Department of Pharmacy

Programme: Master of Pharmacy (Pharmaceutical Chemistry)

Central University of Rajasthan
NH-8, Bandarsindri,
Kishangarh-305817, Dist. Ajmer

Department of Pharmacy
Central University of Rajasthan

Master of Pharmacy (Pharmaceutical Chemistry)

Vision of the Department

To be a centre of excellence in the domain of pharmaceutical teaching and research, and to train the young minds to meet the changing needs of pharmaceutical sector. .

Mission of the Department

MS1. To train the students to recognize the professional needs of the profession and community and carry out professional obligations ethically and in keeping with the objectives of the National Health Policy / National Drug Policy;

MS2. The pass-outs should have mastered most of the competencies pertaining to the speciality that are required to be practiced in the various facets of pharmacy profession;

MS3. The students should be aware of the contemporary advances and developments in the discipline concerned;

MS4. The students should have acquired a spirit of scientific inquiry and are oriented to the principles of research methodology;

MS5. The students should have acquired the basic skills in teaching of the pharmacy and other health professionals

2. Qualification descriptors for Master of Pharmacy

The qualification descriptors for Master of Pharmacy programme in the Department of Pharmacy may include the following:

QD1. Demonstrate (i) Comprehensive knowledge and understanding of the principle, underlying concepts and experimental finding in Pharmaceutical Sciences, its different learning areas and applications, and its linkages with related disciplinary areas/subjects; (ii) know-how about different types of professionals related to Pharmaceutical Sciences, including research and development, teaching and government and public service and pharmaceutical industry; (iii) skills in areas of Pharmaceutical Sciences and its subfields and current developments in the academic field.

QD2. Implement knowledge, understanding and skills for critical assessment of wide range of ideas; identifying problems and issues relating to Pharmaceutical Sciences.

QD3. Connect the results of studies undertaken accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s);

QD4. Satisfy the learning needs, drawing on a range of current research and development work and professional materials;

QD5. Showcase subject knowledge and transferable skills to new/unfamiliar contexts to identify and analyse problems and issues and solve complex problems with appropriate solutions.

QD6. Exhibit subject-related and transferable skills that are relevant to Pharmaceutical Sciences-related job trades and employment opportunities

Mapping Qualification Descriptors (QDs) with Mission Statement (MS)

	MS1	MS2	MS3	MS4	MS5
Q1	3	3	3	3	3
QD2	3	3	2	3	3
QD3	3	3	3	2	3
QD4	3	3	3	3	3
QD5	3	2	3	3	3
QD6	3	3	3	3	3

3= High level mapping; 2=Medium level mapping and 1=Low-level mapping

Programme learning outcomes (PLOs) related to Master of Pharmacy

Master of Pharmacy (Pharmaceutical Chemistry)

The programme learning outcomes relating to Master of Pharmacy in Pharmaceutical Chemistry include the following:

PLO1. Demonstrate(i) in-depth knowledge and understanding concepts, principles and processes underlying the academic field of Pharmaceutical Chemistry,and its linkages with interdisciplinary areas/subjects; (ii) procedural knowledge that creates different types of professionals in the field of Pharmaceutical Chemistryand related domains of pharmacy discipline etc.; (iii) skills related to specialisation areas within Pharmaceutical Chemistryas well as within subfields of Pharmacy.

PLO2. Understanding of the principles of drug identification, characterization and estimation techniques and implement the know-how for academia and industry.

PLO3. Discovery, design and synthesis of bioactives/natural isolates, drugs and pharmaceuticals. Understanding of underlying methodologies in order to conduct the required chemical synthesis, extraction and analysis and apply relevant knowledge and skill to seek solution to problems related to pharmaceutical chemistry as well as from allied streams.

PLO4. Training on the computer-aided drug design aspects, resulting in prediction of biological activities, physicochemical properties of molecules, the knowledge gained can be implemented to synthesize the receptor/biological-target driven synthesis of pharmacologically active molecules.

PLO5. Undertake hands on lab work and practical activities which develop problem solving abilities required for successful career in pharmaceuticaland chemical industry, teaching, research, consumer goods industry, food products, cosmetics industry, analytical laboratories etc.

PLO6. Use of regulations pertinent to academia and pharmaceutical industries, generic and professional skills, global competencies including knowledge and skills that enable students to undertake further studies/employment/entrepreneurship in the field of pharmaceutical chemistry.

PLO7. Strengthening of speaking and discussion skills, develop general computer proficiency, group discussions and personality development. Skills related to scientific publications and their framing, analysis to identify promising new directions and apply in academic, industrial, economic, environmental and social context.

PLO8. Able to carry out substantial research-based project leading to findings, conclusion and recommendation arising from theproject; and to develop critical thinking and acquire leadership skills so as to handle the scientific research project independently

Mapping of PLOs with QDs for M. Pharm. (Pharm. Chem.)

	QD1	QD2	QD3	QD4	QD5	QD6
PLO1	3	3	3	2	3	3
PLO2	3	3	3	2	3	3
PLO3	3	3	3	2	3	3
PLO4	3	3	3	2	3	3
PLO5	3	3	3	3	2	
PLO6	3	3	3	3	2	
PLO7	3	3	3	3	2	
PLO8	3	3	3	3	3	

3= High level mapping; 2=Medium level mapping and 1=Low-level mapping

SEMESTER WISE DISTRIBUTION OF THE COURSES

Semester I

Code	Title of Course	Type of Course	Credit
MPC101T	Modern Pharmaceutical Analytical Techniques	DE	4
MPC102T	Advanced Organic Chemistry -I	C	4
MPC103T	Advanced Medicinal Chemistry	C	4
MPC104T	Chemistry of Natural Products	C	4
MPC105P	Pharmaceutical Chemistry Practical I	Lab	6
MPC106S	Seminar/Assignment	DE	2

