MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI – 627 012

Department of Pharmaceutical Chemistry jointly with Department of Chemistry offers

M.Sc. ORGANIC CHEMISTRY (CBCS) Programme

(Effective from the Academic year 2017-2018 onwards)

PREAMBLE

Organic Chemistry is a discipline within chemistry that involves the scientific study of the structure, properties, composition, reactions and preparation of all the organic compounds. M.Sc. Organic Chemistry (CBCS) course gives a wide focus on the identification, synthesis and development of new chemical entities suitable for therapeutic use and also on quality aspects of medicines and aims to assure fitness for the purpose of pharmaceutical products. This course will prepare the student to take the challenge of meeting not only national needs in diverse areas of Organic Chemistry and Pharmaceutical Sciences but also to continue toward advanced studies anywhere in the world.

OBJECTIVES OF THE PROGRAMME

- To prepare the students to become Teachers of Chemistry in Higher Education Institutions.
- To mould the student to suit to the varied requirements of Pharmaceutical industry such as Research & Development, Manufacturing, Quality Control, Quality assurance, Packaging and Marketing of dosage forms.
- To train the young entrepreneurs in the area of Chemicals, Drugs & Pharmaceuticals and also its allied disciplines.

ELIGIBILITY FOR ADMISSION

Bachelor degree in Chemistry or any other equivalent branches of Chemistry with a minimum of 50% marks.

DURATION OF THE PROGRAMME

Two years (4 Semesters) with Choice Based Credit System.

NUMBER OF SEATS

A total seat in the present programme is 16. This will be filled according to merit following Tamil Nadu Government Roaster system.

M.Sc. ORGANIC CHEMISTRY (CBCS) Course

(With effect from the Academic year 2017-18 onwards)

STRUCTURE OF THE PROGRAMME & SCHEME OF EXAMINATION

FIRST SEMESTER

Paper	Title of the Paper	Credit	Marks		
			Internal	External	Total
1.	Core – Organic Chemistry -I	4	25	75	100
2.	Core –Inorganic Chemistry -I	4	25	75	100
3.	Core –Physical Chemistry -I	4	25	75	100
4.	Elective -I - Select any one from the list	3	25	75	100
5.	Practical – Inorganic Chemistry – I Practical	2	25	75	100
6.	Practical – Inorganic Chemistry – II Practical	2	25	75	100
	Total Credits	**19**			

SECOND SEMESTER

Paper	Title of the Paper	Credit	Marks		
			Internal	External	Total
7.	Core – Organic Chemistry –II	4	25	75	100
8.	Core – Inorganic Chemistry –II	4	25	75	100
9.	Core – Physical Chemistry –II	4	25	75	100
10.	Elective II – Select any one from the list	3	25	75	100
11.	Supportive Course Paper – I (to be offered by other Department)	3	25	75	100
12.	Practical – Physical Chemistry - I Practical	2	25	75	100
13.	Practical – Physical Chemistry - II Practical	2	25	75	100
	Total Credits	**22**			

THIRD SEMESTER

Paper	Title of the Paper	Credit	Marks		
			Internal	External	Total
14.	Core - Organic Chemistry -III	4	25	75	100
15.	Core - Organic Chemistry -IV	4	25	75	100
16.	Elective III- Select any one from the list	3	25	75	100
17.	Supportive Course Paper -II (to be offered by other Department)	3	25	75	100
18.	Practical – Organic Chemistry –I Practical	2	25	75	100
19.	Practical – Organic Chemistry – II Practical	2	25	75	100
20.	Practical – Organic Chemistry -III Practical	2	25	75	100
	Total Credits	**20**			

FOURTH SEMESTER

Paper	Title of the Paper	Credit	Marks		
			Internal	External	Total
21.	Core - Organic Chemistry -V	4	25	75	100
22.	Project work and Viva - Voce	25	25	75	100
	Total Credits	**29**			

Overall Credits: 90

LIST OF ELECTIVES PAPERS

FIRST SEMESTER

1. Pharmaceutical Analytical Chemistry
2. Pharmacognosy and Phyto Chemistry
3. Pharmacology and Toxicology

SECOND SEMESTER

1. Chemistry of Natural products
2. Pharmaceutical Dosage forms
3. Biopharmaceutics

THIRD SEMESTER

1. Drug Design and Modeling
2. Technology of Fine Chemicals and Bulk drugs
3. Drug regulatory affairs in Pharmaceutical Industries

LIST OF SUPPORTIVE COURSE PAPERS

ODD SEMESTER

1. Natural Products of Medicinal Importance

EVEN SEMESTER

1. Pharmaceutical Analysis

SCHEME OF EXAMINATION AND QUESTION PATTERN

Duration: 3 hours **Max. Marks:75**

Part A: 10 questions full of Objective type. Two questions from each unit of a paper.
Each question carries two marks. 10 x 1=10 Marks

Part B: 5 descriptive questions of either (a) or (b) type (internal choice). One question is from one unit.
Each question carries 4 marks. 5 x 5 = 25 Marks

Part C: 5 descriptive type questions of either (a) or (b) type (internal choice). One question is from one unit.
Each question carries 7 marks. 5 x 8 = 40 Marks

Note: In Part A & Part B, wherever possible questions of creative/analytical type, i.e questions examining the understanding or creative or analytical power of students may be asked. This is to train the students for CSIR-UGC NET/JRF Examination.

COURSE WEIGHT

In each of the courses, credits will be assigned on the basis of the lectures / tutorials / lab work and other forms of learning in a 15 week schedule.

1. One credit for each lecture hr. per week
2. One credit for each tutorial hr. per week
3. One credit for every two hrs. of Lab or Practical work per week

Project evaluation will be done by respective guide and other faculty member in the same Department. Viva-voce examination for the project students will be conducted jointly by the same examiners who evaluated the project work.

FIRST SEMESTER

ORGANIC CHEMISTRY – I

L T P C

4 0 0 4

Objective:

1. To study the chemical bonding and structure of molecules
2. To study the mechanism of reactions
3. To understand the concept of Aromaticity and stability of molecules
4. To know about the Stereochemistry of molecules
5. To understand the structure and function of Proteins and lipids

UNIT I - Chemical bonding and structure

a) Inductive effect - mesomeric effect - steric inhibition of resonance - 'pπ-dπ' bonding - hyperconjugation -cross-conjugation - hydrogen bonding -acidity, basicity, factors affecting the strength of acids and bases- hard and soft acids and bases.

b) Reactive Intermediates: Formation, structure, and stabilization of carbocations, carbanions, free radicals, carbenes, and nitrenes. **(12 L)**

UNIT II - Introduction to reaction mechanism

Kinetic and thermodynamic requirements, kinetic and thermodynamic control, Hammond Postulate, microscopic reversibility, Curtin-Hammet principle, energy profile diagram, intermediates *Vs* transition states.

Methods of determining reaction mechanism: Nonkinetic methods-Identification of products, intermediates, stereochemistry, crossover experiments, nonkinetic isotopic labeling. Kinetic methods-order, molecularity, influence of ionic strength (salt effects), primary and secondary isotopic effects. **(12 L)**

UNIT III - Aromaticity

Huckel's Rule-Craig's Rule-concept of aromaticity, homoaromaticity and antiaromaticity - systems of 2, 4, 8 and 10-π electrons. large cyclic π systems- aromaticity of azulenes, annulenes, sydnones and tropolones. **(10 L)**

UNIT IV - Stereoisomerism

Optical isomerism: Symmetry elements and chirality, necessary and sufficient condition for chirality - concept of prochirality - enantiotropic and diasterotropic-Fischer, Sawhorse and Newmann projection formulae and their interconversions-calculations of number of stereoisomers - R, S-notations-atropisomerism - molecular dissymmetry - optical activity of allenes and spiranes.

Geometrical isomerism: E-Z nomenclature - stereoisomerism in monocyclic compounds upto six-membered rings. Conformation and reactivity of six-membered ring systems. **(16 L)**

UNIT V – Proteins and lipids

General methods of synthesis and reactions of amino acids peptides-solid phase polypeptide synthesis (Merrifield method) Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins, forces responsible for holding of secondary structures, α- helix, β-sheets, super secondary structure. Tertiary structure and Quaternary structure.

Lipids-classification, Fat and oils, chemical properties - formation of micelle, fatty acids, glycolipids, phospholipids. **(10 L)**

(Total 60 L)

REFERENCES:

1. I.L. Finar, Organic Chemistry, Vol-I & Vol-II, 5th Edition 1975, Pearson Education Asia Pte. Ltd., Ist Indian Reprint, 2000.
2. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press Inc., New York, 2001.
3. S.M. Mukherji and S.P Singh, Reaction Mechanisms in Organic Chemistry, Macmillan India Ltd., New Delhi, 1997.
4. E.S. Gould, Mechanism and Structure in Organic Chemistry, Henry Holt, Reinhart and Winston Inc, New York, 1959.
5. T.W.G Solomon, Organic Chemistry, 5th edition, John Wiley & Sons, Inc., New York, 1992.
6. V.M. Potapov, Stereochemistry, MIR Publishers, Moscow, 1979.
7. E.L. Eliel and S.H Wilen, Stereochemistry of Organic Compounds, John Wiley & Sons, Inc. 1994.
8. E.L. Eliel, Stereochemistry of Carbon Compounds, 24th reprint, Tata McGaw-Hill Publishing Company Ltd., New Delhi,1999.
9. D. Nasipuri, Stereochemistry of Organic Compounds, Principles and Applications, 2nd edn., ernational (P) Ltd., New Delhi 2000.
10. Principles of Biochemistry - L. Stryer (W.H. Freeman & Co.)
11. Principles of Biochemistry - A.L.Lehninger, D.W.Nelson & M.M.Cox (Macmillan)
12. Biochemistry - D.Voet & J.G.Voet (John Willey).
13. Harper's Illustrated Biochemistry - R.K.Murray et al. (McGraw Hill).
14. Lehninger's Principle of Biochemistry by David L. Nelson and Michael M. Cox. W. H. Freeman; 4th edition (2004).
15. Text Book of Biochemistry with clinical correlation by Thomas .M. Devlin, John Wiley-Liss, Hobokhen NJ publishers (2006).
16. Biochemistry by Zubey, GL WCB Publishers.

INORGANIC CHEMISTRY – I

L T P C

4 0 0 4

Objective

1. To study about Chemical Bonding and Stereochemistry of inorganic molecules
2. To learn about the Redox potential and Inorganic polymers
3. To study about the Coordination Chemistry of complex molecules
4. To understand the concept of Electronic Spectra of molecules
5. To study about the Nuclear Chemistry of radioactive molecules

UNIT I – Chemical Bonding and Stereochemistry

Nature of covalent bond : MO theory of polyatomic molecules, ionic bond and its energetics : lattice energy – Born Lande equation and Born Haber cycle – covalent character in ionic bond - partial ionic character from dipole moment and electronegativity data.

VSEPR theory – the concept of multicentre bond and structure as applied to boron hydrides. Noble gas chemistry, their halides and pseudohalides – structure and bonding. **(12 L)**

UNIT II – Redox potential and Inorganic polymers

Applications of redox potential to inorganic reactions - factors affecting redox potential.

Catenation and heterocatenation – Three dimensional silicates, one dimensional conductors, isopoly and heteropolyacids, borazines, phosphazenes, S –N ring compounds, phosphorous cage compounds, binuclear metal clusters : synthesis, structure and bonding of $[Re_2Cl_8]^{2-}$. Oxyacids of Selenium and Tellurium. **(12 L)**

UNIT III - Coordination Chemistry – I

VB, CF and MO theories of complexes with four and six coordination numbers – CFSE – factors affecting the magnitude of 10 Dq values - spectrochemical series - applications of CFT - site preferences in spinels - nephelauxetic effect - π bonding and MO theory - static and dynamic Jahn-Tellar behaviour.

