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DEPARTMENT OF PG STUDIES IN PHARMACEUTICAL CHEMISTRY  
P.G. CENTRE, KADUR-577548


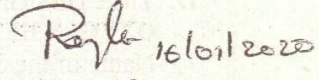
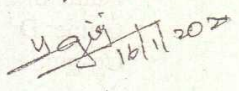
**PROCEEDINGS OF P.G. BOS MEETING**

The Meeting of the Board of Studies in Pharmaceutical Chemistry was held on 16<sup>th</sup> January 2020 at 11.00 AM in the Department of Pharmaceutical Chemistry, Post-Graduate Centre, Kadur. The following agenda were discussed in the meeting.

**Agenda**

1. Review of M. Sc. Pharmaceutical Chemistry Syllabus.
2. To scrutinize and approve the Ph.D. proposals.
3. Revision and approval of Panel of examiners for M. Sc. Pharmaceutical Chemistry.
4. Any other matter with the permission of the Chairman

**Members**

- |   |          |  |
|---|----------|--|
| 1. Dr. N.D. Satyanarayan<br>P.G.Centre, Kadur                                   | Chairman |               |
| 2. Prof. Ananda R Saundane<br>Gulbarga University, Kalburgi                     | Member   | ABSENT   |
| 3. Prof. Basavaraj Padmashali<br>RC University, Belagavi                        | Member   | ABSENT   |
| 4. Prof. Rajeshwara A.N<br>Kuvempu University, Shankaraghatta                   | Member   |  16/01/2020 |
| 5. Dr. Sanjeevkumar Giri<br>AWU, Bijapur  | Member   |  16/1/2020  |
| 6. Dr. Ravi Ujjinimattad R.K.<br>Aurigene Discovery Technologies Ltd, Bangalore | Member   | ABSENT   |



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PROCEEDINGS

1. The M. Sc. Pharmaceutical Chemistry Syllabus was reviewed thoroughly, discussed and approved
2. The following students have submitted the synopsis of their proposed research work and it is scrutinized and approved for further consideration.
  - A. Title: SYNTHESIS AND CHARACTERIZATION OF SMART HYDROGELS IN DRUG DELIVERY SYSTEM  
Name of the Student: MADHUSUDANA T. (Pre. Registration No and Date: 585/02-01-2019)  
Guide: Dr. MAMATHA G.P.  
Co-guide: Dr. DEMAPPA T
  - B. Title: SYNTHESIS AND ANTICANCER EVALUATION OF SOME BRIDGED HETEROCYCLES  
Name of the Student: SACHIN M (Pre Reg No.590/02-01-2019)  
Guide: Dr. N. D. SATYANARAYAN  
Co-guide: Dr. B.T. PRABHAKAR
  - C. Title: SYNTHESIS AND ANTICANCER STUDIES OF NEW HETEROCYCLIC COMPOUNDS CONTAINING OXYGEN, NITROGEN AND SULPHUR RING SYSTEMS  
Name of the Student: ARPITHA K. (Reg No. 589/02-01-19)  
Guide: Dr. N. D. SATYANARAYAN  
Co-guide: Dr. MANJUNATHA H
  - D. Title: DESIGN, SYNTHESIS AND ANTICANCER STUDIES OF NOVEL NITROGEN AND OXYGEN HETEROCYCLES  
Name of the Student: Miss. Anusha B. R. (Pre-Reg. No.-588/Date 07-03-2019)  
Guide: Dr. N. D. SATYANARAYAN  
Co-guide: Dr. SANTHOSH KUMAR H.S.
  - E. Title: SYNTHESIS AND ANTIMICROBIAL EVALUATION OF QUINOLINE DERIVATIVES AGAINST ORGANISMS CAUSING INFECTIOUS DISEASE.  
Name of the Student: SAKSHIT PRASAD R. (Pre-Reg. No.-587/02-01-19)  
Guide: Dr A SATISHKUMAR SHETTY  
Co-guide: Dr. N. D. SATYANARAYAN
3. Panel of Examiners for 2020-2021 was revised and approved.
4. No other matter was put forth, hence the meeting was adjourned for sine die.

  
CHAIRMAN

BOS (PG) in Pharmaceutical Chemistry  
BOS (PG) Chairman  
Dept. of Pharmaceutical Chemistry,  
Kuvempu University  
P. G. Centre  
KADUR - 577 548.