Total Credit: 24

C-Core Courses; DE-Discipline Elective Course; E-Elective Course

Semester II

Code	Title of Course	Type of Course	Credit
MPC201T	Advanced Spectral Analysis	C	4
MPC202T	Advanced Organic Chemistry -II	C	4
MPC203T	Computer Aided Drug Design	C	4
MPC204T	Pharmaceutical Process Chemistry	C	4
MPC205P	Pharmaceutical Chemistry Practical II	Lab	6
MPC206S	Seminar/Assignment	DE	2

Total Credit: 24

C-Core Courses; DE-Discipline Elective Course; E-Elective Course

Semester III

Code	Title of Course	Type of Course	Credit
MRM 301T	Research Methodology and Biostatistics	E	4
MPC302JC	Journal club	DE	2
MPC303PP	Discussion / Presentation (Proposal Presentation)	C	4
MPC304RW	Research Work	C	14

C-Core Courses; DE-Discipline Elective Course; E-Elective Course

Total Credit: 24

Semester IV

Code	Title of Course	Type of Course	Credit
MPC401JC	Journal Club	DE	2
MPC402RW	Research Work	C	18
MPC403FP	Discussion/Final Presentation	C	4

C-Core Courses; DE-Discipline Elective Course; E-Elective Course; S-Societal Course
Total Credit: 24

Summary:

Semester	No. of Courses	Credits
I	**6**	**24**
II	**6**	**24**
III	**4**	**24**
IV	**3**	**24**
Total	**18**	**96**

Course-level learning outcomes to Master of Pharmacy in Pharmaceutical Chemistry

MPC 101T: Modern Pharmaceutical Analytical Techniques

Course Learning Objectives (CLOs) are indicated below:

CLO1. Understanding theory, instrumentation applications of spectroscopic techniques like UV, IR, Raman, NMR, ESR, Mass, X-ray spectroscopy
CLO2. Pharmaceutical applications of various thermo gravimetric, chromatographic and electrophoresis techniques
CLO3. Concepts of Optical Rotatory dispersion and Circular Dichroism and their applications.
CLO4. Spectral analysis of Chemicals and Excipients
CLO5. The analysis of various drugs in single and combination dosage forms
CLO6. Theoretical and practical skills of the instruments
CLO7. The analysis of various APIs, chemicals and analysis of various drugs in single and combination dosage form
CLO8. Theoretical and practical skills of the commonly used analytical instruments

Mapping of CLOs with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3			3	3		3
CLO2	3	3			3	3		3
CLO3	3	3			3	3		3
CLO4	3	3			3	3		3
CLO5	3	3			3	3		3
CLO6	3	3			3	3		3
CLO7	3	3			3	3		3
CLO8	3	3			3	3		3

Detailed Syllabus:

Unit	Details	Contact Hours
I	a. UV-Visible spectroscopy: Introduction, Theory, Laws,Instrumentation associated with UV-Visible spectroscopy, Choiceof solvents and solvent effect and Applications of UV-Visiblespectroscopy, Difference/ Derivative spectroscopy. b. IR spectroscopy: Theory, Modes of Molecular vibrations,Sample handling, Instrumentation of Dispersive and Fourier -Transform IR Spectrometer, Factors affecting vibrationalfrequencies and Applications of IR spectroscopy, DataInterpretation. c. Spectroflourimetry: Theory of Fluorescence, Factors affectingfluorescence (Characteristics of drugs that can be analysed byflourimetry), Quenchers, Instrumentation and Applications offluorescence spectrophotometer. d. Flame emission spectroscopy and Atomic absorptionspectroscopy: Principle, Instrumentation, Interferences andApplications.	10
II	NMR spectroscopy: Quantum numbers and their role in NMR,Principle, Instrumentation, Solvent requirement in NMR,Relaxation process, NMR signals in various compounds,Chemical shift, Factors influencing chemical shift, Spin-Spincoupling, Coupling constant, Nuclear magnetic double resonance,Brief outline of principles of FT-NMR and 13C NMR. Applicationsof NMR spectroscopy.	10
III	Mass Spectroscopy: Principle, Theory, Instrumentation of MassSpectroscopy, Different types of ionization like electron impact,chemical, field, FAB and MALDI, APCI, ESI, APPI Analyzers ofQuadrupole and Time of Flight, Mass fragmentation and its rules,Meta stable ions, Isotopic peaks and Applications of Massspectroscopy.	10
IV	Chromatography: Principle, apparatus, instrumentation,chromatographic parameters, factors affecting resolution, isolationof drug from excipients, data interpretation and applications of thefollowing: a) Thin Layer chromatography b) High Performance Thin Layer Chromatography c) Ion exchange chromatography d) Column chromatography	10

	e) Gas chromatography f) High Performance Liquid chromatography g) Ultra High Performance Liquid chromatography h) Affinity chromatography i) Gel Chromatography	
V	a. Electrophoresis: Principle, Instrumentation, Workingconditions, factors affecting separation and applications of thefollowing: a) Paper electrophoresis b) Gel electrophoresis c) Capillaryelectrophoresis d) Zone electrophoresis e) Moving boundaryelectrophoresis f) Iso electric focusing b. X ray Crystallography: Production of X rays, Different X raymethods, Bragg's law, Rotating crystal technique, X ray powdertechnique, Types of crystals and applications of X-ray diffraction.	10
VI	a. Potentiometry: Principle, working, Ion selective Electrodesand Application of potentiometry. b. Thermal Techniques: Principle, thermal transitions andInstrumentation (Heat flux and power-compensation and designs),Modulated DSC, Hyper DSC, experimental parameters (samplepreparation, experimental conditions, calibration, heating andcooling rates, resolution, source of errors) and their influence,advantage and disadvantages, pharmaceutical applications.Differential Thermal Analysis (DTA): Principle, instrumentationand advantage and disadvantages, pharmaceutical applications,derivative differential thermal analysis (DDTA). TGA: Principle,instrumentation, factors affecting results, advantage anddisadvantages, pharmaceutical applications.	10

Suggested Readings

1.Spectrometric Identification of Organic compounds - Robert M Silverstein,Sixth edition, John Wiley & Sons, 2004.
2. Principles of Instrumental Analysis - Doglas A Skoog, F. James Holler,Timothy A. Nieman, 5th edition, Eastern press, Bangalore, 1998.
3. Instrumental methods of analysis – Willards, 7th edition, CBS publishers.
4. Practical Pharmaceutical Chemistry – Beckett and Stenlake, Vol II, 4thedition, CBS Publishers, New Delhi, 1997.
5. Organic Spectroscopy - William Kemp, 3rd edition, ELBS, 1991.
6. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi,3rd Edition, CBS Publishers, New Delhi, 1997.
7. Pharmaceutical Analysis - Modern Methods – Part B - J W Munson, Vol11, Marcel. Dekker Series
8. Spectroscopy of Organic Compounds, 2nd edn., P.S/Kalsi, Wiley esternLtd., Delhi.
9. Textbook of Pharmaceutical Analysis, KA.Connors, 3rd Edition, John Wiley& Sons, 1982.