Different types of magnetic behaviour, magnetic moment determination by Guoy and Faraday methods, spin only value - quenching of orbital angular momentum - spin-orbit coupling - determination of geometry of Co and Ni complexes from magnetic data - spin crossover phenomenon - magnetic properties of lanthanides**.** **(14 L)**

UNIT IV – Electronic Spectroscopy

L-S coupling scheme, microstates, term symbols and Hund's rule - splitting of terms, hole formalism and selection rules - Orgel and Tanabe – Sugano diagrams - evaluation of 10 Dq and β for octahedral d^2, d^6 and d^8 systems - effect of distortion and spin-orbit coupling on the spectra - charge-transfer spectra - electronic spectra of lanthanide complexes.

Optical isomerism in octahedral complexes - absolute configuration of chelate complexes from ORD and CD techniques. **(12 L)**

UNIT V – Nuclear Chemistry

Radioactive decay and equilibrium, nuclear structure and models; types of nuclear reactions – Q value, cross section – fission and fusion; fission products and fission yields, nuclear reactors, nuclear power projects in India - radioactive techniques (radiometric titrations, isotope dilution method and neutron activation analysis), counting techniques (G.M., ionization, scintillation and proportional counters). **(10 L)**

(Total 60 L)

REFERENCES:

1. J.E. Huheey, E.A. Keiter and R.L. Keier, Inorganic Chemistry, Harper and Row, 4th Edn., 1993.
2. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, John Wiley & Sons, 5th Edn., 1988.
3. B.E. Douglas, D.H. McDaniel and J.J. Alexander, Concepts and Models of Inorganic Chemistry, John Wiley & Sons, 2 Edn. 1983.
4. R.S. Drago, Physical Methods in Chemistry, W.B. Saunders, 1997.
5. E.A. V. Ebsworth et al., Structural Methods in Inorganic Chemistry, ELBS 1987.
6. J.D. Lee, Concise Inorganic Chemistry, ELBS 1990.
7. M.C. Day, Jr., and J. Selbin, Theoretical Inorganic Chemistry, East West Press.
8. S. Glasstone, Source book on atomic energy, East West press, 3rd Edn. 1967.
9. H.J. Arniker, Essentials of Nuclear Chemistry, Wiley Eastern, 1983.
10. M.G. Friedlander, J.M. Kennedy, E.S. Macian and J.M. Miller, Nuclear and Radiochemistry, 3rd Edn. John Wiley & Sons, 1981.
11. M.G. Arora and M. Singh, Nuclear Chemistry, Anmol Publications, 1994.

PHYSICAL CHEMISTRY-I

Chemical Kinetics, Thermodynamics and Electrochemistry

L T P C

4 0 0 4

Objectives

1. To understand the concept of chemical equilibrium and kinetics of reactions
2. To learn about the heat exchange and thermodynamics of reactions
3. To study about the electrical properties of ions in solutions

UNIT I –Chemical Kinetics –I

Absolute reaction rate theory (ARRT) including thermodynamic treatment – application of ARRT to simple bimolecular processes – potential energy surfaces – kinetic isotope effect- termolecular reactions; theory of unimolecular reactions – Lindemann's theory , Hindshelwood theory, KRR theory, KRRM theory and Slater's theory.

Chain reactions –general characteristics – kinetic – thermal reaction between H_2 and Br_2, thermal decomposition of N_2O_5, formation and decomposition of phosgene- Rice-Herzfeld mechanisms – application to reactions of 0.5, 1 and 1.5 order; explosions – hydrogen-oxygen reaction. **(12 L)**

UNIT II –Chemical Kinetics- II

Kinetics of reactions in solution –ion-ion and ion-dipole reaction – role of dielectric constant, effect of ionic strength and influence of pressure on the reaction rates.

Homogeneous catalysis – acid-base catalysis – methods for investigating acid-base catalysis – salt effect in acid base catalysis – mechanisms of acid-base catalysis; acidity functions and their importance; Bronsted catalysis law.

Enzyme kinetics – effect of substrate concentration – Michaelis-Menten law – Lineweaver –Burk and Eadie methods – effect of pH and temperature; inhibition competitive, uncompetitive and non-competitive inhibitions. **(12 L)**

UNIT III – Thermodynamics - I

Thermodynamics of systems of variable composition – partial molar properties- chemical potential – Gibbs Duhem equation – apparent molar properties-methods of determination of partial molar quantities, partial molar thermal properties – differential and integral heats of solution thermodynamics of mixing

Thermodynamic properties of real gases – fugacity concept – determination of fugacity – real amd mixture of gases – Lewis – Randall rule. Nernst heat theorem – different forms of stating the third law – thermodynamic quantities at absolute zero. **(12 L)**

UNIT IV– Electrochemistry-I

Debye-Huckel-Onsager equation – derivation and experimental verification – Debye-Falkenhagen and Wien effect; activity and activity coefficient – Debye-Huckel limiting law – derivation and verification – activity at appreciable concentration and extension of Debye-Huckel theory. Nernst equation – reduction system – electrochemical cells.

Electrodics – types of electrode – EMF and its measurements – application of EMF measurements – determination of thermodynamics parameters, equilibrium constant, solubility product and dissociation constant. **(12 L)**

UNIT V – Electrochemistry - II

Kinetics of electrode processes – Butler Volmer equation – Tafel equation- electrical double layer – zetapotential – electrokinetic phenomena- over voltage – hydrogen over voltage – theories of over voltage; polarography – principle and applications; primary and secondary coulometric titration.

Passivity – electrochemical, chemical and mechanical passivity; corrosion – theories, methods of preventing corrosion; electrochemical processes as sources of energy – dry cells – storage batteries – fuel cells. **(12 L)**

(Total 60 L)

REFERENCES:

1. K. J. Laidler, Chemical Kinetics, 2nd Edition, Tata McGraw-Hill, New Delhi, 1991.
2. K. J. Laidler, Theories of Chemical Reaction Rates, McGraw-Hill, New York, 1969.
3. D. V. Roberts, Enzyme Kinetics, Cambridge University Press, Cambridge, 1977.
4. J. C. Kuriacose, Catalysis, Macmillan India, Ltd., New Delhi, 1991.
5. W. J. Moore, Basic Physical Chemistry, Prentice Hall, 1986.
6. S. Glasstone, An introduction to Electrochemistry, Van Nostrand, New York, 1965.
7. J. D. M. Bockris, A.K.N. Reddy, Modern Electrochemistry, Vol. I & II, Plenum Press, New York, 3rd Reprint, 1977.
8. A. J. Bard, L.R. Faulkner, Electrochemical Methods: Fundamentals and Applications, John Wiley and Sons, New York, 1980.
9. R. Crow, Principles and Applications of Electrochemistry, Chapman and Hall, London, 1979.

PHARMACEUTICAL ANALYTICAL CHEMISTRY

L T P C

3 0 0 3

Objective: This course deals with the fundamentals of analytical chemistry, application of instrumental and non-instrumental methods used in qualitative and quantitative analysis of drugs and the principle & instrumentation of various chromatographic technique.

UNIT I – Volumetric analysis

Significance of Quantitative analysis in quality control – Isolation and identification of drugs – Different techniques of analysis – Significant figures – Concept of error – Fundamentals of volumetric analysis – Methods of expressing concentration – Primary and secondary standards – Acid base concepts – Relative strength of acids and bases – Law of mass action – Common ion effect – Ionic product of water, pH, Henderson – Hassel Balch equation – Buffer solutions – Neutralization curves – Acid-base indicators and their choice. **(9 L)**

UNIT II

a) Oxidation – Reduction Titrations

Theory and Pharmaceutical applications – Strength and equivalent weights of oxidizing and reducing agents – Measurement of electrode potential – oxidation – reduction curves and redox indicators – Titrations involving Potassium Permanganate, Potassium iodate, Potassium bromate, Cerric ammonium sulphate, Titanous chloride, Sodium 2,6-dichlorophenol – Indophenol – Iodimetry and Iodometry. **(5 L)**

b) Precipitation Titrations

Principles – Titrations involving mercuric nitrate, ammonium or Potassium thiocyanate, barium sulphate – Argentometric titrations and adsorption indicators. **(4 L)**

UNIT III

a) Gravimetric analysis: Basic concepts – Precipitation techniques – Co-precipitation- Post-precipitation – Various steps involved in gravimetric analysis and their pharmaceutical applications. **(3 L)**

b) Complexometric titrations: Complexation and chelation – Werner's coordination number – stability of complexes, titrants, titrations curves – Types of complexometric titrations and methods of end point detection. **(3 L)**

c) Non-aqueous titrations: Theoretical consideration – Scope and limitations – Titration of weakly acidic and weakly basic drugs. **(3 L)**

UNIT IV – Physical Methods

Refractive index, Kjeldahl method of nitrogen estimation – Oxygen flask combustion method, Flame photometry, Kinematic viscosity. **(9 L)**

UNIT V – Chromatographic Techniques

Introduction – Classification of Chromatographic techniques – adsorption and partition – Principles and application of TLC, HPTLC, Paper Chromatography – ascending and descending – Ion exchange chromatography, Counter-current extraction- Gas Chromatography and GC–MS – Identity tests of Pharamcopoeal products – Analysis of methyl testosterone in tablets, atropine in eye drops – HPLC and Electrophoresis-classification-moving boundary zone electrophoresis and applications. **(9 L)**

(Total : 45 L)

REFERENCES:

1. Clarke, Isolation and Identification of drugs, the Pharmaceutical Press, 1986.
2. Vogel's Text Book of Quantitative Chemical Analysis by J. Mendham, R.C. Denney, J.D. Barnes and MJK Thomas ELBS, 7th Edn., 2005.
3. H.H. Willard, L.L. Merritt, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, Wadsworth Publishing Company; 7 Sub edition, 1988.
4. David Harvey, Modern Analytical Chemistry, Mc Graw Hill. 1999.
5. H. Gerhard Vogel, Drug Discovery and Evaluation-Pharmacological Assays, 2nd Edn. Springer, 2008.
6. E. Heftmann, A Laboratory Handbook of Chromatographic and electrophoresis methods, 3rd Edn, Van Nostrand Reinhold, 1975.
7. Raymond PW Scott, Techniques and Practice of Chromatography. 1st Edn, Marcel Dekker Inc., 1995.
8. P.D. Sethi, Identification of Drugs and Pharmaceutical Formulations by Thin Layer Chromatography, 2nd Edn, CBS Publishers & Distributors, 2008.
9. James M. Bobbitt, Thin Layer Chromatography, Reinbold pub. Corp., Chapman and Hall, London, 2007.
10. P.D. Sethi, HPTLC – Quantitative Analysis of Pharmaceutical Formulations, 3rd Edn, CBS Publishers & Distributors, 2008.

PHARMACOGNOSY AND PHYTOCHEMISTRY

L T P C

3 0 0 3

Objective: This course facilitates an understanding of the principles of cultivation & collection of vegetable drugs from plant origin , study the various chemicals from plants, information about plant tissue culture and Preliminary phytochemical screening.