# KUVEMPU UNIVERSITY

Department of Pharmaceutical Chemistry Post -Graduate Center, Kadur  
M.Sc. Pharmaceutical Chemistry Syllabus (CBCS Scheme w. e. f. 2020-2021)

Courses(i.e., Papers) Offered (Structure of the Programme): M. Sc., Pharmaceutical Chemistry					
Paper Code	Paper Type	Title of the Paper	Hrs.	Credits	Total Credit points/semester
<b>SEMESTER-I</b>					
PC.HC. 1.01	Hardcore	Inorganic Chemistry	4	4	22
PC.HC.1.02	Hardcore	Organic Chemistry	4	4	
PC.HC. 1.03	Hardcore	Physical Chemistry	4	4	
PC.HC. 1.04	Hardcore	Analytical Chemistry	4	4	
PC.1.05	Practical-I	Inorganic Chemistry	4	2	
PC.1.06	Practical-II	Organic Chemistry	4	2	
PC.1.07	Practical-III	Physical Chemistry	4	2	
<b>SEMESTER-II</b>					
PC.HC. 2.01	Hardcore	Advanced Inorganic Chemistry	4	4	24
PC.HC.2.02	Hardcore	Advanced Organic Chemistry	4	4	
PC.HC. 2.03	Hardcore	Advanced Physical Chemistry	4	4	
PC.HC. 2.04	Hardcore	Advanced Analytical Chemistry and Nano Chemistry	4	4	
PC.2.05	Elective	Drug Discovery and Dosage Forms	2	2	
PC.2.06	Practical-I	Advanced Inorganic Chemistry	4	2	
PC.2.07	Practical-II	Advanced Organic Chemistry	4	2	
PC.2.08	Practical-III	Advanced Analytical Chemistry	4	2	
<b>Total Credit points</b>					<b>46</b>
<b>SEMESTER-III</b>					
PC.HC. 3.01	Hardcore	Spectroscopic Techniques	4	4	22
PC.HC. 3.02	Hardcore	Biorganic Chemistry	4	4	
PC.SC. 3.21	Softcore	Separation Techniques	3	3	
PC.SC. 3.22	Softcore	Pharmaceutical Analysis	3	3	
PC.SC. 3.23	Softcore	Drug Discovery and Development	3	3	
PC.3.03	Elective	Drug Design and Metabolism	2	2	
PC. 3.04	Practical-I	Synthesis of Drugs and Drug intermediates-I	4	2	
PC.3.05	Practical-II	Separation Techniques	4	2	



PC.3.06	Practical-III	Assay of Drugs by titrimetric and instrumental methods-I	4	2	
<b>SEMESTER-IV</b>					
PC.HC.4.01	Hardcore	Medicinal Chemistry-I	4	4	22
PC.HC.4.02	Hardcore	Medicinal Chemistry-II	4	4	
PC.SC.4.21	Softcore	General Pharmacology	3	3	
PC.SC.4.22	Softcore	Dosage forms and regulatory aspects	3	3	
PC.SC.4.23	Softcore	Biopharmaceutics	3	3	
PC.4.03	Practical-I	Synthesis of Drugs and Drug Intermediates-II	4	2	
PC.4.04	Practical-II	Assay of Drugs by titrimetric and instrumental methods-II	4	2	
PC.4.05	Project work	Project work	4	4	
<b>Total Programme Credit points</b>					<b>44</b>
<b>Total Programme Credit points</b>					<b>90</b>

Note: Among three soft core papers students have a choice to opt any two.