MPC 102T: Advanced Organic Chemistry-I

Course Learning Objectives (CLOs)

CLO1. The principles, applications and mechanism & applications of various chemical reactions
CLO2. Various processes to determine mechanism of organic reactions
CLO3. Various redox processes employed in the synthesis of drugs
CLO4. The concept of stereochemistry

Mapping of CLOs with PLOs

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3		3					
CLO2	3		3					
CLO3	3		3					
CLO4	3		3					

Detailed Syllabus:

Unit	Details	Contact Hours
I	1.Basic Aspects of OrganicChemistry: 1. Organic intermediates: Carbocations, carbanions, free radicals, carbenes and nitrenes. Their method of formation, stability and syntheticapplications. 2. Types of reaction mechanisms and methods of determiningthem, 3. Detailed knowledge regarding the reactions, mechanisms and their relative reactivity andorientations. 2.Addition reactions a) Nucleophilic uni- and bimolecular reactions (SN1 and SN2) b) Elimination reactions (E1 & E2; Hoffman &Saytzeff's rule) c) Rearrangementreaction	12
II	Study of mechanism and synthetic applications of following named Reactions: Ugi reaction, Brook rearrangement, Ullmann coupling reactions, Dieckmann Reaction, Doebner-Miller Reaction, Sandmeyer Reaction, Mitsunobu reaction, Mannich reaction, Vilsmeyer-Haack Reaction, Sharpless asymmetric epoxidation, Baeyer-Villiger oxidation, Shapiro & Suzuki reaction, Ozonolysis and Michael addition reaction	12
III	Synthetic Reagents &Applications: Aluminiumisopropoxide, N-bromosuccinamide, diazomethane, dicyclohexylcarbodimide, Wilkinson reagent, Witting reagent. Osmium tetroxide, titanium chloride, diazopropane, diethyl azodicarboxylate, Triphenylphosphine, Benzotriazol-1-yloxy) tris (dimethylamino) phosphonium hexafluoro-phosphate (BOP). Protecting groups a. Role of protection in organicsynthesis b. Protection for the hydroxyl group, including 1,2-and1,3-diols: ethers, esters, carbonates, cyclic acetals &ketals c. Protection for the Carbonyl Group: Acetals andKetals d. Protection for the Carboxyl Group: amides and hydrazides, esters e. Protection for the Amino Group and Amino acids: carbamates andamides	12
IV	HeterocyclicChemistry: Organic Name reactions with their respective mechanism and application involved in synthesis of drugs containing five, six membered and fused hetrocyclics such as Debus-Radziszewski imidazole synthesis,	12

	Knorr Pyrazole Synthesis Pinner Pyrimidine Synthesis, Combes Quinoline Synthesis, Bernthsen Acridine Synthesis, Smiles rearrangement and Traube purine synthesis. Synthesis of few representative drugs containing these hetrocyclic nucleus such as Ketoconazole, Metronidazole, Miconazole, celecoxib, antipyrin, Metamizole sodium, Terconazole, Alprazolam, Triamterene, Sulfamerazine, Trimethoprim, Hydroxychloroquine, Quinine, Chloroquine, Quinacrine, Amsacrine, Prochlorpherazine, Promazine, Chlorpromazine,Theophylline , Mercaptopurine and Thioguanine.	
V	Synthon approach and retrosynthesisapplications i. Basic principles, terminologies and advantages of retrosynthesis; guidelines for dissection of molecules. Functional group inter-convertion and addition (FGI andFGA) ii. C-X disconnections; C-C disconnections – alcohols and carbonyl compounds; 1,2-, 1,3-,1,4-, 1,5-, 1,6-difunctionalized compounds iii. Strategies for synthesis of three, four, five and six-membered ring.	12

Suggested Readings

1. "Advanced Organic chemistry, Reaction, Mechanisms and Structure", J March, John Wiley and Sons, NewYork.
2. "Mechanism and Structure in Organic Chemistry", ES Gould, Hold Rinchart and Winston, NewYork.
3. "Organic Chemistry" Clayden, Greeves, Warren and Woihers., Oxford University Press2001.
4. "Organic Chemistry" Vol I and II. I.L. Finar. ELBS, Pearson Education Lts, Dorling Kindersley 9India) Pvt.Ltd.,.
5. A guide to mechanisms in Organic Chemistry, Peter Skyes (Orient Longman, NewDelhi).
6. Reactive Intermediates in Organic Chemistry, Tandom and Gowel, Oxford & IBH Publishers.
7. Combinational Chemistry – Synthesis and applications – Stephen R Wilson& Anthony W Czarnik, Wiley –Blackwell.
8. Carey, Organic Chemistry, 5th Edition (Viva Books Pvt.Ltd.)
9. Organic Synthesis - The Disconnection Approach, S. Warren, WilyIndia
10. Principles of Organic Synthesis, ROC Norman and JM Coxan, Nelson Thorns.
11. Organic Synthesis - Special Techniques. VK Ahluwalia and R Agarwal, Narosa Publishers.
12. Organic Reaction Mechanisms IVthEdtn, VK Ahluwalia and RK Parashar, Narosa Publishers.