UNIT I - Pharmacognosy

Definition, history, present status, future scope & development of pharmacognosy. Classification of crude drugs -Alphabetical, biological, chemical, pharmacological, taxonomical, chemotaxonomicial & serotaxonomical. **(4 L)**

General principles of cultivation & collection of vegetable drugs, Histopathology of Plants- leaf, stem, roots etc., Factors influencing cultivation of medicinal plants. Processing, storage and preservation of crude drugs. Study of natural pesticides . **(5 L)**

UNIT II – Alkaloids

Sources, chemical structures with description of structural features, tests for identification, uses, mechanism of action of Morphine and its derivatives and analogues, Caffeine and Theophylline, Quinine and Quinidine and Atropine. **(9 L)**

UNIT III – Glycosides

Sources, chemical structures with description of structural features, tests for identification, uses, mechanism of action of Cardio active sterols - Digitalis, Squill and Strophanthus. **(9 L)**

UNIT IV – Plant Tissue culture

Types, techniques, nutritional requirements. Preparation and sterilization of media, preparation of explant, measurement of growth parameters. Organogenesis and Embryo genesis. Micropropagation of medicinal and aromatic plants. **(9 L)**

UNIT V – Phytochemical Screening

Preliminary Phytochemical Screening - Successive solvent extraction - Qualitative chemical examination- Detection of different classes of phyto constituents by test tube and chromatographic methods. - Detection of volatile oil by Hydrodistillation Method. **(9 L)**

(Total : 45 L)

REFERENCES:

1. W.C.Evans, Trease and Evans Pharmacognosy, 15th edition, W.B. Sounders & Co., London, 2002.
2. Tyler, V.E., Brady, L.R. and Robbers, J.E., Pharmacognosy, 9th Edn., Lea and Febiger, Philadelphia, 1988.
3. J. Reinert and Y.P.S Bajaj, Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, Narora Publishing House, New Delhi, 1998.
4. S. S. Purohit and S. B. Vyas, Medicinal plant cultivation (A Scientific approach), Agrobios, Jodhpur, 2004.
6. Herbal Drugs Industry by R.D. Chowdary
7. A.N. Kalia, Textbook of Industrial Pharmacognosy, CBS Publishers, New Delhi, 2005.
8. Pharmacognosy, Phytochemistry, Medicinal Plants by Jean Bruneton
9. Natural Products a laboratory guide by Raphael Ikan.
10. Foye's Principles of Medicinal Chemistry by Thomas L.Lemke David A. Williams et.al.
11. Pharmacognosy by C.K. Kokate
12. Text book of Pharmacognosy, by G.E. Treese and W.C. Evans, 15^{th} edition, W.B. Saunders Edenburg, New York.,
13. Wilson and Gisvold's Text Book of Organic medicinal and Pharmaceutical Chemistry.

PHARMACOLOGY & TOXICOLOGY

L T P C

3 0 0 3

Objective: The main purpose of the subject is to understand what drugs do to the living organisms and how their effects can be applied to therapeutics. The subject covers the information about the drugs like mechanism of action, physiological and biochemical effects along with the adverse effects, clinical uses, interactions, doses, contraindications and routes of administration of different classes of drugs and also study the toxicology aspects of drugs.

UNIT I - General Pharmacology

Routes of administration, Pharmacokinetics, Pharmacodynamics, Receptors, Mechanism of action of drugs, Factors modifying drug action, adverse drug reaction, drug interactions, Bioassay of drugs, drug discovery and development. **(9 L)**

UNIT II - Peripheral and Central Nervous System

Classification , Mechanism of action, Pharmacology of parasympathomimetics, parasympatholytics, sympathomimetics, sympatholytics, neuromuscular blocking agent, general anaesthetics, antipsychotics, antidepressants, antiepileptic, analgesics, antipyretic, anti-inflammatory (NSAIDS), CNS stimulants. **(9 L)**

UNIT III - Cardiovascular Pharmacology

Classification, Mechanism of action, Pharmacology of cardiac glycosides, anti anginal, antihypertensive agents, vasodilators including calcium channel blockers, anti arrhythmic and anti hyperlipidemic agents**.** **(9L)**

UNIT IV - Chemotheraphy

General principles of chemotherapy, sulphonamides, antibiotics– penicillins, cephalosporins, chloramphenicol, macrolides, fluroquinolones. Chemotherapy of tuberculosis, leprosy, fungal, viral diseases, malignancy and immunosuppressive agents**.** **(9 L)**

UNIT V – Toxicology

Principles of toxicology - Abnormal action of drugs such as tolerance, addiction, habituation, idiosyncracy, allergy, hypersensitivity, antagonism, synergism, potentiation, tachyphylaxis. Adverse drug reactions and its monitoring. Heavy metals poisoning**.** **(9 L)**

(Total : 45 L)

REFERENCES:

1. Satoskar, R.S., Bhandarkar, S.D. and Rege, N.N., "Pharmacology and Pharmacotherapeutics", Popular Prakashan (P) Ltd., 2006.
2. Tripathi, K.D., "Essentials of Medical Pharmacology", 4th Edition, Jaypee BrothersMedical Publishers (P) Ltd, 1999.
3. Hardman, J.G. and Limbird, L.E., "Goodman and Gilman's: The Pharmacological Basis of Therapeutics" 10th Edition, Medical Publishing Division, 2001.
4. Das, M.M., "Pharmacology for Second Professional Students" 5th Edition, Books and Allied (P) Ltd, 2004.
5. Katzung BG. Basic and clinical Pharmacology, Prentice Hall International.
6. Goodman and Gilman's The Pharmacological Basis of Therapeutics. (International Edition) McGraw Hill, New York (2001), 10th Edition.
7. Pharmacology by Rang HP, Dale MM and Ritter JM. Churchill Livingstone, London, 6th Edition, 1999.
8. General and applied toxicology by B.Ballantyne, T. Marrs, P. Turner (Eds) The Macmillan Press Ltd, London.
9. Basic and Clinical Pharmacology by Bertram G Katzung (International Edition) Lange Medical Book/McGraw-Hill, U.S.A. (2001) 8th Edition.
10. Harrison's Principles of Internal Medicine. (2 Volumes 2001) by Braunwald, Fauci, Kasper, Hauser, Longo Jameson, McGraw Hill, New York, 15th Edition.

INORGANIC CHEMISTRY PRACTICAL - I

L T P C

0 0 4 2

Objective: Semi micro qualitative analysis, Complexometric titration and hardness estimation are to be given for develop the technical skill of the inorganic analysis and estimation of the student

1. Semi micro qualitative analysis of inorganic mixture containing two less-familiar cations, W, Tl, Se, Te, Mo, Ce, Th, Zr, Ti, V, U and Li.
2. Complexometric titrations – Estimation of Cu, Zn and Mg by EDTA titration in the presence of either Pb or Ba.

INORGANIC CHEMISTRY PRACTICAL – II

L T P C

0 0 4 2

Objective: Separation and estimation of inorganic molecules to be adopted for improve the skill of Inorganic analysis to the students.

1. Separation and estimation of metal ions in a mixture by volumetric and gravimetric methods. Some typical recommended mixtures are:
   Cu(II) & Ni(II); Fe(II) & Cu(II); Cu(II) & Zn(II); Ca(II) & Ba(II); Fe(II) & Ni(II)
2. Preparation of co-ordination complexes (a minimum of 8) and their characterization by conductivity, electronic & IR spectral and chromatographic techniques.

REFERENCES:

1. V.V. Ramanujam, 'Inorganic Semimicro Qualitative analysis, 3rd revised Edn, The National publishing Co., Chennai, 1988.
2. 'Vogel's Text Book of Quantitative Chemical Analysis', Eds. G.H. Jeffrey, J.Banett, J. Mendham and R.C. Denney, ELBS, 5th Edn. Reprint 1991.

SECOND SEMESTER

ORGANIC CHEMISTRY – II

L T P C

4 0 0 4

Objective

1. To study about the Aliphatic and aromatic nucleophilic substitution reactions
2. To study about the Aliphatic and aromatic electrophilic substitution reactions
3. To understand the concept of asymmetric synthesis of organic molecules
4. To know about the concept of elimination and addition reactions
5. To learn about the function and structure of Carbohydrates and Nucleic acids:

UNIT I

a) Aliphatic nucleophilic substitution

S_N1, S_N2, S_Ni, S_Ni' and tetrahedral mechanisms - ambident nucleophiles and ambident substrates - effect of substrate, attacking nucleophile, leaving group, and reaction medium - neighbouring group participation (NGP) - hydrolysis of esters.

b) Aromatic nucleophilic substitution

S_NAr, S_N1 and benzyne mechanisms **(15 L)**

UNIT II

a) Aliphatic electrophilic substitution

S_E1, S_E2 and S_Ei mechanisms.

b) Aromatic electrophilic substitution reactions

Arenium ion and S_E1 mechanisms. Orientation and reactivity of monosubstituted benzene rings - ortho/para ratio - Ipso attack. Quantitative treatment - reactivity in the substrate - reactivity of the electrophile, effect of leaving group. **(12 L)**

UNIT III - Asymmetric Synthesis

Chiral auxiliatries, methods of asymmetric induction – substrate, reagent and catalyst controlled reactions; determination of enantiometric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic. Cram's rule, Prelog's rule-stereoselective and stereospecific syntheses.

Asymmetric reactions with mechanism: Aldol and related reactions including Cram's rule, Sharpless enantioselective epoxidation, hydroxylation, aminohydroxylation, Diels-Alder reactions. **(15 L)**

UNIT IV - Elimination and Addition reactions

Elimination Reactions

E1, E2, E1CB mechanisms - stereochemistry of eliminations - elimination versus substitution - orientation of double bond - Sayzteff and Hoffman rules - pyrolytic eliminations - mechanism of pyrolysis of esters of carboxylic acids.

Addition reactions

Electrophilic, nucleophilic and free radical additions - Orientation and stereochemistry of addition of halogens and hydrogen halides to carbon-carbon multiple bonds - hydroboration, Sharpless asymmetric epoxidation and hydroxylation - Addition to α, β - unsaturated carbonyl compounds. **(10 L)**

UNIT V - Carbohydrates and Nucleic acids

a) Carbohydrates: classification of carbohydrates, sugar and non-sugar compounds, ring structure of carbohydrates, amylose, cellulose, acetylation of carbohydrates, epimerisation, carbohydrates reaction with phosphoric acids and amines, Optical activity –mutarotation of glucose.

b) Nucleic acids: Structure and function of physiologically important nucleotides (c-AMP, ADP, ATP) and nucleic acids (DNA and RNA), replication, genetic code, protein biosynthesis, mutation. **(08 L)**

(Total 60 L)

REFERENCES:

1. Peter Sykes, A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi, 1989.
2. J. Clayden, N. Greeves, S. Warren and P. Wothers, Organic Chemistry, Oxford University Press Inc., New York, 2001.
3. Jerry March, Advanced Organic Chemistry, 4th edition, John Wiley & Sons Inc., New York, 1992.
4. S.M. Mukherji and S.P Singh, Reaction Mechanisms in Organic Chemistry, Macmillan India Ltd., New Delhi, 1997.
5. E.S. Gould, Mechanism and Structure in Organic Chemistry, Henry Holt, Reinhart and Winston Inc, New York, 1959.
6. T.W.G Solomon, Organic Chemistry, 5th edition, John Wiley & Sons, Inc., New York, 1992.
7. F.A Carey and R.J. Sundberg, Advanced Organic Chemistry, part A & B 3rd Edn. Plenum Press, New York, 1993.
8. R.O.C Norman and J.M. Coxon, Principles of Organic Synthesis, 3rd Ed. ELBS with Chapman & Hall, 1993.
9. A. Streitweiser and C.H. Heathcock, Introduction to Organic Chemistry, Macmillan Publishing Co., Inc., New York, 1976.
10. G.M. Badger Aromatic Character and Aromaticity, Cambridge, 1969.

11. P.J. Garratt, Aromaticity, McGraw-Hill Book Co., New York, 1971.
12. T.H. Lowry and K.S. Richardson, Mechanism and Theory in Organic Chemistry.
13. V.K. Ahluwalia and R.K. Parashar, Organic Reaction Mechanisms, Narosa Publishing House
14. Principles of Biochemistry - L. Stryer (W.H. Freeman & Co.)
15. Principles of Biochemistry - A.L.Lehninger, D.W.Nelson & M.M.Cox (Macmillan)
16. Biochemistry - D.Voet & J.G.Voet (John Willey).
17. Harper's Illustrated Biochemistry - R.K.Murray et al. (McGraw Hill).
18. Lehninger's Principle of Biochemistry by David L. Nelson and Michael M. Cox. W. H. Freeman; 4th edition (2004).
19. Text Book of Biochemistry with clinical correlation by Thomas .M. Devlin, John Wiley-Liss, Hobokhen NJ publishers (2006).