Hours		64
UNIT-I	<p><b>Periodic properties:</b> A] Review of periodicity and properties: Atomic size, ionic radii, ionization potential, electron affinity and electronegativity. Applications of electronegativity</p> <p>B] General characteristics of s, p, d, f, block elements: Comparative studies with reference to electronic configuration, relative study of various oxidation states, trends in physical and chemical properties, complexation tendency, Stereochemistry and biological applications.</p> <p>C] Transition elements: Characteristic properties, Correlation with electronic configuration, 3d, 4d, 5d series, trends in their chemistry.</p> <p>D] Lanthanides and actinides- General properties, electronic configurations, stable oxidation states, absorption spectra, magnetic properties, lanthanide contraction, causes of lanthanide contraction and comparison of general properties lanthanides with 3d and 4f block elements. General properties of actinides, actinide contraction and comparison of actinides with lanthanides.</p> <p>E] Noble gas compounds- Preparation and structures of xenon compounds.</p>	16 Hours
UNIT-II	<p><b>Chemical bonding:</b> A] Introduction to atomic orbitals, bonding, molecular orbitals- attainment of a stable configuration, types of bonds with examples. Transitions between the main types of bonding.</p> <p>B] Ionic bonding: Introduction, structure of ionic solids, properties of ionic compounds, ionic radii, factors affecting ionic radii, radius ratio rule, types and structures of simple ionic compounds NaCl, CsCl, TiO<sub>2</sub>. Lattice energy, defects in crystal - Stoichiometric defects Schottky defect and Frankel defect, Non-Stoichiometric defects - F center, interstitial ions and electrons. Born-Lande equation, Born-Haber cycle-applications, size effects, polarizing power and polarisability of ions. Fajan's rule, covalent character in ionic bonds. Hydration energy and solubility of ionic solids.</p> <p>C] Covalent bond: Valence bond approach, orbital overlaps resonance and hybridization, bond angles and shapes of molecules. MOT-LCAO methods, sigma, pi and delta MO's. Molecular orbital treatment of delocalized pi-bonding systems, polarity of covalent molecules, bond energies (bond dissociate) and bond length. Hydrogen bonding: Definition, types with examples and their importance.</p>	16 Hours
UNIT-III	<p><b>Co-ordination chemistry :</b></p> <p>A] Introduction, types of ligands, chelating, bridging and macrocyclic ligands. Nomenclature and isomerism in metal complexes. Bonding in metal complexes. Valence bond, crystal field and molecular orbital theories (salient features) crystal field splitting of d orbital in octahedral, tetrahedral, tetragonal and square planar fields. Magnitude of <math>\Delta</math>, factor affecting <math>\Delta</math>, CFSE, spectrochemical series. Shortcomings of CFT. Jahn-Teller distortion in coordination compounds. Evidences for covalency. M.O. treatment of coordination compounds involving sigma bonding.</p> <p>B] Electronic spectra and magnetic properties of complexes: Spectra of transition metal complexes Spectroscopic terms and microstates for free ions, spin-orbit coupling (L-S) scheme, obtaining terms for p<sup>2</sup> and d<sup>2</sup> configurations. Ground state terms, hole formalism, ground state terms for d<sup>1</sup> to d<sup>9</sup> configurations; splitting of terms in weak crystal fields. Ligand field (d-d) spectra: selection rules for d-d transitions - spin and Laporte selection rules and their relaxation, band intensities, band widths; Racah parameters. Orgel diagrams.</p>	16 Hours
UNIT-IV	<p><b>Modern concepts of acids and bases:</b> Bronsted theory of conjugate acid base pair, solvent system [or autoionisation] concept; strength of acids and bases -role of solvents, leveling effects of solvents, leveling and differentiating solvents; factors affecting relative strengths acids and bases [including organic acids and bases]; Lux-Flood concept, and Usanovich concept, Lewis concept-Lewis acids and bases, relative strengths of Lewis acids and bases-factors affecting Lewis acidity and basicity; HSAB concept-Pearson's principle, classification of acids and bases as hard and soft; acid-base strengths and hardness and softness; symbiosis, theoretical basis of HSAB concept, application of HSAB concept. Reactions in Non- aqueous solvents types of solvents, physical properties of solvents.</p>	16 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. F.A.Cotton and G. Wilkibnson; John Wiley and sons in Advanced Inorganic Chemistry, 5<sup>th</sup> edition - 1988.</li> <li>2. James E, Huheey, Ellen E. Keither and Richard L Keither, Harper Collins Collage in Inorganic Chemistry, Principles of Structure and reactivity, 3<sup>rd</sup> edition, Pub. 1993.</li> <li>3. Shriver and Atkins in Inorganic Chemistry, Oxford University, 3<sup>rd</sup> edition, Press 1999.</li> <li>4. J.D. Lee in Concise Inorganic Chemistry, ELBS, Edition 5<sup>th</sup>, 2017, Wiley india (P) Ltd.</li> <li>5. G.S. Manku, Tata in Theoretical Principles of Inorganic Chemistry, 4<sup>th</sup> edition, McGraw Hill 1990.</li> <li>6. B.R. Puri, L.R. Sharma, K.C. Kalia in Principles of Inorganic Chemistry (UGC Syllabus) Milestone Publishers, New Delhi, India, 2008.</li> <li>7. S. Chand and - R.D.Madan Company in Modern Inorganic Chemistry, New Delhi, First edition-1957, Reprint 2009.</li> <li>8. Dr. Sulekh Chandra in Comprehensive Inorganic Chemistry (for B.Sc. I year), New age international publishers.</li> </ol>	