MPC 103T: Advanced Medicinal Chemistry-I

Course Learning Objectives (CLOs) are shown below:

CLO1. Different strategies of lead identification and lead modification for optimization.
CLO2. Different techniques of analog design.
CLO3. Role of medicinal chemistry in drug research
CLO4. Different techniques for drug discovery
CLO5. Various strategies to design and develop new drug like molecules for biological targets
CLO6. Basic concepts of receptors, receptor theories, receptor classification and receptor binding assays.
CLO7. Knowledge of enzymes, enzyme kinetics, various mechanisms of enzyme catalysis.
CLO8. Understanding various types of prodrugs and their activation mechanisms.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3		3	3				
CLO2	3		3	3				
CLO3	3		3	3				
CLO4	3		3	3				
CLO5	3		3	3				
CLO6	3		3	3				
CLO7	3		3	3				
CLO8	3		3	3				

Detailed Syllabus:

Unit	Details	Contact Hours
I	**Drug discovery:** Stages of drug discovery, lead discovery; identification, validation and diversity of drugtargets. **Biological drug targets:** Receptors, types, binding and activation, theories of drug receptor interaction, drug receptor interactions, agonists vs antagonists, artificialenzymes.	12
II	**Prodrug Design and Analogdesign:** a) **Prodrug design**: Basic concept, Carrier linked prodrugs/ Bioprecursors, Prodrugs of functional group, Prodrugs to improve patient acceptability, Drug solubility, Drug absorption and distribution, site specific drug delivery and sustained drug action. Rationale of prodrug design and practical consideration of prodrugdesign. b) **Combating drug resistance:** Causes for drug resistance, strategies to combat drug resistance in antibiotics and anticancer therapy, Genetic principles of drugresistance. **Analog Design:** Introduction, Classical & Non classical, Bioisosteric replacement strategies, rigidanalogs, alteration of chain branching, changes in ring size, ring position isomers, design of stereo isomers and geometric isomers, fragments of a lead molecule, variation in inter atomicdistance.	12
III	a) Medicinal chemistry aspects of the following class ofdrugs Systematic study, SAR, Mechanism of action and synthesis of new generation molecules of following class ofdrugs: a) Anti-hypertensive drugs, Psychoactive drugs, Anticonvulsant drugs, H1 & H2 receptor antagonist, COX1 & COX2 inhibitors, Adrenergic & Cholinergic agents, Antineoplastic and Antiviral agents. b) Stereochemistry and Drug action: Realization that stereo selectivity is a pre-requisite for evolution. Role of chirality in selective and specific therapeutic agents. Case studies, Enantio selectivity in drug adsorption, metabolism, distribution andelimination.	12
IV	Rational Design of EnzymeInhibitors Enzyme kinetics & Principles of Enzyme inhibitors, Enzyme inhibitors in medicine, Enzyme inhibitors in basic research, rational design of non-covalently and covalently binding enzyme inhibitors.	12
V	Peptidomimetics: Therapeutic values of Peptidomimetics, design of peptidomimetics by manipulation of the amino acids, modification of the peptide backbone, incorporating conformational constraints locally or globally. Chemistry of prostaglandins, leukotrienes and thromboxones.	12

Suggested Readings

1. Medicinal Chemistry by Burger, Vol I–VI.
2. Wilson and Gisvold's Text book of Organic Medicinal and Pharmaceutical Chemistry, 12th Edition, Lippincott Williams & Wilkins, Woltess Kluwer (India) Pvt.Ltd, NewDelhi.
3. Comprehensive Medicinal Chemistry – Corwin and Hansch.
4. Computational and structural approaches to drug design edited by Robert M Stroud and Janet. FMoore
5. Introduction to Quantitative Drug Design by Y.C.Martin.
6. Principles of Medicinal Chemistry by William Foye, 7th Edition, Ippincott Williams & Wilkins, Woltess Kluwer (India) Pvt.Ltd, NewDelhi.
7. Drug Design Volumes by Arienes, Academic Press, Elsevier Publishers, Noida, UttarPradesh..
8. Principles of Drug Design by Smith.
9. The Organic Chemistry of the Drug Design and Drug action by Richard B.Silverman, II Edition, Elsevier Publishers, NewDelhi.
10. An Introduction to Medicinal Chemistry, Graham L.Patrick, III Edition, Oxford University Press,USA.
11. Biopharmaceutics and pharmacokinetics, DM.Brahmankar, Sunil B. Jaiswal II Edition, 2014, Vallabh Prakashan, NewDelhi.
12. Peptidomimetics in Organic and Medicinal Chemistry by Antonio Guarna and Andrea Trabocchi, First edition, Wiley publishers.

MPC 104T: Chemistry of Natural Products

Course Learning Outcomes (CLOs):

CLO1. Different types of natural compounds and their chemistry and medicinal importance
CLO2. The importance of natural compounds as lead molecules for new drug discovery
CLO3. The concept of rDNA technology tool for new drug discovery
CLO4. Total synthesis of selected natural products
CLO5. Isolation, purification and characterization of simple chemical constituents from natural source.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3		3					
CLO2	3		3					
CLO3	3		3					
CLO4	3		3					
CLO5	3		3					

