA)= 30 Marks in the form of:-**

  iii) Practical file - 10 marks **ii) PracticalPerformane-** 10 marks **iii) Viva-**10 marks

Attendance percentage	Marks

Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO 1	**2**	**1**	**0**	**0**	**1**	**2**	**1**	**0**	**0**	**0**	1	√	**0**	**0**	**3**	1
CO 2	2	**1**	**0**	**0**	**2**	**2**	**1**	**0**	**0**	**0**	2	√	**0**	**0**	**3**	2
CO 3	**2**	**1**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	1	√	**0**	**0**	**3**	1
CO 4	**2**	**1**	**0**	**0**	**1**	**1**	**2**	**0**	**0**	**0**	2	√	**0**	**0**	**3**	1

Program: M.Sc. Pharmaceutical Chemistry	Semester: II
Course Title: Biochemistry	Course Code: MPCH-201

Course Description: Biochemistry offers in-depth knowledge of biology and chemistry with regard to plants, humans and animals processes, human physiology, basic immunology, microbiology, enzymology etc. The main aim of the program is to make students understand the dynamics and mechanism of the biological activities taking place inside the human body. The knowledge gained through the studying biochemistry is widely used in various industries like medical research, food and packaging, pharmaceuticals, medicine and genetics etc. The main aim to introduce biochemistry is to provide field-specific knowledge and skill sets through theoretical and practical sessions.

Course Outcomes

CO1: The student will have an understanding of the metabolic processes by which energy is produced in cells and amino acids, lipids, purines and pyrimidines and carbohydrates are synthesized.

CO2: The student will be able to identify the structural elements of proteins, the basic features of enzyme catalysis and regulation, and the function of hemoglobin in oxygen binding and transport activity.

CO3: 2. Understand the regulation of biochemical pathway and possible process modifications for improved control over microorganisms for microbial product synthesis.

CO4: Students can aware about biochemical aspects of Diet and Diet related Diseases, Balanced diet formulation, Determination of nutritive value of proteins, Biological value of proteins (BV), Protein efficiency ratio (PER), Digestibility coefficient, Net Protein Ratio (NPR) and Life Style diseases.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	Metabolism of Carbohydrates: Overview of glycolysis, gluconeogenesis, citric acid cycle, galactose and fructose metabolism, Metabolism of Lipids: Metabolism of ketone bodies - Formation, utilization, excretion and clinical significance. Metabolism of triglycerides, phospholipids and sphingolipids. Fatty acid derivatives: eicosanoids, their function and metabolism, Catabolism of amino acid nitrogen - transamination, deamination, ammonia formation and the urea cycle, metabolism of amygdalin, general methods of structure and ring size determination with particular reference to maltose, lactose, sucrose, pectin.	16
2	Biochemical aspects of Diet and Diet related Diseases Balanced diet formulation, Determination of nutritive value of proteins, Biological value of proteins (BV), Protein efficiency ratio (PER), Digestibility coefficient, Net protein utilization, Net Protein Ratio (NPR), Chemical score, Protein energy malnutrition – Kwashiorkor, Marasmus. Life Style diseases – Atherosclerosis, Diabetes, Cancer, Inflammatory arthritis, Obesity – Risk factors, Molecular pathogenesis, Biochemical and clinical features, diagnosis, treatment.	12
3	Enzymes – Historical perspective, general characteristics, nomenclature, IUB enzyme classification (specific examples), measurement and expression of enzyme activity,	17

	enzyme assay. Definitions of IU, Katal , enzyme turnover and specific activity, functions of carbonic anhydrase, Methods for isolation, purification and characterization of enzymes, tests for homogeneity of enzyme preparation, structure of carbonic anhydrase A & B.	
4	Microbial Biochemistry: Morphology and structure of bacteria, gram positive and gram negative organisms, Fluid Mosaic Model, Microscopy (Bright field, Dark field, Phase contrast and Fluorescence microscopy), sterilization, nutritional requirements and growth characteristics of bacteria, media for growing bacteria and fungi. Bacterial toxins – Classification, structure and mode of action of bacterial protein toxins. Viruses – General structure, properties and classification, chemistry of insulin and oxytocin.	20

Textbooks

- F S K Barar, Essentials of Pharmacotherapeutics, S. Chand Limited, 2000.
- J. Lippincot co,pharmaceutical chemistry, Philadelphia.
- Bertram Katzung, Anthony Trevor, Basic and Clinical Pharmacology, McGraw Hill Professional, 2014.

Reference Books

- Biochemistry by Garret & Grisham
- Principles of Biochemistry by White, Handler & Smith
- Food science, Chemistry and experimental Foods - Dr. M. Swaminathan
- Clinical biochemistry:Metabolic concepts and clinical Aspects by W.J. Marshall and S. K. Bangrit
- Klaassen, Curtis D., ed. Casarett and Doull's toxicology: the basic science of poisons. McGraw-Hill, 2013.
- Screening methods in pharmacology. Robert A Turner, academic press, Newyork

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**1**	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	1	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**1**	**3**
CO 4	3	3	2	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: II
Course Title: Chemistry Lab – 3	Course Code: MPCH-251P

Course Description: The major goals of the practical courses are to acquire basic chemical laboratory skills and learn the safe manipulation of chemicals and chemical reactions, become skilled in precisely observing and documenting experiments, learn and practice basic chemical principles by performing experiments in inorganic, Organic, stereo and Physical Chemistry by yourself. Students will also acquire knowledge pertaining the disposal and recovery of chemicals as well as to gain awareness of environmental protection from a chemical point of view.

Course Outcomes

CO1: Students will calculate heat of solution of electrolytes by solubility measurements.

CO2: Students will able to calculate Heat of transfer for benzoic acid between benzene and water and I_2 between CCl_4 and water.

CO3: Students will determine water equivalent of thermos flask, and estimation of heat of neutralization for strong acid strong base, weak acid strong base or vice – versa, heat of hydration and solution of salts.

CO4: Students will perform Kinetic Measurement and determination of % Loss on dryness (LOD) of given compound $KMnO_4$, MNO_2, $K_2Cr_2O_7$.

Practical: 60 hr./Sem

Sr No.	Experiment Title
1	Solubility Measurements: Heat of solution of electrolytes by solubility measurements.
2	Heat of transfer Measurements: Heat of transfer for benzoic acid between benzene and water and I_2 between CCl_4 and water.
3	Thermochemistry: Determination of water equivalent of thermos flask, and estimation of heat of neutralization for strong acid strong base, weak acid strong base or vice – versa, heat of hydration and solution of salts.
4	Kinetic Measurement: Kinetics of Hydrolysis of methylacetate and ethylacetate in the presence of HCl.
5	Determination of % Loss on dryness (LOD) of given compound $KMnO_4$, MNO_2, $K_2Cr_2O_7$.

Textbooks

- Practical Physical Chemistry: B. Vishwanathan and P.S. Raghavan.
- Practical in Physical Chemistry: P.S. Sindhu

Reference books

- Senior Practical Physical Chemistry: B.D. Khosla, V.C. Garg and A. Khosla
- Experimental Physical Chemistry: V. Athawale and P. Mathur.