INORGANIC CHEMISTRY – II

L T P C

4 0 0 4

Objective

1. To study about the Coordination chemistry of thermodynamics stability kinetics of complex molecules.
2. To learn about the spectral techniques of NMR & EPR.
3. To understand the concept of crystal structure of solid materials.
4. To learn about the Photochemistry of inorganic molecules

UNIT I – Coordination Chemistry - II

Thermodynamic stability – stepwise and overall stability constants and their relationship – determination of stability constant by potentiometric and spectrophotometric methods, factors affecting stability : chelate effect, kinetic and thermodynamic template effects and their application in the synthesis of macrocyclic ligands; HSAB concept : applications and theoretical basis, characterization of stabilities of mixed ligand complexes. **(10 L)**

UNIT II – Coordination Chemistry - III

Kinetic stability, lability and inertness; ligand substitution reactions in octahedral and square planar complexes: acid hydrolysis, base hydrolysis and anation reactions; trans effect – theories and applications; electron transfer reactions: complementary and non-complementary types; inner and outer-sphere processes – applications of electron transfer reactions in synthesis of coordination complexes – reactions of coordinated ligand : mechanism of ascorbic acid oxidation by free and chelate Cu(II) Complexes. **(14 L)**

UNIT III - NMR & EPR Spectroscopy

NMR: Applications of chemical shift and spin – spin coupling to structure determination using multiprobe NMR (B^{11}, F^{19} and P^{31}); effect of quadrupole nuclei on spectra; NMR studies on exchange rates and fluxional behavior; paramagnetic NMR and contact shifts.

EPR: Zero field splitting and Kramer's degeneracy; covalency of M-L bonding by EPR; EPR studies on Jahn Teller distortion in Cu(II) complexes; structural elucidation of inorganic compounds by EPR data.

(**10 L)**

UNIT IV - Solid state chemistry

Crystal defects : point, line and plane defects - intrinsic point defects: Schottky and Frenkel defects - extrinsic point defects: non-stoichiometric defect - preparation and physical properties of non-stoichiometric compounds, colour center.

Electronic structure of solids: free electron and band theories - types of solids: insulators. intrinsic and extrinsic semiconductors - optical and electrical properties of semiconductors: photovoltaic and Hall effect; superconductor, high T_c superconductors – properties and applications, BCS theory; solid electrolytes: β-alumina and silver compounds and their applications.

Unique nature of solid state reactions and their different types with one example for each. (**14 L)**

UNIT V – Inorganic Photochemistry

Properties of excited states, electronically excited states of metal complexes and charge transfer excitations - bimolecular deactivation and energy transfer processes; ligand field photochemistry – photosubstitution, photoisomerisation and photoredox reactions; synthesis, properties and charge transfer photochemistry of $Ru(bpy)_3^{2+}$ - photochemical conversion and storage of solar energy - photochemistry at semiconductor electrodes –Honda cell and water photolysis. (**12 L)**

(Total 60 L)

REFERENCES:

1. D.F. Shriver, P.W. Atkins and C.H. Longford, Inorganic Chemistry, Oxford, 1990.
2. W.L.Jolly, Modern Inorganic Chemistry, McGraw Hill Company, 2nd Edn. 1991.
3. J.E. Huheey, E.A. Keiter and R.L. Keiter, Inorganic Chemistry, Harper and Row/Pearson Asia, 2,3 & 4th Edn.1993.
4. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, John Wiley & Sons, 3,4&5th Edn.1988.
5. B.E. Douglas, D.H. McDaniel and J.J. Alexander, Concepts and Models of Inorganic Chemistry, John Wiley & Sons, 2nd Edn. 1983.
6. J.D. Lee, Concise Inorganic Chemistry, ELBS 1990.
7. R.F. Purcell and J. Kotz, Advanced Inorganic Chemistry, Saunders Golden.
8. R.S. Drago, Physical Methods in Chemistry, W.B. Saunders, 1997.
9. E.A. V. Ebsworth et al., Structural Methods in Inorganic Chemistry, ELBS 1987.
10. Azaraff, Introduction to Solids, Tata McGraw Hill, 11th Reprint, 1992.
11. C.Kittel, Introduction to Solid State Physics, Wiley Eastern, 5th Edn. 1992.
12. A. R. West, Solid state chemistry and its applications, John Wiley & Sons, New York, 2004.
13. J.K. Rohatgi – Mukherjee, Fundamentals of Photochemistry, Wiley Eastern Revised Edn. J. Chem. Ed., October 1983 issue, American Chemical Society
14. A.W. Anderson and F.D. Fleischer, Concepts of Inorganic Photochemistry, John Wiley and Sons, New York, 1975.

PHYSICAL CHEMISTRY-II

Quantum Chemistry, Thermodynamics and Surface Chemistry

L T P C

4 0 0 4

Objective

1. To study about the quantum mechanics of the molecules
2. To understand the concept of thermodynamics of chemical reaction
3. To study about the physical and chemical behavior on the surface of the molecule

UNIT I - Quantum Chemistry - I

Planck's Quantum theory – Wave particle duality – uncertainity principle, operators and commutation relation, postulates of quantum mechanics – simples systems – one dimensional box, three dimensional box – rigid rotator – harmonic oscillator – hydrogen atom, shapes of atomic orbitals – orbital and spin angular momenta. **(12 L)**

UNIT II - Quantum Chemistry-II

Many electron systems – Pauli's antisymmetry principle – slater determinant – Approximation methods – variation and perturbation – applications to helium atom – Hartree Self Consistent field theory. Spin-orbit interaction –term symbols – vector model of the atom

Born-oppenheimer approximation – LCAO – MO for H_2^+ ion – VB treatment of H_2 molecule. Homo and heteronuclear diatomic - Hybridisation – sp, sp^2, sp^3, HMO theory – ethylene and butadiene. **(14 L)**

UNIT III - Thermodynamics- II

Ensemble of systems – state of a system – phase space – statistical equilibrium- microcanonical, canonical and grand canonical ensemble – micro and macro states; derivation of classical Boltzman distribution law; quantum statistics – Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann statistics – comparison of B. E. and F. D. statistics with Boltlzman statistics – photon gas and electron gas; Boltzmann-Planck equation; partition function – partition function and thermodynamics properties – partition function and equilibrium constant; concept of negative Kelvin temperature. **(14 L)**

UNIT VI - Surface Chemistry -I

Liquid interfaces – Gibbs adsorption isotherm – surface films – spreading of one liquid on another – measurement of film pressure; solid-liquid interfaces – contact angle – wetting as a contact angle phenomenon – wetting as a capillary action phenomenon; detergency – general aspects of soil removal – factors in detergent action; foams and aerosols. **(10 L)**

UNIT V - Surface Chemistry -II

Solid-gas interfaces – physisorption , chemisorptions –Langmuir, Freundlich and BET isotherms - surface area determination – heats of adsorption; heterogeneous catalysis – role of surfaces in catalysis – semiconductor catalysis – n-and p-type surfaces; kinetics of surface reactions involving adsorbed species – Langmuir- Hinshelwood mechanism – Langmuir – Rideal mechanism. **(10 L)**

(Total 60 L)

REFERENCES:

1. A.K. Chandra, Introduction to quantum Chemistry, Tata McGraw Hill, New Delhi, 1997.
2. L.N. Levine, Quantum Chemistry, Prentice Hall, New Delhi 1994
3. R.K. Prasad Quantum Chemistry, Wiley Eastern, 1993
4. F.E. Pilar, Elementary Quantum Chemistry, McGraw-Hill, New Delhi, 1968
5. S. Glasstone, Theoretical Chemistry, Van Nostrand, New York, 1944
6. S. Glasstone, Thermodynamics for chemists, Van Nostrand, New York, 1969.
7. M. C. Gupta, Statistical Thermodynamics, Wiley-Eastern, New Delhi, 1990.
8. J. Rajaram, J.C. Kuriacose, Thermodynamics for chemistry, Shoban Lal Nagain Chand, New Delhi, 1986.
9. A.W. Adamson, Physical Chemistry of Surfaces, 5^{th} Edition, John Wiley and Sons, New York, 1990.
10. S. Glasstone, Text Book of Physical Chemistry, 2^{nd} Edition, Macmillan India Ltd, New Delhi , 1974.
11. K.J. Laidler, Chemical Kinetics, 2^{nd} Edition, Tata McGraw –Hill, New Delhi 1991.
12. J.C. Kuriacose, Catalysis, Macmillan India Ltd., New Delhi, 1991.

CHEMISTRY OF NATURAL PRODUCTS

L T P C

3 0 0 3

Objective: This course facilitates an understanding of the preparation and properties of selective heterocyclic compounds and some medicinally important chemicals obtained from plant origin.

UNIT I – Heterocyclic compounds

Preparation and properties of some of the important mono-heterocycles like indole, quinoline, isoquinoline, - Compounds with two heteroatoms – pyrazoles and thiazoles - Purines and pyrimidines – uric acid, adenine and guanine.

Xanthine bases: Caffeine, Theobromine and Theophylline. **(9 L)**

UNIT II -Terpenoids

Classification – General methods of determining structure – Chemistry of acyclic monoterpenes (Myrcene), Monocyclic monoterpenes (Terpeniol), Bicyclic monoterpenes (Camphor) and sesquiterpenes (Squalene)- Abietic acid. **(9 L)**

UNIT III - Alkaloids

General methods of structural elucidation – Structure, stereochemistry and synthesis of the quinine, morphine, reserpine and atropine . **(9 L)**

UNIT IV - Steroids

Classification and nomenclature – Structure and stereochemistry of cholesterol- Male Sex hormones (Testosterone and Androsterone) - Female Sex hormones (Oestrone, Oestriol and Oestradiol, Progesterone) – Ergosterol and its irradiation product- A General study of adrenocortical steroids- cardiac glycosides – Diosgenin.

Prostaglandins- structure, stereochemistry, physiological effects and synthesis of PGE1 and $PGF_1 \alpha$.

(9 L)

UNIT V - Antibiotics

Definition and Classification – A detailed study of structural elucidation and synthesis of penicillin (β- lactam)-Elementary idea about the structure and physiological action of Fluoroquinolone, Ciprofloxacin and Norfloxacine -Tetracyclines and Griseofulvin. **(9 L)**

(Total : 45 L)

REFERENCES:

1. I.L. Finar Organic Chemistry, vol II, Longman, 5th edition,1988.
2. A.R. Kartitzkey and J.M. Lagowski, Principles of Heterocyclic Chemistry, Chapman & Hall, New edition, 1971.
3. R.M. Acheson., Chemistry of Heterocyclic compounds, Wiley-Interscience; 2nd Edition, Volume 9 edition, 2007.
4. R.K. Bansal, Heterocyclic Chemistry – Synthesis , reactions and mechanism, Wiley Eastern, New Delhi, 1990.
5. K.W. Bently, Alkaloids Vol. I, Inter-science, 1957.
6. L.F. Fieser and M. Fieser, Steriods, Literary Licensing, LLC, 2013.
7. G.A. Cordell, Introduction to Alkalodis: A Biogenetic Approach, John Wiley & Sons Inc, 1981.
8. K.B.G. Torsell, Natural Products Chemistry, John Wiley & Sons, New York, 1983.
9. Burger's Medicinal Chemistry and Drug Discovery 8 Volume Set Wiley, 7th Edition, 2010.
10. P.M. Ramwell, The Prostaglandins, Vol I, Plenum press, 1973.
11. Gurdeep Chatwal, Organic Chemistry of Natural Products, Vol. II, Himalaya Pub. House, Bombay 1985.
12. Manfred E. Wolff, Burger's Medicinal Chemistry, Part I to III, 4th Edn. John Wiley & Sons, New York, 1980.