Detailed Syllabus

Unit	Details	Contact Hours
I	Study of Natural products as leads for new pharmaceuticals for the following class ofdrugs a) Drugs Affecting the Central Nervous System: Morphine Alkaloids b) Anticancer Drugs: Paclitaxel and Docetaxel, Etoposide, and Teniposide c) Cardiovascular Drugs: Lovastatin, Teprotide andDicoumarol d) Neuromuscular Blocking Drugs: Curarealkaloids e) Anti-malarial drugs and Analogues f) Chemistry of macrolid antibiotics (Erythromycin, Azithromycin, Roxithromycin, and Clarithromycin) and β - Lactam antibiotics (Cephalosporins andCarbapenem)	12
II	a) Alkaloids General introduction, classification, isolation, purification, molecular modification and biological activity of alkaloids, general methods of structural determination of alkaloids, structural elucidation and stereochemistry of ephedrine, morphine, ergot, emetine and reserpine. b) Flavonoids Introduction, isolation and purification of flavonoids, General methods of structural determination of flavonoids; Structural elucidation of quercetin. c)Steroids General introduction, chemistry of sterols, sapogenin and cardiac glycosides. Stereochemistry and nomenclature of steroids, chemistry of contraceptive agents male & female sex hormones (Testosterone, Estradiol, Progesterone), adrenocorticoids (Cortisone), contraceptive agents and steroids (Vit – D).	12
III	a) Terpenoids Classification, isolation, isoprene rule and general methods of structural elucidation of Terpenoids; Structural elucidation of drugs belonging to mono (citral, menthol, camphor), di(retinol, Phytol, taxol) and tri terpenoids (Squalene,Ginsenoside) carotinoids (βcarotene). b) Vitamins Chemistry and Physiological significance of Vitamin A, B1, B2, B12, C, E, Folic acid and Niacin.	12
IV	a). Recombinant DNA technology and drugdiscovery rDNA technology, hybridoma technology, New pharmaceuticals derived from biotechnology; Oligonucleotide therapy. Gene therapy: Introduction, Clinical application and recent advances in gene therapy,	12

	principles of RNA & DNA estimation b). Active constituent of certain crude drugs used in Indigenous system Diabetic therapy – Gymnemasylvestre, Salacia reticulate, Pterocarpus marsupiam, Swertiachirata, Trigonellafoenumgraccum; Liver dysfunction – Phyllanthus niruri; Antitumor – Curcuma longa Linn.	
V	Structural Characterization of naturalcompounds Structural characterization of natural compounds using IR, 1HNMR, 13CNMR and MS Spectroscopy of specific drugs e.g., Penicillin, Morphine, Camphor, Vit-D, Quercetin and Digitalis glycosides.	12

Suggested Readings

1. Modern Methods of Plant Analysis, Peech and M.V.Tracey, Springer – Verlag, Berlin,Heidelberg.
2. Phytochemistry Vol. I and II by Miller, Jan Nostrant ReinHld.
3. Recent advances in Phytochemistry Vol. I to IV – ScikelRuneckles, Springer Science & BusinessMedia.
4. Chemistry of natural products Vol I onwardsIWPAC.
5. Natural Product Chemistry Nakanishi Gggolo, University Science Books, California.
6. Natural Product Chemistry "A laboratory guide" – RaphealKhan.
7. The Alkaloid Chemistry and Physiology by RHF Manske, AcademicPress.
8. Introduction to molecular Phytochemistry – CHJ Wells,Chapmannstall.
9. Organic Chemistry of Natural Products Vol I and II by Gurdeep and Chatwall, Himalaya PublishingHouse.
10. Organic Chemistry of Natural Products Vol I and II by O.P. Agarwal, KrishanPrakashan.
11. Organic Chemistry Vol I and II by I.L. Finar, Pearsoneducation.
12. Elements of Biotechnology by P.K. Gupta, RastogiPublishers.
13. Pharmaceutical Biotechnology by S.P.Vyas and V.K.Dixit, CBSPublishers.
14. Biotechnology by Purohit and Mathur, Agro-Bios, 13thedition.
15. Phytochemical methods of Harborne, Springer,Netherlands.
16. Burger's MedicinalChemistry.

MPC 105P/106P/209P/210P: Pharmaceutical Chemistry Lab.-I-IV (Semester I/Core Course V and VI and Semester II/Core Course VI and VII)

Course Learning Outcomes (CLOs)

CLO1. To gain the knowledge and competence for making valid and relevant observations based on the experimental/Laboratory studies and to perform such studies as are relevant to the subject
CLO2. To plan and carry out experiments in
CLO3. Friedel crafts alkylation: Synthesis of medicinally relevant scaffolds based on basic organic reactions,
CLO4. Synthesis of heterocycles such as quinoline, benzimidazole, benztriazoles, pyrazoleetc,
CLO5. Determination of Pharmacokinetic Parameters such Log P, resolution of racemate mixture,
CLO6. Kinetics of drug distribution etc.
CLO7. Analysis of drugs and their formulations in single and multi-component containing formulations.
CLO8. Synthesize, purify and characterize drugs/chemicals.
CLO9. Develop theoretical models based on QSAR, Molecular modeling and docking, Pharmacophore mapping and virtual screening.
CLO10. Hands on training on developing stereomodels and understanding various concepts related to stereochemistry
CLO11. Measure physicochemical properties of drugs/chemicals.
CLO12. Working with molecular modelling soft wares to design new drug molecules

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3				3			3
CLO2	3				3			3
CLO3	3				3			3
CLO4	3				3			3
CLO5	3				3			3
CLO6	3				3			3
CLO7	3				3			3
CLO8	3				3			3
CLO9	3				3			3
CLO10	3				3			3
CLO11	3				3			3

Details
1. Analysis of Pharmacopoeial compounds and their formulations by UV Vis spectrophotometer, RNA & DNAestimation 2. Simultaneous estimation of multi component containing formulations by UV spectrophotometry 3. Experiments based on Columnchromatography 4. Experiments based onHPLC 5. Experiments based on GasChromatography 6. Estimation of riboflavin/quinine sulphate byfluorimetry 7. Estimation of sodium/potassium by flamephotometry **To perform the following reactions of synthetic importance** 1. Purification of organic solvents, columnchromatography 2. Claisen-schimidtreaction. 3. Benzyllic acidrearrangement. 4. Beckmannrearrangement. 5. Hoffmannrearrangement 6. Mannichreaction 7. Synthesis of medicinally important compounds involving more than one step along with purification and Characterization using TLC, melting point and IR spectroscopy (4experiments) 8. Estimation of elements and functional groups in organic naturalcompounds 9. Isolation, characterization like melting point, mixed melting point, molecular weight determination, functional group analysis, co-chromatographic technique for identification of isolated compounds and interpretation of UV and IR data. 10. Some typical degradation reactions to be carried on selected plant constituents

MPC 201T: Advanced Spectral Analysis (Semester II/Core Course I; 4 credits)

Course Learning Outcomes (CLOs)