Assessment Process (Internal)

- **Continuous Assessment (CA)= 30 Marks in the form of:-**

  iv) Practical file - 10 marks **ii) Practical Performane-** 10 marks **iii) Viva-**10 marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	2	**3**	**1**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 4	3	3	2	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: II
Course Title: ADVANCED ORGANIC CHEMISTRY	Course Code:MPCH-202

Course Description: This course deals with the application of structure and theory to the study of organic reaction mechanisms: Stereochemical features including conformation and stereoelectronic effects; reaction dynamics, isotope effects and molecular orbital theory applied to pericyclic and photochemical reactions; and special reactive intermediates including carbenes, carbanions, and free radicals. Special feature of M. Sc (Advanced Organic Chemistry) Sem.-II is a good foundation of basics and research component through practical and theoretical knowledge, which in turn will provide excellent job prospects in Academics, Industries and other fields of interest. This programme intended to offer a balanced combination of core and applied courses of Organic Chemistry.

Course Outcomes

CO1: Students can understand about carbocation, carbanions, free radicals and mechanism of aliphatic/aromatic nucleophilic and electrophilic substitution reactions.

CO2: Students can learn concept of naming reactions their nature and properties of specific reactions with examples.

CO3: The student would also learn about heterocyclic chemistry their properties and applications of drugs containing five, six membered and fused heterocylces such as: Pyrazoline, triazole, 4-hiazolidinone, purine, quinoline, acridine.

CO4: Students can **r**ecognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	Carbocation, Carbanions, phenonium ions, free radicals, reactivity in aliphatic and aromatic substrates at a bridgehead and attacking radicals. Formation and stability. Mechanism of reaction & methods of determining them. Mechanism involving aliphatic nucleophilic and electrophilic substitution reactions. Mechanisms involving Aromatic electrophilic and aromatic nucleophilic substitution reactions, free radical reactions. Addition to carbon-carbon multiple bonds & elimination reactions.	16
2	**Name reactions:** Study of Name Reactions such as: Fries Rearrangement Beckmann rearrangement, Hofmann rearrangement, Curtius reaction, Schmidt Reaction, Claisen's Condensation, Wittig Reaction, wurtz reaction. Oppenauer oxidation, Meerwein Pondroff Valery Reduction, Birch Reduction, Clemmensen reduction, Reimer-Tiemann Reaction, Demjanov ring expansion, Wolf Kishner's Reduction, Pinacol-Pinacolone Rearrangement and Aldol Condensation. Esterification of carboxylic acid.	17
3	Heterocyclic chemistry, General methods of synthesis, properties and applications of drugs containing five, six membered and fused heterocylces such as: Pyrazoline, triazole, 4-hiazolidinone, purine, quinoline, acridine. Synthesis of few representative drugs	12

	containing these heterocyclic nucleus, Stereochemistry of five and six membered and fused rings, Methods of asymmetric synthesis using chiral pool, chiral auxiliaries and catalytic asymmetric synthesis, enantiopure separation, stereoselective and stereospecific synthesis with examples.	
4	Optical isomerism, configuration, Cahn-bIngold-Prelog rule for designation of configuration. Stereochemistry of carbon compounds with no chiral atom, Biphenyls, Allenes, Alkylidene cycloalkanes, spirans and Geometrical isomerism. Stereoisomerism of rings, stability of rings, ease of ring formation, Optical activity in the absence of chiral carbon. Actual shape of six membered rings & its relation to properties & reactivity and Conformational analysis of Butane, chirality due to helical shape.	20

Textbooks

- Eliel E. L., Wilen S. H., Mander L.N., Stereochemistry of Organic Compounds, John Wiley and Sons, New York.
- Vogel A.I., Elementary Practical Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education Ltd.), Singapore.

Reference Books

- E.L. Eliel Stereochemistry of carbon compounds, Tata McGra Hill Publishing Company New

Delhi 1975.

- Jerry March, Advance organic Chemistry 4th ed.. A Wiley-Interscience Publication, 1999.
- Singh M.S. Advanced Organic Chemistry: Reactions and Mechanisms, Dorling Kindersley (India) Pvt. Ltd, New Delhi.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	1	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 4	3	3	1	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: II
Course Title: Advanced organic chemistry Lab	Course Code: MPCH -252 P

Course Description: In this course students will perform different organic synthesis like oxidation, Grignard reaction etc. The major goals of the practical courses are to acquire basic chemical laboratory skills and learn the safe manipulation of chemicals and chemical reactions, become skilled in precisely observing and documenting experiments, learn and practice basic chemical principles by performing experiments in inorganic, Organic, and Physical Chemistry by yourself. Students will also acquire knowledge pertaining the disposal and recovery of chemicals as well as to gain awareness of environmental protection from a chemical point of view.

Course Outcomes

CO1: Students will know method of synthesis of Acetylation of cholesterol and separation of cholesteryl acetate by column chromatography.

CO2: Students will perform preparation of iodoform from acetone (Haloform reaction).

CO3: Students will understand and perform methods for the preparation of specific reactions like Grignard reaction, Sandmeyer reaction and aldol condensation etc.

CO4: Students will synthesize ethyl-n-butylacetoacetate by A.E.E condensation.

Practical: 60 hr./Sem

Sr No.	Experiment Title
1	Organic Synthesis: Acetylation: - Acetylation of cholesterol and separation of cholesteryl acetate by column chromatography.
2	Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol.
3	Preparation of iodoform from acetone (Haloform reaction).
4	Grignard reaction: Synthesis of triphenyl methanol from benzoic acid.
5	Aldol condensation: Dibenzal acetone from benzaldehyde.
6	Sandmeyer reaction: p-chlorotoluene from p-toluidine.
7	Acetoacetic ester condensation: Synthesis of ethyl-n-butylacetoacetate by A.E.E condensation.
8	Preparation of polystyrene, anthranilic acid, fluorosceine-eosin, and methyl orange

Textbooks

- Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C.Heath.
- Systematic Qualitative Organic Analysis, H.Middleton, Adward Arnold.

Reference books

- Experiments and Techniques in Organic Chemistry, D.Pasto, C. Johnson and M.Miller, Prentice Hall.

- Handbook of Organic Analysis-Qualitative and Quantitative, H.Clark, Adward Arnold.
- Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.

Assessment Process (Internal)

- **Continuous Assessment (CA)= 30 Marks in the form of:-**

  v) Practical file - 10 marks **ii) PracticalPerformane-** 10 marks **iii) Viva-**10 marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	2	**3**	**1**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 4	3	3	2	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: II
Course Title: Coordination Chemistry	Course Code: MPCH-203

Course Description: This course will give an excellent opportunity to study and use knowledge of coordination chemistry. The study will also lead to understand complexation reactions, stability constants, structures, geometrical and optical isomerism, bonding, reactions, magneto-chemistry and reactivity will be discussed. Color and electronic, CFT, atomic spectroscopy, electronic spectra and magnetic properties will be delineated with respect to their application in analytical chemistry, industry and medicine. Use of coordination compounds of some precious metal ions will be explained in relation to homogeneous catalysis for the production of useful organic and pharmaceutically important substances.

Course Outcomes

CO1: Students will explain to bonding in complexes using Moleculer Orbital Theory and The Combination of Atomic Orbitals.