FIRST SEMESTER		
PC.HC.1.02: ORGANIC CHEMISTRY		64 Hours
UNIT-I	<p><b>A] Acid-Base Concept in Organic Molecules:</b> Effect of substituents on strength of acids and bases (appropriate examples to be given). Concept of hybridization: <math>sp^3</math>, <math>sp^2</math> and <math>sp</math> hybridization with examples. Inductive, mesomeric, resonance and hyper conjugation effect.</p> <p><b>B] Reaction Mechanism:</b> Homolysis and heterolysis of covalent bond. Types of organic reagents, Formation, Structure, Stability and Reactions of Carbocation, Carbanion, Free radical, Nitrene, Carbenes and Aryne intermediates. Types of reactions, (substitution reactions <math>SN_1</math> and <math>SN_2</math>, addition reaction, elimination reactions <math>E_1</math> and <math>E_2</math> reaction) thermodynamic and kinetic requirements of reactions. Concepts of free radicals, electrophilic and nucleophilic reactions. Methods of determination reaction mechanism (Kinetic and non-kinetic methods, Identification of products, Detection of intermediates, Study of catalyst, isotopic labelling, Stereochemical evidences).</p>	16 Hours
UNIT-II	<p><b>A] Aromaticity:</b> Aromaticity in benzenoid and nonbenzenoid compounds, alternant, nonalternant hydrocarbons. Huckel's rule, annulenes. Aromaticity, antiaromaticity, nonaromaticity of organic rings systems (3-7 membered rings and ring ions).</p> <p><b>B] Reagents in Organic reactions:</b> Application of following reagents in Organic reactions. Dicyclohexyl carbodiimide (DCC). Lead tetraacetate (LTA). Osmium tetroxide. DDQ. Selenium dioxide. Phase transfer catalyst. Ionic liquids. N-Bromosuccinamide. Wilkinson's Catalyst. Diazomethane, Fentons reagent, Boron Trifluoride, Anhydrous <math>AlCl_3</math>, Hydrogen Peroxide, LAH, Periodic acid, Raney Nickel, <math>NaNH_2</math>, <math>NaBH_4</math>, Gillmanns reagent, LDA, 1,3 dithiane and 9-BBN, Ziegler Natta Catalyst.</p>	16 Hours
UNIT-III	<p><b>Named Reactions:</b> Mechanism and applications of Aldol, Perkin, Stobbe, Dickmann condensations, Riemer-Tiemann and Reformatsky reactions, Diels-Alder reaction, Friedel Craft's reaction, Wittig reaction, Micheal addition, Robinson annulation, Oppenaur oxidation, Clemmensen, Wolf-Krishner, Meerwein-Varley-Ponndorf and Birch reduction, Stork enamine, Mannich reaction, Sharpless asymmetric epoxidation, Ene reaction, Barton reaction, Hofmann- Loffler-Feyrag reaction, Shapario reaction, Baer-Villiger reaction, Chichibabin reaction.</p>	16 Hours
UNIT-IV	<p><b>Stereochemistry:</b> Concept of chirality; symmetry elements and chiral structures, Absolute configurations-D, L &amp; R, and S nomenclature. Enantiomers, Epimers, Anomers, Racemic mixtures, Resolution. Diastereomers in cyclic and acyclic systems, Optical activity in the absence of chiral carbon - Biphenyls, allenes, and spiranes. Cis-trans, syn-anti and E, Z, notations for geometrical isomers. Determination of configuration (physical and chemical methods). Conformational analysis of simple acyclic systems (butane, 1,2-dichloroethane) and acyclic systems (Chair and boat forms of cyclohexane). Effect of conformation on reactivity in acyclic and cyclic systems</p> <p><b>Chiral technology:</b> Introduction, Aminoacylase bio resolution of N-acyl aminoacids, Assymetric hydrogenation of prochiral olefins by rhodium-Duphos catalyst, Asymmetric hydrogenation of prochiral ketones by ruthenium-biphosphin-diamine catalyst, Asymmetric hydroformylation with rhodium phosphate catalyst.</p>	16 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. J. Marchin in Advanced Organic Chemistry, Wiley Interscience, 1994.</li> <li>2. F. A. Carey and Sundberg in Advanced Organic Chemistry - Part A &amp; B, 3<sup>rd</sup> edition, Plenum Press, New York, 1990.</li> <li>3. Comprehensive Organic Chemistry, Pergamon Press, New York, Vol 1, 1996,</li> <li>4. H. Pine, Hendrickson, Cram and Hammond in Organic Chemistry, Mac Grow Hill, New York, 1987.</li> <li>5. I. Finar in Organic Chemistry, ELBS Longmann, Vol. I &amp; II, 1984</li> <li>6. F. A. Carey and Sundberg in Advanced Organic Chemistry - Part A &amp; B, 3<sup>rd</sup> edition, Plenum Press, New York, 1990.</li> <li>7. B. M. Trost and I. Fleming series in Comprehensive Organic Synthesis, Pergamon Press, New York, 1991.</li> <li>8. S.S. K. Ghosh in Advanced General Organic Chemistry, Book and Allied (P) Ltd, 1998</li> </ol>	