PHARMACEUTICAL DOSAGE FORMS

L T P C

3 0 0 3

Objective: This course is designed to impart a fundamental knowledge on the preparatory pharmacy with arts and science of preparing the different conventional dosage forms and to study the influence of pharmaceutical additives and various pharmaceutical dosage forms on the performance of the drug product.

UNIT I - Preformulation studies and Monophasic Liquid Dosage Forms

Physical/physicochemical properties of drugs - physical form, particle size, shape, density, wetting, dielectric constant, solubility, polymorphism, dissolution, organoleptic properties and their effect on formulation, stability and bioavailabilty. Dissolution process – Solubility and Physical characters of liquid dosage forms – Liquid formulations for internal use – external use. **(9 L)**

UNIT II - Biphasic Systems and Semi Solid Dosage Forms

Emulsions – formulation of emulsions – stability – evaluation of emulsions – Suspensions – Formulations – problems in suspension – evaluation of suspensions – Suppositoreis – Suppository bases – formulation and packaging – formulation problems – processing of suppositories – drug availabilities from suppositories – evaluation of suppositories – Ointments – skin structure and drug absorption – ointment bases – additives – special type of ointments – processing and evaluation of ointments. Creams-formulation and evaluation **(9 L)**

UNIT III - Solid Dosage Forms

Types of tablets - Tabletting equipments – Granulation technology – Formulation of Tablets – Processing problem of tablets and evaluation of tablets. Tablets Coating – Principles – Tablet coating process – Sugar coating – Film Coating – Specialized coating – Evaluation of coated tablets. Hard gelatin Capsules – Raw materials – Manufacture – Formulations – Filling equipments – Evaluations – Soft gelatin capsule – Rationale – Manufacture –Formulation – Evaluation. **(9 L)**

UNIT IV - Parenteral Products

Diversities of parenteral products – Formulation of parenteral products – Sustained action parenteral products – Processing and Packaging– Evaluation of parenteral products –specialized parentral products. **(9 L)**

UNIT V - Pharmaceutical Aerosols

Components of aerosol package – Formulation, Stability testing, Manufacture, Quality control and Testing of pharmaceutical aerosols. **(9 L)**

(Total 45 L)

REFERENCES:

1. Lachman, Leon et al. "The Theory and Practice of Industrial Pharmacy" 3rd Ed., Varghese Publishing House, 1987.
2. Aulton, Michael E. "Pharmaceutics: The Science of Dosage Form Design" 2nd Ed., Churchill Livingstone, 2002.
3. Allen, Loyd V. et al. "Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems" 9th Ed., Wolters Kluver/Lippin Cott Williams & Wilkins, 2011.
4. Avis, K.E. et al. "Pharmaceutical Dosage Forms: Parenteral Medications" Vol.1-3, 2 nd Ed., Marcel Dekker, 2005.
5. Libermann, H.A. et al. " Pharmaceutical Dosage Forms : Tablets" Vol.1-3, 2nd Ed., Marcel Dekker, 2005.
6. Libermann, H.A. et al., "Pharmaceutical Dosage Forms: Disperse Systems" Vol. 1-3, 2 nd Ed., Marcel dekker, 2005.
7. Remington: The Science and Practice of Pharmacy, Volumes 1-2, 22nd edition, 2012, Edited by Allen L V, Adeboye A, Shane P D, Linda A F, Jointly published by Pharmaceutical Press and Philadelphia College of Pharmacy at University of the Sciences.
8. Modern Pharmaceutics, 4th edition, revised and expanded, 2009, Edited by G S Banker and C T Rhodes, Published by Informa Healthcare USA Inc. New York.
9. B M Mithal, A Text Book of Pharmaceutical Formulation, 6th edition, 13th reprint, 2010, Vallabh Prakashan, Delhi.
10. Bentley's Textbook of Pharmaceutics, 8th edition, 1996, Edited by E A Rawlins, All India Traveller Book Seller, New Delhi.

BIOPHARMACEUTICS

L T P C

3 0 0 3

Objective: This subject is designed to impart knowledge and skills of Biopharmaceutics and its applications in pharmaceutical development and studies the importance of bioavailability and bioequivalent studies

UNIT I - Absorption of drugs

Structure of cell membrane, Gastro-intestinal absorption of drugs, mechanisms of drug absorption, factors affecting drug absorption: Biological, physiological, physico-chemical, pharmaceutical, Absorption of drugs from non-per oral routes. **(9 L)**

UNIT II - Drug dissolution and distribution

Noyes-Whitney's dissolution rate law, study of various approaches to improve dissolution of poorly soluble drugs, In-vitro dissolution testing models, In-vitro and In-vivo correlation. Factors affecting drug distribution, volume of distribution, protein binding – factors affecting, significance and kinetics of protein binding. **(9 L)**

UNIT III - Biotransformation of drugs

Metabolism of drugs, Xenobiotics, Drug metabolizing organs and enzymes (microsomal & nonmicrosomal), Chemical pathways - Phase I reactions (Oxidative, reductive and hydrolytic reactions) and Phase II reactions (Conjugation), Significance of cytochrome P_{450} oxidation – reduction cycle, Factors affecting biotransformation of drugs. **(9 L)**

UNIT IV -Excretion of drugs

Renal excretion – Glomerular filtration, Active tubular secretion, Active (or) passive tubular reabsorption. Concept of clearance –Total body clearance, renal clearance, Organ clearance, extraction ratio and hepatic clearance. Factors affecting renal excretions of drugs.

Non renal excretions – Biliary, pulmonary, salivary, mammary, skin/dermal, gastrointestinal and genital excretions of drugs. **(9 L)**

UNIT V - Bioavailability and Bioequivalency studies

Objectives and considerations in bioavailability studies, Concept of equivalents, Measurements of bioavailability, Determination of the rate of absorption, Bioequivalence studies and its importance, Biopharmaceutical classification of drugs. **(9 L)**

(Total 45 L)

REFERENCES:

1. Biopharmaceutics and Clinical Pharmacokinetics by Milo Gibaldi, 4th edition. Philadelphia, Lea &febiger, 1991.
2. Biopharmaceutics and Pharmacokinetics, A. treatise, D.M. Brahmankar & Sunil B.Jaiswal., Vallabh Prakasan, Pitambura, Delhi.1998.
3. Applied Biopharmaceutics and Pharmacokinetics by Sharjel.L & Yu ABC, Fifth Edition McGraw-Hill Medical, 2004.
4. Current Concepts in Pharmaceutical Sciences : Biopharmaceutics, Swarbrick.J, Lea & febiger, Philadelphia, 1970.
5. Dissolution, Bioavailability and Bioequivalence. Abdou.H.M. Mack Publishing Company, Pennsylvania, 1989.
6. Biopharmaceutics and Clinical Pharmacokinetics, An Introduction, 4th edition, revised and expanded by Robert.E. Notari, Marcel Dekker Inc, New York and Basel, 1987.
7. Biopharmaceutics and Relevant Pharmacokinetics by John.G. Wagner and M.Pernarowski, 1st edition, Drug intelligence Publications, Hamilton, Illionois, 1971.
8. Encyclopedia of Pharmaceutical Technology, Volume 2, Edition 3, Informa Healthcare, 2007.
9. L. Shargel, and A. Yu, Applied Biopharmaceutics and Pharmacokinetics, Appleton and Large, Norwalk, CT, 1993.
10. P.G.Welling, F.L.S. Tse and S.V. Dighe (eds) Pharmaceutical Bioequivalence, Marcel Dekker Inc. New York, USA 1991

PHYSICAL CHEMISTRY PRACTICAL – I

L	T	P	C
0	0	4	2

Objective:

- ✓ To understand the basic concept of conductivity of ions
- ✓ To study about the distribution of molecule between two phases
- ✓ To know about the chemical kinetics of acid hydrolysis and salt effect

1. Determination of density, specific gravity, viscosity and surface tension of given sample.
2. Conductivity
    a. Determination of cell constant
    b. Dissociation constant of a weak acid
    c. Conductometric titrations:
        i) Estimation of HCl and AcOH in a mixture
        ii) Estimation of NH_4Cl and HCl in a mixture
        iii) $BaCl_2$ *vs* $NaCO_3$
3. Distribution law
    a. Partition coefficient of Iodine between two immiscible solvents.
    b. Study of the equilibrium constant of the reaction $KI + I_2 \rightarrow I_3$.
4. Kinetics – acid hydrolysis of ester – comparison of strength of acids.
5. Kinetics – persulfate – Iodide – clock reaction-primary salt effect.

PHYSICAL CHEMISTRY PRACTICAL – II

L T P C

0 0 4 2

Objective:

- ✓ To understand the concept of solubility product, dissociation constant and Potentiometry titrations
- ✓ To study about the physical and chemical behavior of oxalic acid on charcoal

1. Potentiometry
    a. Determination of solubility product of sparingly soluble silver salts.
    b. Determination of dissociation constant of weak acids.
    c. Potentiometric titrations:
        i) Redox titrations
            a) Fe^{2+} vs $Cr_2O_7^{2-}$
            b) Fe^{2+} vs Ce^{4+}
            c) I^- vs $KMnO_4$
        ii) Precipitation titration
            a) Cl^- vs Ag^+
            b) I^- vs Ag^+
            c) Mixture of Cl^- and I^- vs Ag^+
2. Adsorption of oxalic acid/acetic acid on charcoal.
3. Titration using pH meter – determination of dissociation constant of dibasic acid.

REFERENCES:

1. W. J. Popiel, Laboratory Manual of Physical Chemistry, ELBS, London 1970
2. Findlay's Practical Physical Chemistry, B. P. Levitt, Longman, London, 1985
3. D. P. Shoemaker, C. W. Garland, Experiments in Physical Chemistry, McGraw-Hill. New York, 1967.

THIRD SEMESTER

ORGANIC CHEMISTRY – III

L T P C

4 0 0 4

Objective: This course facilitates an understanding of spectral techniques to characterize the compounds and to find the synthetic pathway of organic compounds.

UNIT I

a) UV Spectroscopy

Various electronic transitions (185–800 nm), Beer–Lamberts law, effect of solvent on electronic transitions, ultraviolet bands for saturated and unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser–Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds – Scott's rules – shift reagents – steric effect in biphenyls. **(6 L)**

b) IR Spectroscopy

Instrumentation and sample handling – characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams, and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance, FT–IR. **(6 L)**

UNIT II

a) ^{1}H, ^{13}C–NMR Spectroscopy

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon–(aliphatic, olefinic, acetylenic, aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides and mercaptans), chemical exchange, virtual coupling. Stereochemistry, hindered rotation, Karplus curve – variation of coupling constant with dihedral angle. Simplification of complex spectra – double resonance, shift reagents, NOE, FT–technique – Spin Relaxation.