CO2: Chapter electronic spectra will explain splitting of spectroscopic terms, d^1-d^9 systems in weak fields, transitions from weak to strong crystal fields, Tanabe Sugano diagrams and Orgel diagrams.

CO3: Students will able to define Magnetic moment, factors determining paramagnetism, Russell Saunder's coupling, quenching of orbital angular moment, magnetic susceptibility and Van Vlecks formula for magnetic susceptibility.

CO4: Students will understand atomic spectroscopy and coupling of orbital angular momenta and spin angular momenta, spin orbit coupling, spin orbit coupling p^2 case, determination of ground State Terms-Hund's Rule and hole formulation.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	**Metal-Ligand Bonding-I:** Recapitulation of Crystal Field Theory including splitting of *d*- orbitals in different environments, Factors affecting the magnitude of crystal field splitting, structural effects (ionic radii, Jahn-Teller effect), Thermodynamic effects of crystal field theory (ligation, hydration and lattice energy), Limitations of crystal field theory, Adjusted Crystal Field Theory (ACFT), ,*Molecular Orbital Theory* for octahedral, Evidences for Metal-Ligand overlap in complexes, tetrahedral and square planar complexes (excluding mathematical treatment), Factor effecting Lattice energy.	20
2	**Atomic Spectroscopy:** Principle of atomic spectroscopy**,** Energy levels in an atom, coupling of orbital angular momenta, coupling of spin angular momenta, spin orbit coupling, spin orbit coupling p^2 case, Determining the Ground State Terms-Hund's Rule, Hole formulation (derivation of the Term Symbol for a closed sub-shell, derivation of the terms for a d^2 configuration), Calculation of the number of the microstates.	16
3	**Electronic Spectra-I:** Splitting of spectroscopic terms (*s,p,d.f* and *g,h,i*), d^1-d^9 systems in weak fields (excluding mathematics), strong field configurations, transitions from weak to strong crystal fields.	12

	Electronic Spectra-II: Correlation diagrams (d^1-d^9) in O_h and T_d environments spin-cross over in coordination compounds. Tanabe Sugano diagrams, Orgel diagrams, evaluation of B, C and β parameters.	
4	**Magnetochemistry:** Origin of Magnetic moment, factors determining paramagnetism, application of magnetochemistry in co-ordination chemistry (spin only moment, Russell Saunder's coupling, quenching of orbital angular moment, orbital contribution to a magnetic moment) in spin free and spin paired octahedral, tetrahedral complexes. Magnetic susceptibility (diamagnetic, paramagnetic), magnetic moments from magnetic susceptibilities, Van Vlecks formula for magnetic susceptibility, temperature dependence of magnetic susceptibility, Introduction of ferromagnetic, paramagnetic substances.	17

Textbooks

- Comprehensive Coordination Chemistry – Wilkinson, Gillars and McCleverty.
- Inorganic Electronic Spectroscopy – A.B.P.Lever
- Concise Inorganic Chemistry – J.D.Lee
- Introduction to Ligand Fields – B.N.Figgis

Reference Books

- Advanced Inorganic Chemistry – Cotton and Wilkinson
- Coordination Chemistry- Experimental Methods – K.Burger
- Theoretical Inorganic Chemistry – Day and Selbin
- Magnetochemistry – R.L.Carlin
- Physical Methods in Inorganic Chemistry-R.S.Drago
- Introduction to Magnetochemistry – A.Earnshaw, Academic Press.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	2	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 4	3	3	1	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	**Semester: II**
Course Title: Co-ordination Chemistry- lab	**Course Code: MPCH - 253-P**

Course Description: The major goals of the practical courses are to acquire basic chemical laboratory skills and learn the safe manipulation of chemicals and chemical reactions, become skilled in precisely observing and documenting experiments, learn and practice basic chemical principles by performing experiments in inorganic, Organic, co-ordination and Physical Chemistry by yourself. Students will also acquire knowledge pertaining the disposal and recovery of chemicals as well as to gain awareness of environmental protection from a chemical point of view.

Course Outcomes

CO1: Students will able to perform analysis of mixtures by gravimetric and volumetric methods from different mixtures.

CO2: Students will understand & perform green methods of synthesis for Bis(acetylacetonato)copper(II) and Tris(acetylacetonato)iron(III).

CO3: Students will understand the method of green synthesis for the preparation of trisethylenediaminenickel(II)chloride.

CO4: Students will recognize green methods for the synthesis of different compounds and their benefits.

Practical: 60 hr./Sem

Sr No.	**Experiment Title**

1	Analysis of mixtures by gravimetric and volumetric methods from Copper- Nickel
2	Analysis of mixtures by gravimetric and volumetric methods from Copper-Zinc
3	Analysis of mixtures by gravimetric and volumetric methods from Silver-Zinc
4	Analysis of mixtures by gravimetric and volumetric methods from Copper –Magnesium
5	Analysis of mixtures by gravimetric and volumetric methods from Fe(II)-Fe(III)
6	Analysis of mixtures by gravimetric and volumetric methods from Iron-Magnesium
7	Analysis of mixtures by gravimetric and volumetric methods from Copper-Nickel-Zinc
8	**Green methods of Preparation of:** (i) Bis(acetylacetonato)copper(II) (ii) Tris(acetylacetonato)iron(III)
	(iii) Tris(acetylacetonato)manganese(III)
	(iv) trisethylenediaminenickel(II)chloride
	(v) Potassiumdiaquooxalatochromate(III)
	(vi) Vanadyl acetonate ie oxy-bis-(acetylacetonato) Vanadium (IV)

Textbooks

- Applied Analytical Chemistry: Vermani.

Reference books

- A text Book of Quantitative Inorganic Analysis: A.I.Vogal.
- Commercial Methods of Analysis: Shell & Biffen

Assessment Process (Internal)

- **Continuous Assessment (CA)= 30 Marks in the form of:-**

Practical file - 10 marks **ii) Practical Performane-** 10 marks **iii) Viva-**10 marks

Attendance percentage	**Marks**
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**1**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 2	3	3	2	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**1**	**3**
CO 4	3	3	1	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: II
Course Title: Stereochemistry and Thermo -analytical Methods	Course Code: MPCH-204

Course Description: The Stereochemistry Course's syllabus layout is made with full dedication and is incorporated with the latest details about the new invention being done in the pharmaceutical industries. The course starts with providing the student with the basic information about importance of chirality in drugs is explained to the students and what is its need in the upcoming time of the health industry. It will provide knowledge about solution reactions, titrimetric and gravimetric Methods, Mohr's titration, Volhard's titration, adsorption indicators, Fajan's titration, titration curves in oxidation-reduction titration, redox indicators, DTG, DTA, DSC etc.

Course Outcomes

CO1: Students can **r**ecognize and draw structural isomers (constitutional isomers), stereoisomers including enantiomers and diastereomers, racemic mixture, and meso compounds.

CO2: Chapter solution reactions will introduce law of Mass Action, Activity Coefficient, ionic product of water, Electrolytic dissociation, Strengths of acids and bases, Solubility Product, Common ion effect and Complexones.

CO3: Students will know about Solvents in analytical chemistry, buffers, acid-base equilibria, concentration systems, stoichiometic calculation, complexometric titration, metal-ion indicators, Mohr's titration, Volhard's titration, adsorption indicators and Fajan's titration.