CLO1. Interpretation of the NMR, Mass and IR spectra of various organic compounds
CLO2. Calculation of λ_{max} values of compounds using rules.
CLO3. Understanding NMR spectroscopy with respect to various types of couplings.
CLO4. Understanding advanced NMR techniques like DEPT, NOESY, COSY, HETCOR
CLO5. Solving problems involving structure determination based on UV, IR, NMR and Mass spectra.
CLO6. Theoretical and practical skills of the hyphenated instruments
CLO7. Identification of organic compounds.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3							3
CLO2	3							3
CLO3	3							3
CLO4	3							3
CLO5	3							3
CLO6	3							3
CLO7	3							3

Detailed Syllabus:

Unit	Details	Contact Hours
I	UV and IR spectroscopy: Wood ward – Fieser rule for 1,3- butadienes, cyclic dienes and α, β-carbonyl compounds and interpretation compounds of enones. ATR-IR, IR Interpretation of organic compounds.	12
II	NMR spectroscopy: 1-D and 2-D NMR, NOESY and COSY, HECTOR, INADEQUATE techniques, Interpretation of organic compounds.	12
III	Mass Spectroscopy Mass fragmentation and its rules, Fragmentation of important functional groups like alcohols, amines, carbonyl groups and alkanes, Meta stable ions, Mc Lafferty rearrangement, Ring rule, Isotopic peaks, Interpretation of organic compounds.	12
IV	Chromatography: Principle, Instrumentation and Applications of the following : a)GC-MS b) GC-AAS c) LC-MS d) LC-FTIR e) LC-NMR f) CE- MS g) High Performance Thin Layer chromatography h) Super critical fluid chromatography i) Ion Chromatography j) I-EC (Ion- Exclusion Chromatography) k) Flash chromatography	12
V	a). Thermal methods of analysis Introduction, principle, instrumentation and application of DSC, DTA and TGA. **b).** Raman Spectroscopy Introduction, Principle, Instrumentation and Applications. **c).** Radio immuno assay Biological standardization , bioassay, ELISA, Radioimmuno assay of digitalis and insulin.	12

Suggested Readings

1. Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.
2. Principles of Instrumental Analysis - Doglas A Skoog, F. James Holler, Timothy A. Nieman, 5th edition, Eastern press, Bangalore, 1998.
3. Instrumental methods of analysis – Willards, 7th edition, CBS publishers.
4. Organic Spectroscopy - William Kemp, 3rd edition, ELBS, 1991.
5. Quantitative analysis of Pharmaceutical formulations by HPTLC - P D Sethi, CBS Publishers, New Delhi.
6. Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3rd Edition, CBS Publishers, New Delhi, 1997.
7. Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series

MPC 202T: Advanced Organic Chemistry-II (Semester II/Core Course II; 4 credits)

Course Learning Outcomes (CLOs)

CLO1. Understanding the principle and application of retrosynthesis.
CLO2. Understanding the principles and applications of Green chemistry.
CLO3. The concept of disconnection to develop synthetic routes for small target molecules
CLO4. The various catalysts used in organic reactions
CLO5. The concept of stereochemistry and asymmetric synthesis.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	3					
CLO2	3	3	3					
CLO3	3	3	3					
CLO4	3	3	3					
CLO5	3	3	3					

Detailed Syllabus:

Unit	Details	Contact Hours
I	Green Chemistry: a. Introduction, principles of green chemistry b. Microwave assisted reactions: Merit and demerits of its use, increased reaction rates, mechanism, superheating effects of microwave, effects of solvents in microwave assisted synthesis, microwave technology in process optimization, its applications in various organic reactions and heterocycles synthesis c. Ultrasound assisted reactions: Types of sonochemical reactions, homogenous, heterogeneous liquid-liquid and liquid-solid reactions, synthetic applications d. Continuous flow reactors: Working principle, advantages and synthetic applications.	12
II	Chemistry of peptides a. Coupling reactions in peptide synthesis b. Principles of solid phase peptide synthesis, t-BOC and FMOC protocols, various solid supports and linkers: Activation procedures, peptide bond formation, deprotection and cleavage from resin, low and high HF cleavage protocols, formation of free peptides and peptide amides, purification and case studies, site-specific chemical modifications of peptides c. Segment and sequential strategies for solution phase peptide synthesis with any two case studies Side reactions in peptide synthesis: Deletion peptides, side reactions initiated by proton abstraction, protonation, over- activation and side reactions of individual amino acids.	12
III	Photochemical Reactions Basic principles of photochemical reactions. Photo-oxidation, photo-addition and photo-fragmentation. Pericyclic reactions Mechanism, Types of pericyclic reactions such as cyclo addition, electrocyclic reaction and sigmatrophic rearrangement reactions with examples	12
IV	Catalysis: a. Types of catalysis, heterogeneous and homogenous catalysis, advantages and disadvantages b. Heterogeneous catalysis – preparation, characterization, kinetics, supported catalysts, catalyst deactivation and regeneration, some examples of heterogeneous catalysis used in synthesis of drugs. c. Homogenous catalysis, hydrogenation, hydroformylation, hydrocyanation, Wilkinson catalysts, chiral ligands and chiral induction, Ziegler-Natta catalysts, some examples of homogenous catalysis used in synthesis of	12

	drugs d. Transition-metal and Organo-catalysis in organic synthesis: Metal-catalyzed reactions e. Biocatalysis: Use of enzymes in organic synthesis, immobilized enzymes/cells in organic reaction. f. Phase transfer catalysis - theory and applications	
V	Stereochemistry & Asymmetric Synthesis a. Basic concepts in stereochemistry – optical activity, specific rotation, racemates and resolution of racemates, the Cahn, Ingold, Prelog (CIP) sequence rule, meso compounds, pseudo asymmetric centres, axes of symmetry, Fischers D and L notation, cis-trans isomerism, E and Z notation. b. Methods of asymmetric synthesis using chiral pool, chiral auxiliaries and catalytic asymmetric synthesis, enantiopure separation and Stereo selective synthesis with examples.	12

Suggested Readings

1. "Advanced Organic chemistry, Reaction, mechanisms and structure", J March, John Wiley and sons, New York.
2. "Mechanism and structure in organic chemistry", ES Gould, Hold Rinchart and Winston, NewYork.
3. "Organic Chemistry" Clayden, Greeves, Warren and Woihers., Oxford University Press 2001.
4. "Organic Chemistry" Vol I and II. I.L. Finar. ELBS, Sixth ed., 1995.
5. Carey, Organic chemistry, 5th edition (Viva Books Pvt. Ltd.)
6. Organic synthesis-the disconnection approach, S. Warren, Wily India
7. Principles of organic synthesis, ROCNorman and JMCoxan, Nelson thorns
8. Organic synthesis- Special techniques VK Ahluwalia and R Aggarwal, Narosa Publishers.
9. Organic reaction mechanisms IV edtn, VK Ahluwalia and RK Parashar, Narosa Publishers.