General considerations ^{13}C–NMR Spectroscopy – chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. 2-D NMR–COSY, DEPT. **(6 L)**

b) Mass spectrometry

Introduction to EI. Factors affecting fragmentation. Mass spectral fragmentation of organic compounds containing common functional groups, molecular ion peak, nitrogen rule, metastable peak, McLafferty rearrangement – Isotopic peaks, CI, FAB, MALDI. **(4 L)**

c) Combined Spectral Problems:

Spectral problems involving UV, IR, NMR and Mass spectral data. **(2 L)**

UNIT III - Retro Synthetic Analysis:

Strategy and planning-starting material-Linear and Convergent approach, protecting groups and activating groups. Regioselectivity, chemoselectivity. diastereoselectivity. Target molecules containing one functional group requiring a single disconnection- Synthons and synthetic equivalents. Latent polarity. Target molecules with two functional groups– 1,2-, 1,3-, 1,4-, 1,5-, and 1,6-dicarbonyl compounds, Umpolung reactions. Functional group interconversions. Retrosynthetic analysis of 2,4–dimethyl–2–hydroxypentanoic acid, trans-9-methyl–1–decalone, α-onocerin, β-bisabolene. **(12 L)**

UNIT IV - Supramolecular Chemistry

Definition – host-guest chemistry – classification of supramolecular host-guest compounds – coordination and the lock and key analysis – the chelate, macrocyclic and template effects – nature of supramolecular interactions – spherands, lariat ethers, podants, cryptands – molecular recognition, chiral recognition, molecular sieves, molecular wires, molecular switches. **(12 L)**

UNIT V

a) Selected name reactions: Aldol, Dieckmann condensation, Reformatsky, Wittig and Mannich reaction, Oppenauer oxidation, Clemmenson, Wolff-Kishner, Meerwin-Pondorf-Verley (MPV) and Birch reductions, McMurry and Polonovski reaction. **(6 L)**

b) Reagents in Organic Synthesis

Complex metal hydrides, Gilman reagent (lithium dialkylcuprates), lithium diisopropylamide (LDA), dicyclohexylcarbodiimide(DCC), Woodward and Prevost hydroxylation, DDQ, selenium dioxide, Phase Transfer Catalyst (PTC), Wilkinson catalyst, crown ethers, Peterson's synthesis. **(6 L)**

(Total 60L)

REFERENCES:

1. R.M. Silverstein, G.C. Bassler and T.C. Morrell, Spectrometric Identification of Organic Compounds, 4th Edn, John Wiley, 1981.
2. W. Kemp, Organic Spectroscopy, McMillan Press Ltd., 1996.
3. D.H. Williams and L.Fleming, Spectroscopic Methods in Organic Chemistry, Tata McGraw Hill, New Delhi, 4th Edn, 2011.
4. R.Davis and M. Fearson, Mass Spectrometry, John Wiley, New York, 1991.
5. Chablis Dass, Fundamentals of Contemporary Mass Spectrometry, Wiley-Inter-science; 1st edition, 2007.
6. H.H. Willard, L.L. Merritt, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, Wadsworth Publishing Company; 7 th Sub edition,1988.
7. D.A. Skoog and D.M. West, Principles of Instrumental Analysis, Saunders Golden Sunburst Series, Edition 2, Saunders College, 1981.
8. Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Instrumental Analysis (India Edition), Cengage Learning; 6th edition, 2007.
9. David Harvey, Modern Analytical Chemistry, McGraw Hill, 1999.
10. Vogel's Text Book of Quantitative Chemical Analysis by J. Mendham, R.C. Denney, J.D. Barnes and MJN Thomas, Edition 6th reprint, Pearson Education India, 2006.
11. Jag Mohan, Organic Spectroscopy, Principles and Applications, Narosa publishing House, New Delhi, 2001.
12. P.Y. Bruice, Organic Chemistry, Pearson Education, Inc., Delhi, 2002.
13. P.R.Young, Practical Spectroscopy, The Rapid Interpretation of Spectral Data Brooks/Cole, California, 2000.
14. S. Warren, Designing Organic Syntheses: A Programmed Introduction to the Syntheses Approach, John Wiley & Sons, 1978.
15. C.L Willis and M Wills, Organic Syntheses, Oxford University Press, 1995.
16. R.E. Ireland, Organic Synthesis, Prentice-Hall of India Pvt. Ltd, New Delhi,1975.
17. J.W. Steed and J.L. Atwood, Supramolecular Chemistry, John Wiley & Sons, New York.
18. Supramolecular Chemistry – Steed and Alkins – Jonh Wiley & Sons Ltd.,
19. Name Reactions – JieJackli – 2nd Edn. Springer

ORGANIC CHEMISTRY – IV

L T P C

4 0 0 4

Objective: This course facilitates an understanding of the reaction mechanism and preparation & properties of selective heterocyclic and green chemistry compounds.

UNIT I - Photochemistry

Photophysical processes - Jablonski diagram - Photochemical intramolecular reactions of the olefinic bond, geometrical isomerism, cyclization reactions, rearrangement of 1,3- and 1,5-dienes.

Intramolecular reactions of carbonyl compounds: Structural, cyclic and acyclic, Norrish type I and II, α, β-unsaturated and β, γ-unsaturated compounds – cyclohexadienones.

Intermolecular reactions of carbonyl compounds-cycloaddition reaction, dimerizations, Paterno-Buchi reaction.

Photosensitization, photo-oxidation, auto-oxidation, photo-reduction, Barton reaction, photo-Fries rearrangement, di-π-methane rearrangement. Photo chemistry of vision. **(12 L)**

UNIT II

a) Pericyclic reactions - conservation of molecular orbital symmetry - electrocyclic and cycloaddition reactions - Sigmatropic rearrangements - applications of correlation diagram - Applications of Frontier Molecular Orbital (FMO) theory. Perturbation Molecular Orbital (PMO) theory and Huckel-Mobius approach to the above reactions –Hofmann-Loffler-Freytag reactions, Ene synthesis, cheletropic reactions. **(6L)**

b) Molecular Rearrangements

Rearrangement to electron-deficient carbon: Wagner-Meerwin, benzil-benzilic acid.

Rearrangement to electron-deficient nitrogen: Hofmann, Curtius, Beckmann.

Rearrangement to electron-deficient oxygen: Baeyer-Villiger.

Rearrangement proceeding through electron-rich carbon: Sommelet-Hauser, Favorskii. **(6 L)**

UNIT III

a) Heterocycles

General methods of synthesis and reactions of carbazoles, acridines, oxazoles, isoxazoles, thiazoles, isothiazoles, pyridazine, pyrimidine Synthesis and applications of polypyrrole and polythiophene. **(6 L)**

b) Alkaloids and Terpenoids

Alkaloids: Classification –Biosynthesis of alkaloids and terpenoids – structural elucidation of α-pinene **(6 L)**

Unit IV: Antibiotics, Vitamins and Steroids

Vitamins: A_1, A_2, B_1, B_2, C, H.

Antibiotics: chloramphenicol, cephalosporin.

Steroids: Androsterone, testosterone, estrone, progesterone. **(12 L)**

UNIT V - Catalysis and Green Chemistry

Introduction, basic principles of green chemistry. Designing a green synthesis: Green starting materials, green reagents, green solvents and reaction conditions, green catalysts**.** Use of the following in green synthesis with suitable examples. Green reagents: dimethylcarbonate, polymer supported reagents. Green catalysts: Acid catalysts, oxidation catalysts, basic catalysts, phase transfer catalysts and biocatalysts. Green solvents: water, ionic liquids, deep eutectic solvents, supercritical carbon dioxide. Solid state reactions: solid phase synthesis, solid supported synthesis. Microwave assisted synthesis: reactions in water, reactions in organic solvents, solvent free reactions. Ultrasound assisted reactions. **(12 L)**

(Total 60L)

REFERENCES:

1. J.M. Coxon and B.Halton, Organic Photochemistry, Cambridge University Press, 1974.
2. Jagdamba Singh and Jaya Singh, Photo Chemistry and Pericyclic Reaction, New Age International (P) Ltd., New Delhi, 2003
3. Peter Sykes, A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi, 1989.
4. Jerry March, Advanced Organic Chemistry, 4th edition, John Wiley & Sons Inc., New York, 1992.
5. S.M. Mukherji and S.P Singh, Reaction Mechanisms in Organic Chemistry, Macmillan India Ltd., New Delhi, 1997.
6. E.S. Gould, Mechanism and Structure in Organic Chemistry, Henry Holt, Reinhart and Winston Inc, New York, 1959.
7. F.A Carey and R.J. Sundberg, Advanced Organic Chemistry, part A & B 3rd Edn. Plenum Press, New York, 1993.
8. .G.L Patrick, An Introduction to Medicinal Chemistry, Oxford University press, 1995.
9. Manfredd E. Wolff, Burger's Medicinal Chemistry, Part-I to Par-III, 4th Edn. John Wiley and Sons, New York 1980.
10. J.A Joule and K. Mills, Heterocyclic Chemistry, 4th Edition, Blackwell Science Ltd., Edinburgh, U.K.

11. I.L. Finar, Organic Chemistry, Vol-I & Vol-II, 5th Edition 1975, Pearson Education Asia Pte. Ltd., Ist Indian Reprint, 2000.
12. R.K. Bansal, Heterocyclic Chemistry, Wiley Eastern Ltd., New Delhi, 1990.
13. Rashmi Sanshi, M.M. Srivastra – Green Chemistry – Alpha Sciences, 2003.
14. R. Sanghi and M.M. Srivastava – Green Chemistry (Environment Friendly Alternatives), Alpha Science Internaional Ltd, Pangbourne England, 2003.
15. V.K. Ahluwalia – Green Chemistry (Environmentally Beingn Reactions), Ane Books India, New Delhi, 2006.

DRUG DESIGN AND MODELING

L T P C

3 0 0 3

Objective: This subject is designed to impart fundamental knowledge on the structure, chemistry and therapeutic value of drugs. The subject emphasis on modern techniques of rational drug design like quantitative structure activity relationship (QSAR), Prodrug concept, combinatorial chemistry and Computer aided drug design (CADD).

UNIT I – Principles of Drug Discovery

Drug discovery without lead – Penicillin's and Librium drug. Lead discovery-random screening nonrandom screening (screening of natural products, medical folklore, screening synthetic banks, existing drugs from natural ligand or modulator, combinatorial synthesis, computer aided designing & serendipity – in brief). Drug metabolism studies – Phase I, Phase II metabolism.

Clinical observations : Phase-I, Phase-II, Phase-III and Phase-IV trials (introductory treatment).

Principles of drug design; agonist, antagonist drugs, structure pruning technique in drug design (eg. Morphine pharmacophore). Development of Cimetidine, Captopril from lead molecules- bioisosterism. **(9 L)**

UNIT II - Structure – Activity Relationship Studies

(i) Binding role of hydroxyl group, amino group, aromatic ring, double bond, ketones and amides.

(ii) Variation of substituents –alkyl substituents, aromatic substituents, extension of structure, chain extension/contraction, ring expansion/contraction, ring variation, ring fusion. Isosteres

(iii) Simplification of the structure, rigidification, conformational blockers, X-ray crystallographic studies. eg., a case study of Oxaminquine (schistosomiasis), Sulpha drugs (antibacterial), Benzodiazepines (Hypnotics) and Taxol analogues, (anticancer drugs). **(9 L)**

UNIT III - a) Quantitative Structure –Activity Relationship Studies

Introduction -QSAR parameters – Substituent constants.

(i) Linear relationship between log p and biological activity

(ii) Non-linear relationship between log p and biological activity.

(iii) Electronic parameters, Steric parameters, effect of electronic and steric parameters on lipophilicity. **(5 L)**

b) Methods used in QSAR studies

(i) Linear free energy relationship (LFER). Application of Hammett equation, Hansch analysis, significance of slopes and intercepts in Hansch analysis.

(ii) Craig's plot.