CO4: Chapter Thermo -analytical Methods explains about TGA, DTG, DTA, DSC and their instrumentation and working.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	Stereochemistry: Conformational analysis of n-butane and cyclohexane, stability of conformers and energy profile diagram, Optical activity: Criteria for optical activity, stereoisomers, enantiomers and diastereomers, erythro and threo isomers, a general idea of symmetry elements symmetry criteria for optical activity. Racemic Modifications: Conglomerate, racemate and racemic solid solutions, a general idea of stereo selective synthesis. Resolution of Racemic modifications: by Chemical separation, chromatography, preferential crystallization and asymmetric transformation (a brief idea only).Elimination of 2, 3- dibromobutane densyl chloride, SN_2 reactions at chiral carbon, Asymmetric Synthesis: Principle and categories with specific examples of asymmetric synthesis including newer methods involving enzymatic and catalytic reactions, enantio and diastereo selective synthesis.	20
2	Solution reactions: fundamental theory, applications of fundamental theory, The Law of Mass Action, Activity and Activity Coefficient, Factors affecting chemical reactions in solution, The ionic product of water, Electrolytic dissociation, Strengths of acids and bases, Solubility Product, Common ion effect, Effect of acid, temperature and solvent on	12

	the solubility of the precipitate, Complexation, stability of complexes, Complexones	
3	Titrimetric and Gravimetric Methods of Analysis, General principles: Solvents in analytical chemistry, buffers, acid-base equilibria, concentration systems, stoichiometic calculation, acid-base titration, titration curves, acid base indicators, applications of acid-base titration, complexometric titration, metal-ion indicators, precipitation titration, Mohr's titration, Volhard's titration, adsorption indicators, Fajan's titration, titration curves in oxidation-reduction titration, redox indicators, applications of redox titrations.	17
4	Thermo -analytical Methods: Thermogravimetry, theory of thermogravimetry (TG), factors affecting thermogravimetric curves, derivative thermogravimetry (DTG), thermobalances, applications of thermo gravimetry, differential thermal analysis, factors affecting DTA curve, instrumentation, applications of DTA. Differential scanning calorimetry, theory, instrumentation, applications of DSC, thermometric titration, principle, classification, instrumentation and applications of thermometric titration, EGA (evolved gas analysis), Principles of Gravimetric Analysis, Stoichiometry of gravimetric reactions, formation and properties of precipitates, precipitation from homogeneous solution, nucleation, organic precipitations, applications of gravimetric analysis.	16

Textbooks

- A.I. Vogel, Textbook of Quantitative Chemical Analysis, 5th ed., Addison Wesley Longman, Singapore, pvt. Ltd. (1999)
- G. W. Eving, Instrumental Methods of Chemical Analysis, 5th ed., Mc-Graw ,Hill Book Company (1985)

Reference Books

- D.A. Skoog, F.J. Holler and Nieman, Principles of Instrumental Methods, 5th ed., Thomson Asia Pvt. Ltd., Singapore (2003).
- R.A. Day and A.L. Underwood, Quantitative Analysis, 6th ed., Prentice Hall of India Pvt. Ltd. (1993).
- G.D. Christian., Analytical Chemistry, 6th ed, John Wiley & Sons (2000)
- Ernest L. ELiel and Samuel H. Wilen,Stereochemistry of Organic Compounds , John Wiley & Sons (2003).

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3

90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**1**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	1	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 4	3	3	2	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: III
Course Title: Modern Pharmaceutical Analytical Techniques	Course Code: MPCH-301

Course Description: The special feature of M. Sc. Pharmaceutical chemistry (Modern Pharmaceutical Analytical Techniques) Sem.-III is a good foundation of basics and research component through practical and theoretical knowledge, which in turn will provide excellent job prospects in Academics, Industries and other fields of interest. This programme intended to offer a balanced combination of core and applied courses of Chemistry. 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.

Course Outcomes

CO1: Students will be able to interpret UV-Visible & IR spectroscopy and relevant terms of UV-Visible spectroscopy.

CO2: Chapter mass spectroscopy will **i**ntroduce, in an integrated way, the fundamentals, methods, applications and limitations of mass spectrometry. Interpret and correlate the information provided by the various types of mass spectra.

CO3: Students will be able to interpret NMR spectroscopy, basic principles of NMR spectroscopy, sample preparation procedure in NMR spectroscopy, working principles, taking spectrum and outline of NMR spectroscopy device.

CO4: Students will acquire knowledge about principle, instrumentation and application of TGA, DTA, DSC, SEM & TEM.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	**UV-Visible spectroscopy:** Introduction, theory and laws associated with UV-visible spectroscopy, chromophores, auxochromes and their interaction with UV-Vis radiations, choice of solvents and solvent effect, Woodward-Fieser rule for carbonyl compound, and applications of UV-visible spectroscopy. **IR Spectroscopy:** Theory, modes of molecular vibrations, factors affecting vibrational frequencies and applications of IR spectroscopy. FT-IR. Interpretation of IR spectra of organic compounds, combination bands and Fermi resonance.	12
2	**Mass spectrometry:** Different ionization methods (EI, CI, FAB, ESI, MALDI), analyzers of quadrupole and time of flight. Fragmentation patterns and its rules, relative abundance of ions, molecular ion peak, meta stable ions, isotopic peaks, Mc-Lafferty rearrangement, ring rule. Applications of mass spectrometry. Problems based upon IR, UV, NMR and mass spectroscopy. **Flame emission spectroscopy and atomic absorption spectroscopy*:*** Principle, interferences and applications of flame emission spectroscopy and atomic absorption spectroscopy.	20

3	**NMR Spectroscopy:** Principle, chemical shift, factors influencing chemical shift, spin-spin coupling, coupling constant, solvent requirement in NMR, NMR active compounds, free induction decay, relaxation process and NMR signals in various compounds, Nuclear Overhauser Effect (NOE). Applications of NMR spectroscopy, effect of deuteration.	17
4	**Miscellaneous techniques:** ***Thermal methods of analysis:*** Introduction, principle, instrumentation and application of TGA, DTA, SCA and DSC. ***Electron microscopy:*** Principle, instrumentation and applications of scanning electron microscopy (SEM), transmission electron, microscopy (TEM). ***Radioimmuno assay:*** ELISA.	16

Textbooks

- Pavia D.L., Lampman G.M. and Kriz G.S., Introduction to Spectroscopy, Harcourt College Publishers, Philadelphia.
- Kalsi P.S., Spectroscopy of Organic Compounds, New Age International Publishers, New Delhi.