MPC 203T: Computer Aided Drug Design (Semester II/Core Course III; 4 credits)

Course Learning Outcomes (CLOs)

CLO1. Role of Computer Aided Drug Design in drug discovery
CLO2. Different techniques of Computer Aided Drug Design like QSAR, pharmacophore mapping, docking, de novo and their applications.
CLO3. Understanding Molecular modelling techniques with some understanding of calculating molecular properties using molecular mechanics, quantum mechanics and semi empirical methods
CLO4. Receptor/enzyme-interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design, homology modelling.
CLO5. Various strategies to design and develop new drug like molecules.
CLO6. Working with molecular modelling soft wares to design new drug molecules.
CLO7. The *in silico* virtual screening protocols.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3			3				
CLO2	3			3				
CLO3	3			3				
CLO4	3			3				
CLO5	3			3				
CLO6	3			3				
CLO7	3			3				

Detailed Syllabus

Unit	Details	Contact Hours
I	Introduction to Computer Aided Drug Design (CADD) History, different techniques and applications. Quantitative Structure Activity Relationships: Basics History and development of QSAR: Physicochemical parameters and methods to calculate physicochemical parameters: Hammett equation and electronic parameters (sigma), lipophilicity effects and parameters (log P, pi-substituent constant), steric effects (Taft steric and MR parameters) Experimental and theoretical approaches for the determination of these physicochemical parameters.	12
II	Quantitative Structure Activity Relationships: Applications Hansch analysis, Free Wilson analysis and relationship between them, Advantages and disadvantages; Deriving 2D-QSAR equations. 3D-QSAR approaches and contour map analysis. Statistical methods used in QSAR analysis and importance of statistical parameters.	12
III	Molecular Modeling and Docking a) Molecular and Quantum Mechanics in drug design. b) Energy Minimization Methods: comparison between global minimum conformation and bioactive conformation c) Molecular docking and drug receptor interactions: Rigid docking, flexible docking and extra-precision docking. Agents acting on enzymes such as DHFR, HMG-CoA reductase and HIV protease, choline esterase (AchE & BchE)	12
IV	Molecular Properties and Drug Design a) Prediction and analysis of ADMET properties of new molecules and its importance in drug design. b) *De novo* drug design: Receptor/enzyme-interaction and its analysis, Receptor/enzyme cavity size prediction, predicting the functional components of cavities, Fragment based drug design. c) Homology modeling and generation of 3D-structure of protein.	12
V	Pharmacophore Mapping and Virtual Screening Concept of pharmacophore, pharmacophore mapping, identification of Pharmacophore features and Pharmacophore modeling; Conformational search used in pharmacophore mapping. *In Silico* Drug Design and Virtual Screening Techniques Similarity based methods and Pharmacophore based screening, structure based *In-silico* virtual screening protocols.	12
Suggested Readings 1. Computational and structural approaches to drug discovery, Robert M Stroud and Janet. F Moore, RCS Publishers.		

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

MPC 204T: Pharmaceutical Process Chemistry (Semester II/Core Course IV; 4 credits)

Course Learning Outcomes (CLOs)

CLO1. Develop synthetic routes that are safe, cost-effective, environmentally friendly, and efficient.
CLO2.Development and optimization of a synthetic route/s and the pilot plant procedure for the manufacture of Active Pharmaceutical Ingredients (APIs) and new chemical entities (NCEs) for the drug development phase.
CLO3.The strategies of scale up process of APIs and intermediates
CLO4. The various unit operations and various reactions in process chemistry.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3		3					
CLO2	3		3					
CLO3	3		3					
CLO4	3		3					

Detailed Syllabus:

Unit	Details	Contact Hours
I	Process chemistry Introduction, Synthetic strategy Stages of scale up process: Bench, pilot and large-scale process. In-process control and validation of large-scale process. Case studies of some scale up process of APIs. Impurities in API, types and their sources including genotoxic impurities	12
II	Unit operations a) *Extraction:* Liquid equilibria, extraction with reflux, extraction with agitation, counter current extraction. b) *Filtration*: Theory of filtration, pressure and vacuum filtration, centrifugal filtration, c) *Distillation*: azeotropic and steam distillation d) *Evaporation*: Types of evaporators, factors affecting evaporation. *Crystallization*: Crystallization from aqueous, non- aqueous solutions factors affecting crystallization, nucleation. Principle and general methods of Preparation of polymorphs, hydrates, solvates and amorphous APIs.	12
III	Unit Processes - I a) Nitration: Nitrating agents, Aromatic nitration, kinetics and mechanism of aromatic nitration, process equipment for technical nitration, mixed acid for nitration, b) Halogenation: Kinetics of halogenations, types of halogenations, catalytic halogenations. Case study on industrial halogenation process. c) Oxidation: Introduction, types of oxidative reactions, Liquid phase oxidation with oxidizing agents. Nonmetallic Oxidizing agents such as H_2O_2, sodium hypochlorite, Oxygen gas, ozonolysis	12
IV	Unit Processes – II a) Reduction: Catalytic hydrogenation, Heterogeneous and homogeneous catalyst; Hydrogen transfer reactions, Metal hydrides. Case study on industrial reduction process. b) Fermentation: Aerobic and anaerobic fermentation. Production of i Antibiotics; Penicillin and Streptomycin, ii Vitamins: B2 and B12 iii Statins: Lovastatin, Simvastatin	12
V	Industrial Safety a) MSDS (Material Safety Data Sheet), hazard labels of chemicals and Personal Protection Equipment (PPE) b) Fire hazards, types of fire & fire extinguishers	12

	c) Occupational Health & Safety Assessment Series 1800 (OHSAS-1800) and ISO-14001(Environmental Management System), Effluents and its management	