(iii) Topliss scheme **(4 L)**

UNIT IV - Molecular Modelling

Introduction to molecular modelling ; Coordinate systems – Cartesian, polar, spherical polar, cylindrical and elliptical coordinates. Potential energy surfaces (definition only). Empirical force field models- molecular mechanics, energy calculations. (bond strengths, bond angles, dihedral angle, Non-bonded interactions). Energy minimizations, Molecular dimensions (e.g., Noradrenalin), Molecular properties (partial charges, electrostatic potentials). Molecular modeling studies on SB 206553 and analogues. **(9 L)**

UNIT V - Modelling Biomolecules

Introduction to modelling biomolecules, Protein structure prediction – Protein folding, secondary structure predication, sequence alignment, the inverse folding problem. Modelling by homology – the alignment, construction of the framework, selecting variable regions, side chain placement. Validation of protein models – Ramachandran plot. Molecular modelling in drug discovery, 3 D pharmacophores and detection methods, molecular docking, Denovo ligand design. **(9 L)**

(Total 45 L)

REFERENCES:

1. Donald J. Abraham (Author), David P. Rotella, Burger's Medicinal Chemistry, Drug Discovery and Development, 8 Volume Set (Burger's Medicinal Chemistry and Drug Discovery), Wiley; 7th Edition, 2010.
2. Manfred E. Wolff, Burger's medicinal chemistry and drug discovery: Therapeutic agents, Edition 5, Wiley, 1997.
3. Graham. L. Patrick, Introduction to Medicinal Chemistry, 5th Edition, Oxford University Press , USA, 2013.
4. Silverman ,Introduction to drug design, 2nd Edition, Elsevier Science & Technology books, 2008.
5. Corwin Hansch, Comprehensive Medicinal Chemistry, Pergamon Pr; 6 Volume Set edition, 1990.
6. David A. Williams, Foye's Principles of Medicinal Chemistry, Lippincott Williams & Wilkins; Seventh, North American Edition, 2012.
7. Thomas Nogrady (Author), Donald F. Weaver, Medicinal Chemistry: A Molecular and Biochemical Approach, Oxford University Press, USA; 3rd edition, 2005.
8. Hermann J. Roth, A. Kleemann, T. Beisswenger, M. D. Cooke, P. G. Sammes, Pharmaceutical Chemistry, Vol. 1: Drug Synthesis (Ellis Horwood Books in Biological Sciences, Series in Pharmaceutical Technology). Halstead Press / Ellis Horwood Ltd, 1988.
9. E J Ariens, Drug Design: v. 7 (Medicinal Chemical Monograph), Academic Press Inc., U.S., 1977.

10. Glenn L. Jenkins, Adelbert M. Knevel, Frank E. Digangi, Quantitative Pharmaceutical Chemistry 7th edition McGraw-Hill Inc.,US; 1977.
11. I.A. Khan and A. Khanum, Recent advances in Bioinformatics, 3rd Edition, John Wiley & Sons, 2008.
12. Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers, Molecular Modeling, 3rd Edition, John Wiley & Sons, 2008.
13. Andrew Leach ,Molecular modeling, 2nd Edition, Prentice Hall, 2001.

TECHNOLOGY OF FINE CHEMICALS AND BULK DRUGS

L T P C

3 0 0 3

Objective: This course facilitates an understanding of various unit processes involved in the manufacturing of pharmaceuticals, process development and optimization of bulk drugs and their synthesis and also study the industrial effluents ant its treatments.

UNIT I – Unit Processes

Concept of unit processes in systematization of chemical reactions, explanation of one example each for unit processes: Alkylation, amination, (by ammonolysis, reduction), carbonylation, carboxylation, condensation, dehydration, diazotization, disproportionation, esterification, halogenation, hydration, hydroformylation, hydrogenation, hydrolysis, hydroxylation, nitration, oxidation and reduction. **(9 L)**

UNIT II – Process Development and Optimization of Bulk drugs

a) Pilot- plant – Introduction – Appraisal for the need of pilot – plant – pilot plant (Vs) Small scale plant – Benefits of Pilot plant – Broad guidelines of process development. **(5 L)**

b) Industrial manufacturing method and flow charts of Sulphamethoxazole, Ciprofloxacin, Chloramphenicol maleate, Furazolidone, Cephalosporin and Rifampicin. **(4 L)**

UNIT III - Commercial Synthesis of Bulk drugs

Introduction to pharmaceutical manufacturing – raw materials, detailed manufacturing procedure, therapeutic function, common name, chemical name, structural formulae of the following drugs:

Acyclovir, alprazolam, propanolol, naproxen, ibuprofen, aspirin, levodopa and cimetidine. Licocaine, mephensin, ethambutal hydrochloride, 5-fluorouracil, norfloxacin, amoxycillin and levothroxin sodium. **(9 L)**

UNIT IV – Environment Health & Safety

Introduction to industrial effluents. Classification of effluents. Classification of basic methods of treating the effluents.

(i) Purification of suspended and emulsified impurities by mechanical method. **(3 L)**

(ii) Purification of dissolved impurities **(4 L)**

(a) from mineral matter by ion exchange, reverse osmosis, electrical and reagent methods.

(b) From organic matter by destructive methods, biological oxidation, ozonization, chlorination, extraction, adsorption and ion exchange.

(c) Purification of gases by desorption method.

(iii) Purification by elimination and destruction-by thermal destruction, burying and pumping into depth of oceans. **(2 L)**

UNIT V - a) Risk analysis – Handling procedure - safety management in Pharmaceutical industries **(4 L)**

b) Thermal Methods **(5 L)**

Theory- Instrumentation and applications of Thermo Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC) and Thermo Mechanical Analysis (TMA).

(Total 45 L)

REFERENCES:

1. B.K. Sharma, Industrial Chemistry, Goel Publishing House, Meerut, 14th Edn., 2004.
2. B.K. Sharma, Environmental chemistry. Goel Publishing House, Meerut, 11th Edn.,2007.
3. Philip Herkimer Groggins, Unit Processes in Organic Synthesis, 5th Edn., Tata McGraw-Hill, 1995.
4. Drydens, Unit processes in chemical engineering, McGraw-Hill Higher Education , 2004.
5. William Andrew, Pharmaceutical manufacturing encyclopedia Vol.I & II., 3rd Edn., William Andrew, 2007.
6. W.W.M. Wenland, Thermal Analysis, John Willey & Sons, New York, 2nd Edn., John Wiley & Sons, 1974.
7. S.B. Chandalia, Hand book of Process Development, Multitech Publishing Company, Mumbai. 1998.
8. Kumar G. Gadamasettia, Ambarish K. Singhb, Process Chemistry in Pharmaceutical industries, 3rd ., Edn., Taylor & Francis Group , 2013.
9. Randolph Norris Shreve, George T Autor Austin, Shreve's, Chemical Process Industries, 5th Edn, McGraw Hill Book Company.2000.
10. M.V. Krishnan – Safety Management in Industries, Jaico publishers, Mumbai, 2002.
11. S. Rao & S. Roy , Industrial Safe and Management, Khanna publications, New Delhi.
12. Profiles, Bulk drug manufacture.

DRUG REGULATORY AFFAIRS IN PHARMACEUTICAL INDUSTRIES

L T P C

3 0 0 3

Objective: This course deals with the various aspects of quality control, quality assurance, cGMP, QC tests, documentation, quality certifications and regulatory affairs of pharmaceutical industries. This subject is designed to impart the fundamental knowledge on the regulatory requirements for approval of new drugs, and drug products in regulated markets of India & other countries like US, EU, Japan, Australia,UK etc. It prepares the students to learn in detail on the regulatory requirements, documentation requirements, and registration procedures for marketing the drug products

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UNIT I - Quality Assurance

Basic concepts of quality assurance, Requirements of cGMP / GLP, ISO 9000 series, Quality audits etc.

Precision, accuracy and biases, sampling and operating characteristic curves, sampling plans, statistical inference in estimation of hypothesis testing, statistical procedure in assay development. **(9 L)**

UNIT II - Health regulatory agencies & Intellectual property management

a) Brief introduction to general requirements of health regulatory agencies such as **US FDA, MCA, TGA, WHO, ANVISA** etc. Preparation of documents for new drug application and export registration. **(5 L)**

b) Intellectual property management – Introduction to patents, content of patents and legal implications. **(4 L)**

UNIT III - Quality Control Tests

In-process and finished products quality control tests for various dosage forms including packaging and labeling operations. **(9 L)**

UNIT IV - Validation

Concepts in validation, validation of manufacturing and analytical equipments. Process validation in production of pharmaceuticals. Development of new analytical method and its validation/ Electronic records (21 CFR11). **(9 L)**

UNIT V - Drug development and Drug approval

History and Various phases of drug development and drug approval, Investigational New Drug (IND), New Drug Application (NDA) (Phase I-IV) : content and format, Abbreviated new drug application (ANDA),Content, development flow sheet and format, exclusivity, concept of phase I to IV, Clinical study and basic concepts of Good clinical practice.

Introduction to orange book, freedom of information (FOI), inactive ingredient guide (IIG), Drug master file (DMF), open part of (DMF), codes of therapeutic equivalency, CDER, CBER. **(9 L)**

(Total 45 L)

REFERENCES:

1. S.H. Willig, M.M. Tuckeman and W.S. Hitchings, "Good Manufacturing Practices for Pharmaceuticals", Drugs and Pharm. Sci. Series, Vol. 16, Marcel Dekker Inc., N.Y. 1991.
2. B.T. Loftus & R.A. Nash, "Pharmaceutical Process Validation", Drugs and Pharm Sci. Series, Vol.23, Marcel Dekker Inc., N.Y. 1990.
3. Robert A. Nash, Alfred H. Wachter, Pharmaceutical Process Validation: An International (Drugs and the Pharmaceutical Sciences) Vol. 129, Marcel Dekker Inc., 2003.
4. Sanford Bolton, "Pharmaceutical Statistics : Practical & Clinical Applications", Drugs and Pharm. Sci. Series , Vol.25, Marcel Dekker Inc., N.Y. 1990
5. Gilbert S. Banker, Christopher Rhodes, "Modern Pharmaceutics", Drugs and Pharm. Sci. Series, Vol. 7, Marcel Dekker Inc., N.Y. 4th edition, 2002.
6. Quality Control, Besterfield, D.H., Pearson, 7th Ed., 2004.
7. GLP Quality Audit Manual, Milton A. Anderson, Third Edition, Informa Healthcare.
8. Tom Tibor, Ira Feldman, Implementing ISO 14000: a practical, comprehensive guide to the ISO 14000 environmental management standards, , Tom Tibor, Ira Feldman, Irwin Professional Pub., 1997.
9. Pharmaceutical master validation plan: The ultimate guide to FDA, GMP and GLP Compliance by Syed Imitiaz Haider.
10. Drugs and Cosmetics Act, 1940 and its rules, published by Ministry of health and family welfare, Government of India.

ORGANIC CHEMISTRY PRACTICAL –I

L T P C

0 0 4 2

Objective: To enhance the organic analytical skill of students by using separation, analysis and estimation of organic molecules

1. Separation and systematic analysis of organic binary mixtures.
2. Quantitative analysis via functional groups; Estimation of ketone, aldehydes, phenols and carboxylic acids.

ORGANIC CHEMISTRY PRACTICAL –II

L T P C

0 0 4 2

Objective: To develop the technical skill of the student in extraction of a compound from natural product and single & double stage preparation of organic molecule.

1. Extraction of Natural products:
    a. Caffeine from tea dust
    b. Piperine from pepper
    c. Hesperidine from orange peels
    d. Casein from milk
    e. Lactose from milk
    f. Citric acid from lemon
    g. Lycopene from tomato
    h. Carvone from spearmint
2. Two stage preparations of some important drugs / chemicals.

ORGANIC CHEMISTRY PRACTICAL –III

L T P C

0 0 4 2

Objective: To study the various Chromatographic Techniques, Qualitative & Quantitative analysis of drugs and Quality control tests for selected dosage forms.

1. Chromatographic Techniques: Thin Layer Chromatography and Paper Chromatography (ascending, descending and circular).
2. Qualitative analysis of following categories of drugs in Biological fluids
    i. Barbiturates
    ii. Cardiac glycosides
    iii. Salicylates
    iv. Alkaloids
3. Analysis of drug substance and drug product as per official monographs.
4. Quality control tests for finished Solid dosage forms , Tablets and Capsules.
5. Applications of UV, IR, ^{1}H-and ^{13}C –NMR and Mass spectroscopy towards structural elucidation of drugs.