Reference Books

- Pharmacopoeia of India, Ministry of Health, Govt. of India.
- Skoog D.A., Holler F.J., Crouch S. R., Instrumental Analysis, Indian Edition, Brooks/Cole, Boston.
- Willard H.H., Merrit L.L., Dean J.A., Settle P.A., Instrumental Methods of analysis, CBS Publishers and Distributors New Delhi.
- Kemp W., Organic Spectroscopy, Palgrave, New York.
- Becket A.H. and Stenlake J.B., Practical Pharmaceutical Chemistry Vol. I and II, The Athlone Press of the University of London.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	**Marks**
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4

95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	2	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	1	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 4	3	3	1	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: III
Course Title: MODERN PHARMACEUTICAL ANALYTICAL TECHNIQUES LAB-I	Course Code: MPCH-351-P

Course Description: The major goals of the practical courses are to acquire basic chemical laboratory skills and learn the safe manipulation of chemicals and chemical reactions, become skilled in precisely observing and documenting experiments, learn and practice basic chemical principles by performing experiments in inorganic, Organic, pharmaceutical and Physical Chemistry by yourself. Students will understand the medicinal and pharmaceutical importance of inorganic compounds, introduced to a variety of inorganic drug classes, behavioral needs for a Pharmacist to function effectively in the areas of pharmaceutical operation. Students will also acquire knowledge pertaining the disposal and recovery of chemicals as well as to gain awareness of environmental protection from a chemical point of view.

Course Outcomes

CO1: Students will familiar about Separation, purification and identification of binary mixture of organic compounds by IR spectroscopy.

CO2: Students will able to perform thin layer chromatography and column chromatography.

CO3: Students will understand how to determine unknown compound by using UV-Vis spectroscopy.

CO4: Students will be able to perform separation, purification and identification of binary mixture of organic compounds by chemical tests.

Practical: 60 hr./Sem

Sr No.	Experiment Title
1	**Qualitative Analysis:** Separation, purification and identification of binary mixture of organic compounds by
	IR spectroscopy.
2	TLC
3	Column chromatography and
4	Chemical tests
5	Determination of unknown compound by UV-Vis spectroscopy

Textbooks

- Experiments and Techniques in Organic Chemistry, D.Pasto, C. Johnson and M.Miller, Prentice Hall.
- Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C.Heath.

Reference books

- Systematic Qualitative Organic Analysis, H.Middleton, Adward Arnold.

- Handbook of Organic Analysis-Qualitative and Quantitative, H.Clark, Adward Arnold.
- Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley

Assessment Process (Internal)

- **Continuous Assessment (CA)= 30 Marks in the form of:-**

  Practical file - 10 marks **ii) Practical Performane-** 10 marks **iii) Viva-**10 marks

Attendance percentage	**Marks**
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO 1	**3**	**3**	**1**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	1	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 4	3	3	2	**3**	**1**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: III
Course Title: Medicinal Chemistry	Course Code: MPCH - 302

Course Description: This course will provide an in-depth look at how novel, pharmacologically active molecules are designed to treat human diseases. An overview of modern medicinal chemistry, from first principles of drug action to design and development of potential therapeutics, will be presented. The action and behavior of pharmaceutical compounds and the relationship between their structure and their chemical and therapeutic properties and therefore, the chemical considerations in drug design will be explored. Structure activity relationships will be explored through case studies. Methods of drug discovery will be investigated, including the development of drugs from natural products, computer modeling and rational drug design.

Course Outcomes

CO1: This course will explore the process of drug development, from target identification to final drug registration.

CO2: The student would also learn about Systematic study, SAR, mechanism of action and synthesis of adrenergic agents, cholinergic agents, antidepressants, anticonvulsants and psychoactive drugs.

CO3: Students would learn anti-hypertensive drugs, H1 and H2 receptor antagonists, oral hypoglycemic, antineoplastic agents and anti-HIV agents.

CO4: Rational design of enzyme inhibitors Chapter provides knowledge about Enzyme kinetics, principles of enzyme inhibitors, enzyme inhibitors in medicine, artificial enzymes and therapeutic applications of peptidomimetics.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	**Drug discovery:** Stages of drug discovery, lead discovery, identification, validation and diversity of drug targets. Some novel molecular targets along with their pharmacodynamic agents: Polyketide synthase (Pks13), signal transducer and activator of transcription-3 (STAT-3) and sodium glucose cotransporter-2 (SGLT-2). **Stereochemistry and drug action:** Pharmacodynamic, pharmacokinetic (drug adsorption, metabolism, distribution and elimination) and toxicological aspects of stereoisomers (Geometrical, optical and conformational), Significance of drug metabolism in medicinal chemistry.	20
2	**Prodrug design**: Basic concepts, prodrugs of functional group, rationale and practical consideration of prodrug design. Rational versus analog approach of drug design. Elementary treatment of drug receptor interactions, Chemical parameters: lipophilicity, partition coefficient, electronic ionization constants. **Combating drug resistance:** Causes for drug resistance, strategies to combat drug resistance in antibiotics therapy, Hansch analysis, Genetic principles of drug resistance.	17

3	Systematic study, SAR, mechanism of action and synthesis (synthesis of individually mentioned drugs only) of new generation molecules of following classes: Adrenergic agents (Celiprolol, Olodaterol), cholinergic agents (Sazetidine-A), antidepressants (Vortioxetine, Levomilnacipram), anticonvulsants (Levetiracetam, Perampanel) and psychoactive drugs (Brexpiperazole, Iloperidone). Concepts of drug receptors. Sulfonamide inhibition and probable mechanisms of bacterial resistance to sulfonamides.	12
4	Systematic study, SAR, Mechanism of action and synthesis (synthesis of individually mentioned drugs only) of new generation molecules of following classes: Anti-hypertensive drugs (Cilazapril, Saprisartan), H1 and H2 receptor antagonists (Dimetindene, Olopatadine, Lafutidine), oral hypoglycemic (Omargliptin, Dulaglutide), antineoplastic agents (Alectinib, Capacitabine) and anti-HIV agents (Dolutegravir, Elvitegravir),partition coefficient, Free-Wilson analysis.	8
5	**Rational design of enzyme inhibitors:** Enzyme kinetics and principles of enzyme inhibitors,enzyme inhibitors in medicine, rational design of non-covalently and covalently binding enzymeinhibitors. Introduction to artificial enzymes. Introduction, design and therapeutic applications of peptidomimetics, elementary treatment of enzyme stimulation, chloroquin and primaquin.	8

Textbooks

- Abraham D.J., Burger's Medicinal Chemistry and Drug Discovery, John Wiley and Sons Inc., New York.
- Block J.H. and Beale J.M., Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins, Philadelphia.
- Lemke T.L., Williams D.A., Roche V.F. and Zito S.W., Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins, Philadelphia.

Reference Books

- Vardanyan R.S. and Hruby V.J., Synthesis of Essential Drugs, Elsevier, Philadelphia.
- Nogrady T., Medicinal Chemistry: A Biochemical Approach, Oxford University Press, New York.
- Patrick G.L., An Introduction to Medicinal Chemistry, Oxford University Press, New York.
- Hansch C., Comprehensive Medicinal Chemistry, Pergamon Press, Oxford.
- Thomas G., Fundamentals of Medical Chemistry, Wiley Publication, New Jersey.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**

  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	Marks
Below 75%	0
75% - 80%	1

80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**2**	**3**	**1**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	2	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	1	**1**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 4	3	3	2	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	**Semester:III**
Course Title: Medicinal chemistry Lab	**Course Code: MPCH-352-P**

Course Description: This course will provide knowledge of the connection between the structural features of the drugs and their physico-chemical characteristics, mechanism of action, use and application the gained knowledge about the therapeutic classes of drugs. The major goals of the practical courses are to acquire basic chemical laboratory skills and learn the safe manipulation of chemicals and chemical reactions, become skilled in precisely observing and documenting experiments, learn and practice basic chemical principles by performing experiments in inorganic, Organic, and Physical Chemistry by yourself. Students will also acquire knowledge pertaining the disposal and recovery of chemicals as well as to gain awareness of environmental protection from a chemical point of view.