Suggested Readings

1. Process Chemistry in the Pharmaceutical Industry: Challenges in an Ever- Changing Climate- An Overview; K. Gadamasetti, CRC Press.
2. Pharmaceutical Manufacturing Encyclopedia, 3rd edition, Volume 2.
3. Medicinal Chemistry by Burger, 6th edition, Volume 1-8.
4. W.L. McCabe, J.C Smith, Peter Harriott. Unit operations of chemical engineering, 7th edition, McGraw Hill
5. Polymorphism in Pharmaceutical Solids. Dekker Series Volume 95 Ed: H G Brittain (1999)
6. Regina M. Murphy: Introduction to Chemical Processes: Principles, Analysis, Synthesis
7. Peter J. Harrington: Pharmaceutical Process Chemistry for Synthesis: Rethinking the Routes to Scale-Up
8. P. H. Groggins: Unit processes in organic synthesis (MGH)
9. F. A. Henglein: Chemical Technology (Pergamon)
10. M.Gopal: Dryden's Outlines of Chemical Technology, WEP East-West Press
11. Clausen, Mattson: Principle of Industrial Chemistry, Wiley Publishing Co.,
12. Lowenheim & M.K. Moran: Industrial Chemicals
13. S.D. Shukla & G.N. Pandey: A text book of Chemical Technology Vol. II, Vikas Publishing House
14. J.K. Stille: Industrial Organic Chemistry (PH)
15. Shreve: Chemical Process, Mc Grawhill.
16. B. K. Sharma: Industrial Chemistry, Goel Publishing House
17. ICH Guidelines
18. United States Food and Drug Administration official website www.fda.gov

MRM 301T: Research Methodology

Course Learning Outcomes (CLOs)

CLO1. Understand some basic concepts of research and its methodologies
CLO2. Understanding the sojourn of research since its conception till compilation
CLO3. Understanding of journals, metrics and criteria for journal selection
CLO4. Statistical analysis of the data collected
CLO5. Writing a research report, thesis and research proposals for fellowships and grants
CLO6. Introduction to intellectual property rights, the governing laws and the process of patenting in India

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3				3	3		
CLO2	3				3	3		
CLO3	3				3	3		
CLO4	3				3	3		
CLO5	3				3	3		
CLO6	3				3	3		

Detailed Syllabus:

Unit	Details	Contact Hours
I	General Research Methodology: Research, objective, requirements, practical difficulties, review of literature, study design, types of studies, strategies to eliminate errors/bias, controls, randomization, crossover design, placebo, blinding techniques.	12
II	Biostatistics: Definition, application, sample size, importance of sample size, factors influencing sample size, dropouts, statistical tests of significance, type of significance tests, parametric tests(students "t" test, ANOVA, Correlation coefficient, regression), non-parametric tests (wilcoxan rank tests, analysis of variance, correlation, chi square test), null hypothesis, P values, degree of freedom, interpretation of P values.	12
III	Medical Research: History, values in medical ethics, autonomy, beneficence, non-maleficence, double effect, conflicts between autonomy and beneficence/non-maleficence, euthanasia, informed consent, confidentiality, criticisms of orthodox medical ethics, importance of communication, control resolution, guidelines, ethics committees, cultural concerns, truth telling, online business practices, conflicts of interest, referral, vendor relationships, treatment of family members, sexual relationships, fatality.	12
IV	CPCSEA guidelines for laboratory animal facility: Goals, veterinary care, quarantine, surveillance, diagnosis, treatment and control of disease, personal hygiene, location of animal facilities to laboratories, anesthesia, euthanasia, physical facilities, environment, animal husbandry, record keeping, SOPs, personnel and training, transport of lab animals.	10
V	Declaration of Helsinki: History, introduction, basic principles for all medical research, and additional principles for medical research combined with medical care.	12

MPC302JC/ MPC 401JC Journal Club (Semester III/IV Elective Course)

Course Learning Outcomes (CLOs)

CLO1. The presentation skills on a particular research topic
CLO2. How to discuss the work of others effectively
CLO3. What makes research presentations effective?
CLO4. About how papers are refereed and published.
CLO5. Evaluate research and review papers.
CLO6. How papers are referred and published.
CLO7. Read research papers critically and efficiently.
CLO8. Understanding a new field in the absence of text book.
CLO9. Summarize and review research articles.
CLO10. Effective use of ICT tools.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3						3	
CLO2	3						3	
CLO3	3						3	
CLO4	3						3	
CLO5	3						3	
CLO6	3						3	
CLO7	3						3	
CLO8	3						3	
CLO9	3						3	
CLO10	3						3	

MPC303PP/ MPC304RW/ MPC402RW/ MPC 403FP: Research Project/Discussion Final Presentation

Course Learning Outcomes (CLOs)

CLO1. Attitudes including communication skills, critical thinking to address a research problem
CLO2. Undertake an individual research topic in discussion with the assigned supervisor and submit a thesis at the end for evaluation
CLO3. Develop research skills through individual research project, and time-management and planning skills
CLO4. Undertaking subjective research independently
CLO5. Development of interpersonal skills for collaborative approach
CLO6. Acquire theoretical knowledge, practical /clinical skills, thesis compilation and writing scientific reports.

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8
CLO1	3	3	3	3	3	3	3	3
CLO2	3	3	3	3	3	3	3	3
CLO3	3	3	3	3	3	3	3	3
CLO4	3	3	3	3	3	3	3	3
CLO5	3	3	3	3	3	3	3	3
CLO6	3	3	3	3	3	3	3	3