REFERENCES:

1. A. I. Vogel, A Text Book of Practical Organic Chemistry.
2. A. Ault, Techniques and Experiments for Organic Chemistry.
3. N. K. Vishnoi, Advanced Practical Organic Chemistry.
4. B. B. Dey and M.V. Sitaraman, Laboratory Manual of Organic Chemistry.
5. Raj K. Bansal, Laboratory Manual in Organic Chemistry.
6. Indian Pharmacopoeia (I.P), British Pharmacopoeia (B.P) and National formulary (N.F).

FOURTH SEMESTER

ORGANIC CHEMISTRY-V

L T P C

4 0 0 4

Objective: This subject is designed to impart fundamental knowledge on the structure, chemistry and therapeutic value of drugs. The syllabus also emphasizes on chemical synthesis of important drugs under each class.

UNIT I – Medicinally useful antibiotics and steroids

a) Classifications of antibiotics**,** Structural features and mode of action of Penicillin G, Cephalosporin and their synthetic analogues – (β-lactam), Streptomycin (aminoglycoside), Terramycin (tetracycline) Erythromycin (macrolide) and Chloramphenicol. **(6 L)**

b) Classifications of steroids, Physiologically active steroids – Their structural features and therapeutic use-Oral contraceptives, anabolic steroids, anti-inflammatory and cardiac active steroids. **(6 L)**

UNIT II – Chemotherapeutic agents

Synthesis, assay and therapeutic action of:

a) Antineoplastic agents: Classification, synthesis and assay of Cyclophosphamide, Ifosfamide, Chlorambucil, Busulfan and Decarbazine,. **(4L)**

b) Antitubercular drugs: Classification, synthesis and assay of Isoniazid, Rifampicin (structure only), Pyrazinamide, Ethambutol, Thiacetazone, Para aminosalicylic acid and Ethionamide. **(4 L)**

c) Antimalarial drugs: Classification, synthesis and assay of Chloroquine, Primaquine, Amodiaquine, Mefloquine and Proguanil. **(4 L)**

UNIT III– Diuretics and Antihypertensive drugs

Synthesis, assay and therapeutic action of:

a) Diuretics: Classification, synthesis and assay of Frusemide, Bumetanide, Acetazolamide, Ethacrynic acid and Hydrochlorothiazide. **(6 L)**

b) Antihypertensive drugs: Classification, synthesis and assay of Nifedipine, Captopril, Hydralazine, Clonidine and Methyldopa. **(6 L)**

UNIT IV- Antihistamines

Classification, Synthesis, assay and therapeutic action of:

a) H1–Antagonists: Pheniramine, Chlorpheniramine, Triprolidine, Diphenhydramine and Dimenhydrinate. **(6 L)**

b) H2 - Antagonists: Cimetidine, Ranitidine and Famotidine **(6 L)**

UNIT V – NSAIDs, CNS – Stimulant and CNS- Depressant drugs

Classification, Synthesis, assay and therapeutic action of:

a) Non-Steroidal Anti-inflammatory drugs: Aspirin, Paracetamal, Analgin, Ibuprofen, Mephenamic acid, and Diclofenac sodium. **(4 L)**

b) CNS – Stimulant drugs: Amphetamine, Bemegride, Nickthamide, Methyl phenidate and Piracetam. **(4 L)**

c) CNS- Depressant drugs: Phenelzine, Isocarboxazid, Imipramine, Clomipramine and Nortriptyline, **(4 L**

(Total : 60 L)

REFERENCES:

1. Bentley & Driver, Text book of Pharmaceutical Chemistry, Oxford University Press. 1969.
2. Herman J. Roth, Pharmaceutical Chemistry (Drug Synthesis) Taylor & Francis Group, 2004.
3. Kadam, Principles of Medicinal Chemistry, Vol.I and Vol.II. Nirali Prakashan, 17th Edn, 2008.
4. Tripathi, Essentials of Medical Pharmacology, Jaypee Brothers, Medical Publishers, 6th Edn, 2008.
5. Gleen L. Jenkins, Chemistry of Organic Medicinal Product, Daya Publishing House, Asian Books, UBS, 2002.
6. Ashutoshkar, Medicinal Chemistry, Anshan, 3rd Edn, 2006.
7. I.L. Finar, Organic Chemistry, Vol-II., Longman, 5th Edn, 1975.
8. Burger's Medicinal Chemistry., Vol. I, II, III, John Wiley & Sons, 6th Edn, 2003.
9. T. Robinson, Organic Constituents of Higher plants. Ulan Press, 2012.
10. Goodman and Gilman's The Pharmacological Basis of Therapeutics. (International Edition) McGraw Hill, New York (2001), 10th Edition.

PROJECT WORK AND VIVA – VOCE

Every candidate is required to submit a project work in a reputed pharmaceutical or chemical industry on a topic selected from the theory papers to be approved by the allotted guide. The project work will involve objectives, literature survey, materials and methods, results and discussion, summary &.conclusions

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SUPPORTIVE COURSE PAPER (ODD SEMESTER)

NATURAL PRODUCTS OF MEDICINAL IMPORTANCE

L T P C

3 0 0 3

Objective: This course facilitates an understanding of medicinally useful heterocyclic compounds, terpenoids , hormones, vitamins, antibiotic and steroids

UNIT – I Heterocyclic compounds:

Preparation and properties of some important mono-heterocyclic like indole, quinoline and carbazole- Compounds with two heteroatom – oxazoles, pyrazoles and thiazoles - Purines and pyrimidines – uric acid- Caffeine. **(9L)**

UNIT- II a) Terpenoids:

Classification – General methods of determining the structure -structural elucidation and synthesis of α-pinene and Camphor **(4 L)**

b) Alkaloids:

Definition and classification- General methods of determining the structure- Structure, stereochemistry and synthesis of the quinine and morphine. **(5 L)**

UNIT-III a) Proteins and Nucleic Acids:

N–Terminal and C-Terminal analysis –N- and C- protection and activation –solid phase peptide synthesis- Structural features of Oxytocin and Insulin-Structures of DNA and RNA **(5 L)**

b) Vitamins:

Introduction -Sources and deficiency diseases of Vitamin A, B_1, B_2, B_6, B_{12}, C and D – Elementary idea about their structures. **(4 L)**

UNIT-IV Antibiotics:

Definition and Classification – A detailed study of structural elucidation and synthesis of Penicillin, Chlorophenicol- Elementary idea about the structural features of Streptomycin and Tetracyclines. **(9 L)**

UNIT-V Steroids:

Classification and nomenclature – Structural features of Cholesterol- Sex hormones – Bile acids- Corticosteroids. **(9 L)**

(Total 45 L)

REFERENCES

1. I.L. Finar Organic Chemistry, vol II, Longman, 5th edition,1988.
2. A.R. Kartitzkey and J.M. Lagowski, Principles of Heterocyclic Chemistry, Chapman & Hall, New edition, 1971.
3. R.M. Acheson., Chemistry of Heterocyclic compounds, Wiley-Interscience; 2nd Edition, Volume 9 edition, 2007.
4. R.K. Bansal, Heterocyclic Chemistry – Synthesis , reactions and mechanism, Wiley Eastern, New Delhi, 1990.
5. K.W. Bently, Alkaloids Vol. I, Inter-science, 1957.
6. L.F. Fieser and M. Fieser, Steriods, Literary Licensing, LLC, 2013.
7. G.A. Cordell, Introduction to Alkalodis: A Biogenetic Approach, John Wiley & Sons Inc, 1981.
8. K.B.G. Torsell, Natural Products Chemistry, John Wiley & Sons, New York, 1983.
9. Burger's Medicinal Chemistry and Drug Discovery 8 Volume Set Wiley, 7th Edition, 2010.
10. P.M. Ramwell, The Prostaglandins, Vol I, Plenum press, 1973.
11. Gurdeep Chatwal, Organic Chemistry of Natural Products, Vol. II, Himalaya Pub. House, Bombay 1985.
12. Manfred E. Wolff, Burger's Medicinal Chemistry, Part I to III, 4th Edn. John Wiley & Sons, New York, 1980.

SUPPORTIVE COURSE PAPER (EVEN SEMESTER)

PHARMACEUTICAL ANALYSIS

L T P C

3 0 0 3

Objective: This course facilitates an understanding of fundamentals of volumetric analysis, various types of titrations, physical methods of analysis and chromatographic techniques.

UNIT–I Volumetric analysis

Significance of Quantitative analysis in quality control – Isolation and identification of drugs – Different techniques of analysis – Significant figures – Fundamentals of volumetric analysis – Methods of expressing concentration – Primary and secondary standards – Acid base concepts – Relative strength of acids and bases – Law of mass action – Common ion effect – Ionic product of water, pH, Henderson – Hesselbach equation – Buffer solutions – Neutralisation curves – Acid-base indicators and their choice. **(9 L)**

UNIT–II

a) Oxidation – Reduction Titrations: Theory and Pharmaceutical applications – Strength and equivalent weights of oxidizing and reducing agents –Titrations involving Potassium Permanganate, Potassium iodate, Potassium bromate, cerric ammonium sulphate – Iodimetry and Iodometry.

b) Precipitation Titrations: Principles – Titrations involving mercuric nitrate, ammonium or Potassium thiocyanate, barium sulphate – Argentometric titrations **(9 L)**

UNIT–III

a) Gravimetric analysis: Basic concepts – Precipitation techniques – co-precipitation- post-precipitation – Various steps involved in gravimetric analysis and their pharmaceutical applications. **(3 L)**

b) Complexometric titrations: Complexation and chelation – Werner's coordination number – stability of complexes, titrants and titrations curves – Types of complexometric titrations and methods of end point detection. **(4 L)**

c) Non- aqueous titrations: Theoritical consideration – Scope and limitations – titration of weak acids, weak bases. **(2 L)**

UNIT – IV Physical Methods:

Electrophoresis, Refractive index, Kjeldahl method of nitrogen estimation, Flame photometry – Kinematic viscosity. **(9 L)**

UNIT –V Chromatographic Techniques:

Introduction – Classification of Chromatographic techniques – adsorption and partition – Principles and application of TLC, HPTLC, Paper Chromatography – ascending and descending – Gas Chromatography. **(9 L)**

(Total 45 L)

REFERENCES

1. Clarke, Isolation and Identification of drugs, the Pharmaceutical Press, 1986.
2. Vogel's Text Book of Quantitative Chemical Analysis by J. Mendham, R.C. Denney, J.D. Barnes and MJK Thomas ELBS, 7th Edn., 2005.
3. H.H. Willard, L.L. Merritt, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, Wadsworth Publishing Company; 7 Sub edition, 1988.
4. David Harvey, Modern Analytical Chemistry, Mc Graw Hill. 1999.
5. H. Gerhard Vogel, Drug Discovery and Evaluation-Pharmacological Assays, 2nd Edn. Springer, 2008.
6. E. Heftmann, A Laboratory Handbook of Chromatographic and electrophoresis methods, 3rd Edn, Van Nostrand Reinhold, 1975.
7. Raymond PW Scott, Techniques and Practice of Chromatography. 1st Edn, Marcel Dekker Inc., 1995.
8. P.D. Sethi, Identification of Drugs and Pharmaceutical Formulations by Thin Layer Chromatography, 2nd Edn, CBS Publishers & Distributors, 2008.
9. James M. Bobbitt, Thin Layer Chromatography, Reinbold pub. Corp., Chapman and Hall, London, 2007.
10. P.D. Sethi, HPTLC – Quantitative Analysis of Pharmaceutical Formulations, 3rd Edn, CBS Publishers & Distributors, 2008.