Course Outcomes

CO1: Students can synthesize Benzimidazole from o-phenylenediamine.

CO2: The students will become familiar about synthesis ethyl p-amino benzoate (benzocaine) from p-amino benzoic acid.

CO3: Students will be able to perform preparation of phenytoin from benzyl and urea.

CO4: Students will be able to understand methods used to prepare barbituric acid from urea and diethyl malonate.

Practical: 60 hr./Sem

Sr No.	Experiment Title
1	To synthesize Benzimidazole from o-phenylenediamine.
2	To synthesize ethyl p-amino benzoate (benzocaine) from p-amino benzoic acid.
3	To prepare phenytoin from benzyl and urea.
4	To prepare barbituric acid from urea and diethyl malonate.

Textbooks

- Hansch C., Comprehensive Medicinal Chemistry, Pergamon Press, Oxford.
- Thomas G., Fundamentals of Medical Chemistry, Wiley Publication, New Jersey.

Reference books

- Block J.H. and Beale J.M., Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams and Wilkins, Philadelphia.
- Lemke T.L., Williams D.A., Roche V.F. and Zito S.W., Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins, Philadelphia.

Assessment Process (Internal)

- **Continuous Assessment (CA)= 30 Marks in the form of:-**

  Practical file - 10 marks **ii) Practical Performane-** 10 marks **iii) Viva-**10 marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4

CO 1	**3**	**3**	**1**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	2	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 4	3	3	1	**3**	**1**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: III
Course Title: Environmental Biotechnology	Course Code: MPCH-303

Course Description: The course is an introduction to environmental biotechnology and focuses on the utilization of microbial processes in waste and water treatment, and bioremediation. Topics included are microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, bio mineralization, microbial ecology, approaches for studying microbial communities and basic principles in bioremediation and biological water and waste treatment.

Course Outcomes

CO1: This course includes several topics pertaining with solutions to certain difficult environmental problems such as gene-environment interaction, detection of pollutants, elimination and treatment of toxic wastes, development of environment friendly products and improved energy sources.

CO2: Course will empower students to acquire values and attitudes towards understanding complex environmental-economic, social challenges and participating actively in solving current environmental problems and preventing the future ones.

CO3: To apply the knowledge of mathematics, science, and engineering for effective solid waste collection systems, for waste collection route optimization and for processing of solid waste.

CO4: Unit Bio mineralization imparts knowledge about decontamination process of heavy metal bearing wastes, environmental biocatalysis and degradation of xenobiotics, biomediation and phytoremediation.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	Environment: Basic concepts and issues. Environment pollution: Types, Methods for measurement of pollution. Soil pollution, marine pollution, water pollution, air Pollution: Its impact, assessment and control through biotechnology. Water pollution: Its effect, control molecular methods for wastewater monitoring and its treatment (physical, chemical and biological processes). oxides of C,N,S and their effects.	12
2	Microbial waste treatment: Aerobic processes-activated sludge, trickling Filters, aerated lagoons, Oxidation ponds. Anaerobic Processes: Biodegradation methods viz. anaerobic lagoons, up flow anaerobic sludge blanket reactor. Cleaner technologies: Fermentation, paper and plastic industry, Reducing environment impact of industrial effluents. Solid waste treatment: Composting process- Types, parameters and its aim, Vermicomposting and its advantages and limitations, waste water treatment, domestic waste water (aerobic and anaerobic treatment), and industrial waste water treatment.	20
3	Biomedical waste and its management. Non-conventional energy sources: Biofuels-Biogas, Biodiesel etc. Biopesticides: Impact of biopesticides and its limitations, integrated pest management (IPM) – An ecological approach. Environmental monitoring: Bioindicators, Conservation of biodiversity.	8
4	Biomineralization: A decontamination process of heavy metal bearing wastes. Environmental biocatalysis: Degradation of xenobiotics, degradation pathway, genetic	8

	basis and mechanism of genetic adaptation. Biomediation: *Insitu* and *Exsitu* techniques, advantages of bioremediation, applications of genetically engineered microbes (GEM) in bioremediation. Phytoremediation: Types and its applications. Hot-spot of biodiversity.	
5	Hazardous waste management. Basic concepts of Environmental Impact Assessment (EIA). Global Environment problems: Ozone depletion, UV-B, Greenhouse effect, acid rain and its effects, their impact and biotechnology approaches for management, Agenda 21. Restoration of waste land / degraded ecosystem, analytical methods for monitoring air pollution.	17

Textbooks

- Environmental Biotechnology; Theory and Applications; G M Evans and J. C. Furlong.
- Environmental Biotechnologies and Cleaner Bioprocess by Eugenia J Olguuin et al.
- Industrial water pollution control by W. Wesley Eckenfelder Jr.

Reference Books

- . Wastewater Engineering Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi.
- Comprehensive Biotechnology. Vol. 4, M. Moo-Young (Ed-in-chief), Pergmon Press, Oxford.
- Environmental Chemistry, A. K. De, Wiley Eastern Ltd., New Delhi.
- Introduction to Biodeterioration, D. Allsopp and Seal, ELBS / Edward Arnold.
- Environmental Science Physical Principles and applications by Egbert Boeker et al.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**
  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**0**	**0**	**0**	**2**	**1**	**2**	**2**	**2**	**0**	**3**	**0**	**0**	**0**	**1**	**0**	**0**
CO 2	0	0	0	**2**	**1**	**2**	**2**	**2**	0	**3**	**0**	**0**	**0**	**1**	**0**	**0**
CO 3	0	0	0	**2**	**1**	**2**	**1**	**2**	0	**3**	**0**	**0**	**0**	**2**	**0**	**0**
CO 4	0	0	0	**1**	**1**	**2**	**1**	**1**	0	**3**	**0**	**0**	**0**	**2**	**0**	**0**

Program: M.Sc. Pharmaceutical Chemistry	Semester: III
Course Title: Drug Delivery System& Biopharmaceutics	Course Code: MPCH - 304

Course Description:

Drug Delivery System& Biopharmaceutics gives knowledge about drug delivery systms including drug development, regulation, absorption and desorption routes of administration and dosage forms, controlled drug release etc. This course offers a unique way for professionals to learn about cutting-edge drug delivery systems and approaches that can be used in the treatment and prevention of disease. Biopharmaceutics is a field that has emerged out of the intersection of biotechnology and pharmaceutics. Both biotechnology and pharmaceutics have a great scope and tremendous potential for future growth. It has a very innovation-friendly environment that engages in not only production but also the creation of new pharmaceuticals, therapeutics and enzymes.
The pharma and allied industries in foreign countries enjoy even more prominence and open up a large number of opportunities for the students of biopharmaceutics courses. Many companies, big and small, have been emerging with a wide array of research-based innovations.

Course Outcomes

CO1: Student shall understand the chemistry of drugs with respect to their pharmacological activity.

CO2: Students will **k**now the Structural Activity Relationship of different class of drugs.

CO3: Chapter controlled release drug delivery system explain the drug metabolic pathways, adverse effect and therapeutic value of drugs.

CO4: Students can study the chemical synthesis of selected drugs like liposomes, neosomes, nanoparticles, Resealed erythrocytes.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	Types, advantages, disadvantages & formulation and evaluation/quality control of oral dosage forms including: a) Liquid dosage forms like solution, syrups, suspension & emulsion. b) Solid dosage forms like tablets, capsules etc. c) Semisolid dosage like ointment, cream, gels.	12
2	**Parenteral drug delivery system:** Preparation, Evaluation and quality control. Quantitative structure activity relationship. A brief introduction to new approach such as liposomes, neosomes, nanoparticles, Resealed erythrocytes as novel parenteral drug delivery. Free-Wilson analysis	16
3	**Controlled release drug delivery system.** Advantages, drug properties relevant of controlled release formulation. Oral dosage form: diffusion system, dissolution system, osmotic pump ion exchange resin & prodrug.	17

	Parenteral dosage form: Intramuscular injection & implants, local antiinfective drugs: Introduction and general mode of action. Examples: sulphonamides, furazolidone, nalidixic acid, acetamide, Mafenide related compounds .	
4	**Drug absorption:** factors affecting drug absorption including physicochemical, biological and Pharmaceutical, Passive and active diffusion, Drug disposition: Distribution in blood, plasma protein binding, cellular distribution, drug excertion, biotransformation of drugs, Bioavailability: Concept of bioavailability & comparative bioavailability, methods of estimation of bioavailability, bioequivalence studies. Central Nervous System Stimulants Central Nervous System Stimulants: Strychnine, Purines, Phenylethylamine, analeptics, Indole.	20

Textbooks

- Pharmacokinetics-Gibaldi M. & Perrier, D., 2nd ed., Marcel Dekker, New York, 1982.
- Biopharmaceutcs and Pharmacokinetics- Notrari, R.E., 2nd ed., marcel Dekker, New York, 1975.

Reference Books

- Remington's Pharmaceutical Sciences-Gennaro A.R., ed., 19th Edition, Mack Publishing co., Easton, PA. 1995.
- Leon Lachman, Herbert A, Lieberman, Joseph L. Kanig; The Theory & Practice of Industrial Pharmacy; 3rd ed . 1987
- B. M. Mithal, A text book of pharmaceutical formulation, 6th edition, Vallabh prakashan
- Fundamentals of Clinical Pharmacokinetics-Wagner, J.C., Drug Intelligence Publication, M. Hamilton, 1975.
- Clinical Pharmacokinetics-Rowland, M, & Tozer, N., 2nd edition, Lea & Febiger, Philadelphia, 1989.
- Biopharmaceutcs and Pharmacokinetics: Bramhankar & Jaiswal.

Assessment Process (Internal)

Internal assessment = 60 Marks

- **Mid-Term Exams (MSE) = 40 Marks**
- **Continuous Assessment (CA)= 20 Marks in the form of:-**
  (i) Assignments = 15 Marks (ii) Attendance = 05 Marks

Attendance percentage	Marks
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4

95% - 100%	5

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	2	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 4	3	3	2	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: III
Course Title: Pharmacokinetics Practical - Lab	Course Code: MPCH-353 - P

Course Description: Students will understand the medicinal and pharmaceutical importance of inorganic compounds, introduced to a variety of inorganic drug classes, behavioural needs for a Pharmacist to function effectively in the areas of pharmaceutical operation. The major goals of the practical courses are to acquire basic chemical laboratory skills and learn the safe manipulation of chemicals and chemical reactions, become skilled in precisely observing and documenting experiments, learn and practice basic chemical principles by performing experiments in inorganic, Organic, and Physical Chemistry by yourself. Students will also acquire knowledge pertaining the disposal and recovery of chemicals as well as to gain awareness of environmental protection from a chemical point of view.

Course Outcomes

CO1: Students would study In-vitro dissolution study of compressed tablet and release tablet.

CO2: Students can determine partition coefficient and dissociation constant of ibuprofen.

CO3: Students can determine protein binding using equilibrium dialysis method.

CO4: Students get insight to design and evaluate transdermal patches containing diclofenac sodium.

CO5: Students can evaluate modelling of drug release from delivery system using kinetics software.

Practical: 60 hr./Sem

Sr No.	Experiment Title
1	Invitro Dissolution study of compressed tablet
2	In-vitro dissolution study of marketed sustained Release tablet
3	Determination of partition coefficient and dissociation constant
4	Determination of partition coefficient and dissociation constant of ibuprofen
5	protein binding study using dynamic dialysis method
6	Determination of protein binding using equilibrium dialysis method
7	Formulation and evaluation of transdermal patches of ibuprofen
8	Determination of release for kinetics for the dissolution data
9	design and evaluation of transdermal patches containing diclofenac sodium
10	Modelling of drug release from delivery system using kinetics software

Textbooks

- B. M. Mithal, A text book of pharmaceutical formulation, 6th edition, Vallabh prakashan

- Fundamentals of Clinical Pharmacokinetics-Wagner, J.C., Drug Intelligence Publication, M. Hamilton, 1975.
- **Reference books**
- B. M. Mithal, A text book of pharmaceutical formulation, 6th edition, Vallabh prakashan
- Fundamentals of Clinical Pharmacokinetics-Wagner, J.C., Drug Intelligence Publication, M. Hamilton, 1975.

Assessment Process (Internal)

- **Continuous Assessment (CA)= 30 Marks in the form of:-**

Practical file - 10 marks **ii) Practical Performane-** 10 marks **iii) Viva-**10 marks

Attendance percentage	**Marks**
Below75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO 1	**3**	**3**	**2**	**3**	**1**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	2	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 3	3	3	1	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**
CO 4	3	3	1	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**

Program: M.Sc. Pharmaceutical Chemistry	Semester: IV
Course Title: Pharmaceutical process chemistry	Course Code: MPCH-401

Course Description: Process chemistry is the arm of pharmaceutical chemistry concerned with the development and optimization of a synthetic scheme and pilot plant procedure to manufacture compounds for the drug development phase. The industrial laboratory environment has gone through a major transformation in the industrial process chemistry. In order to discover and develop robust and efficient syntheses and processes for a pharmaceutical portfolio with growing synthetic complexity and increased regulatory expectations, the round-bottom flask and other conventional equipment familiar to a traditional organic chemistry laboratory are being replaced.Processchemistryisdistinguishedfrom medicinal chemistry,which is the arm of pharmaceutical chemistry tasked with designing and synthesizing molecules on small scale in the early drug discovery phase. Process chemists are tasked with identifying a chemical process that is safe, cost and labor efficient, "green," and reproducible, among other considerations.

Course Outcomes

CO1: Process chemistry introduces stages of scale up process including bench, pilot and large scale process.

CO2: Students would understand genotoxic impurities, Isolation, characterization and profiling of impurities in APIs and Reaction progress kinetic analysis.

CO3: Students can find out about unit processes like Nitration: Nitrating agents, process equipment for technical nitration. Halogenation, Reduction and oxidation in detail.

CO4: Chapter Fermentation would make student aware about aerobic and anaerobic fermentation production of Antibiotics (Penicillin and Streptomycin), Vitamins (B2 and B12) and Statins (Lovastatin).

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	Process chemistry: Introduction, properties , Importance of process chemistry ,stages of scale up process: Bench, pilot and large scale process with at least two examples	16
2	Impurities in API and their types including genotoxic impurities, Isolation, characterization and profiling of impurities in APIs with at least one example. Reaction progress kinetic analysis: Streamlining reaction steps, route selection, characteristics of expedient and cost-effective routes, reagent selection. Active pharmaceutical ingredients.	17
3	Unit Processes: The following unit processes should be studied with mechanism and with example of each process-Nitration: Nitrating agents, process equipment for technical nitration. Halogenation: Types of halogenations, some reactions of halogenation catalytic halogenations. Reduction: Catalytic hydrogenation, hydrogen transfer reactions, metal hydrides. Oxidation: Types of oxidative reactions, examples of oxidative reactions and nonmetallic oxidizing agents such as H, sodium hypochlorite, oxygen gas, ozonolysis.	20
4	**Fermentation**: Aerobic and anaerobic fermentation. Production of **a)** ***Antibiotics:*** Penicillin and Streptomycin. **b)** ***Vitamins:*** B2 and B12. **c)** ***Statins:*** Lovastatin, biological	12

	action of antibiotics.	

Textbooks

- Brittain H.G., and Fiese E.F., Effects of Pharmaceutical Processing on Drug Polymorphs and Solvates. (In Brittain H.G., Ed. Polymorphism in Pharmaceutical Solids) Vol. 95: Drugs and the Pharmaceutical Sciences, Marcel Dekker, New York.
- Murphy R.M., Introduction to Chemical Processes: Principles, Analysis, Synthesis, McGraw-Hill

Reference Books

- Burger A., A Guide to the Chemical Basis of Drug Design, Volume 1-8, Wiley Interscience Publication (John
- Wiley & Sons), New York.
- Sharma A.M., Safety and Health in Industry A Handbook, BS Publications Hyderabaad. Pharmaceutical Manufacturing Encyclopedia, Volume 2.
- Gadamasetti K., Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever-ChangingClimate-An Overview, Vol-2, CRC Press, London.

Assessment Process (Internal)

Internal assessment = 60 Marks

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CO-PO Mapping

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CO	**3**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**1**	**3**	**3**	**3**	**2**	**3**

1																
CO 2	3	3	1	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	2	**1**	**2**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 4	3	3	1	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**1**	**3**	**3**	**3**	**1**	**3**

Program: M.sc. Pharmaceutical Chemistry	Semester: IV
Course Title: Chemistry of Natural Products	Course Code: MPCH-402

Course Description: The special feature of M.Sc Pharmaceutical chemistry (Natural Product) Sem.-IV is a good foundation of basics and research component through practical and theoretical knowledge, which in turn will provide excellent job prospects in Academics, Industries and other fields of interest. This course will focus on the medical and nutritional applications of natural products and be organized on the basis of the biosynthetic pathways that lead to these natural organic compounds. The course is meant to complement other courses in the curriculum, principally chemical ecology and pharmaceutical chemistry This course will provide competence to tackle frontier area in terpenoids, alkanoids, steroids and Carotenoids and Xanthophylls, plant pigments etc.

The course and syllabus are designed in such a manner that the students become expertise in the structural diversity of organic molecules produced in nature is matched only by the range of their biological activities and applications: poisons, painkillers, anticancer and antiviral drugs, insecticides, herbicides and stimulants. An understanding of and the ability to apply the fundamentals of environment role and biological processes to the interpretation and evaluation of scientific data.

Course Outcomes

CO1: Students would learn the different types of alkaloids, glycosides & terpenes etc and their chemistry and medicinal importance.

CO2: Students would understand isolation, purification and characterization of simple chemical constituents from the natural source.

CO3: This course also explain the importance of natural compounds as lead molecules for new drug discovery.

CO4: Able to understand the importance of natural products in drug development and to look for various strategies used to have drug leads from various classes of natural products.

CO5: Able to use synthetic methodology to develop better lead compounds of various classes of natural products.

Theory: **65 hr./Sem**

Unit	Topic	Hours
1	**Terpenoids:** Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, biosynthesis and synthesis of the following representative molecules: Monoterpenoids: Citral, geraniol (acyclic), α-terpeneol, menthol (monocyclic). Sesquiterpenoids: Farnesol (acyclic), zingiberene (monocyclic), santonin(bicyclic), Diterpenoids: Phytol and abietic acid. Pharmacokinetics: Introduction to drug absorption, disposition, elimination using pharmacokinetics.	16
2	**Carotenoids and Xanthophylls:** General methods of structure determination of Carotenes: β- carotene, α- carotene, γ- carotene, lycopene and vitamin A. Xanthophylls: Spirilloxanthin, Capsorubin, Fucoxanthin. Carotenoid acids (Apocarotenoids): Bixin and Crocetin. Bio synthesis of carotenoids **Plant Pigments:** Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of Anthocyanins	17

	(Cyanin and pelargonidin), polyphenols: Flavones (chrysin), Flavonols (quercitin) and isoflavones (daidzein) coumarin, Quinones (lapachol), Hirsutidin. Biosynthesis of flavonoids: Acetate pathway and Shikimic acid pathway.	
3	**Alkaloids:** Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, synthesis and biosynthesis of the following: Ephedrine , Coniine, Nicotine, Atropine, Quinine and Morphine. **Steroids:** Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry.Isolation, structure determination and synthesis of Cholesterol, Androsterone, Testosterone, Estrone, Progestrone. Biosynthesis of steroids. Theories of drug activity: occupancy theory, rate theory.	20
4	Study of natural products as leads for new pharmaceuticals for the following class of drugs: **a) Drugs affecting the central nervous system:** Morphine alkaloids. Analeptics, Indole ethylamine derivatives. **b) Anticancer drugs:** Paclitaxel and Etoposide, Hydroxyurea, Amsacrine, Platinum-based drugs. **c) Cardiovascular drugs:** Teprotide and Dicoumarol. **d) Neuromuscular blocking drugs:** Curare alkaloids.	12

Textbooks

- Rohm, B.A. Introduction to Flavonoids, Harwood Academic Publishers.
- Dev, Sukh Insecticides of Natural Origin, CRC Press 1997.
- Mann, J.; Davidson, R.S.; Hobbs, J.B.; Banthrope, D.V.; Harborne, J.B. Natural Products: Chemistry and Biological Significance, Longman, Essex1994

Reference Books

- Finar, I.L. Organic Chemistry, Vol. 2, 5th edition, ELBS, 1975.
- Hostettmann, Kurt; Gupta, M.P.; Marston, A. Chemistry, Biological andPharmacological Properties of Medicinal Plants from the Americas, Harwood Academic Publishers, CRC Press 1999.

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	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO 1	**3**	**3**	**1**	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO 2	3	3	2	**3**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 3	3	3	1	**1**	**2**	**1**	**3**	**1**	**0**	**3**	**2**	**3**	**3**	**3**	**1**	**3**
CO 4	3	3	2	**3**	**1**	**1**	**3**	**2**	**0**	**3**	**2**	**3**	**3**	**3**	**2**	**3**