FIRST SEMESTER

PC.HC. 1:04: ANALYTICAL CHEMISTRY

64 Hours

UNIT-I	<p>Evaluation of analytical data: Role of Analytical Chemistry. Classification of analytical methods; type of instrumental analysis; Analytical methods on the basis of sample size. Errors, types of errors-determinate and indeterminate errors, accuracy and precision. Distribution of random errors, frequency-mean, median, range, average deviation, relative average deviation, standard deviation and variance. Students confidence interval of the mean. Testing for significance comparison of two means and two standard deviation. ANOVA, Criteria for rejection of an observation-Q test. Control charts. Propagation of errors, Significant figures. Least square method of deriving calibration of plots. Principles of sampling the sampling step. Methods for sampling solid, liquid and gaseous samples.</p>	16 Hours
UNIT-II	<p><b>Titrimetric Methods of Analysis.</b> Titrimetry: Theory of indicators, indicator action, theoretical basis for titrimetric analysis, classification of titrimetric analysis - acid-base titration - Ibuprofen, Tolbutamide, Redox titration: Iodometric method - Analgin, Iodometric method, Cerimetric method - Ascorbic acid, Bromometric titration - Isoniazid, complexometric method - Calcium gluconate, and Non- aqueous titration - Chloroquin, Metronidazole, precipitation titrations in non - aqueous media. Karlfisher titrimetry and its application. <i>Gravimetry:</i> General principles, conditions for precipitation, choice of precipitation, advantages of using organic precipitations, factors influencing the solubility of the precipitate, theories of precipitation, post precipitation, effect of digestion, pH change, ion release reagents, change in oxidation states, use of mixed solvents and analytical applications. Principle and applications of TGA.</p>	16 Hours
UNIT-III	<p><b>Extraction Techniques:</b> A) Solvent extraction (liquid-liquid extraction): general principles, nature of partition forces, (dispersion, interaction dipole-dipole interaction, induction interaction, hydrogen bond inter action); Relationship between percentage of extraction and distribution coefficient and distribution ratio, extraction of metal organic complexes and ion association complexes, multiple extraction, continuous extraction and Craig tube. Ultracentrifugation, Supercritical fluid extraction. <b>B) Pure and Impure compounds:</b> Impurities in drugs, sources of impurities, effect of impurities. Limits of impurities test for purity. Limit test for Cl<sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, Pb, As, heavy metals. Introduction to inorganic pharmaceutical chemistry, Necessity of pharmacopoeia, IP, BP, USP, BPC. Formularies, European formulary, Indian national formulary.</p>	16 Hours
UNIT-IV	<p><b>Instrumentation and applications:</b> Principle, instrumentation and applications of the following techniques: Fluorescence spectroscopy, Flame photometry, Atomic absorption spectroscopy, DSC, SEM, conductometry, potentiometry, and polarimetry, Colourimetry, Spectrophotometry.</p>	16 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. Robert de Levie in Principles of Quantitative Chemical Analysis- International Edition 1997 McGraw Hill Co.</li> <li>2. Day and Underwood in Quantitative Analysis-, Printic hall India Pvt Ltd, 6<sup>th</sup> edition (1993)</li> <li>3. G.H.Jaffery, J. Bassett, J. Mendhrn and R.C. Denney ELBS in Vogels Text Book of Quantitative Chemical analysis-Revised by 5<sup>th</sup> edition (1998)</li> <li>4. D.C.Harris, W.M. Freeman in Quantitative Chemical analysis and Co, NY, USA, IVED, 1995.</li> <li>5. Gray D. Christian in Analytical Chemistry, , 5<sup>th</sup> edition John Wiley and sons, Inc.</li> <li>6. Skoog, West and Hollar, Harcourt in Fundamentals of Analytical Chemistry- Asia Pvt. Ltd. India, New Delhi 7<sup>th</sup> edition 1998.</li> <li>7. D.A. Skoog, E.J. Holler, S.R. Crouch in Instrumental Analysis, ,11<sup>th</sup> Indian Reprint, Cengage Learning India Pvt. Ltd., New Delhi, 2012.</li> </ol>	



FIRST SEMESTER		64
PC.HC. 1.03: PHYSICAL CHEMISTRY Hours		
UNIT-I	<p><b>Thermodynamics:</b> Terminology of thermodynamics-types of system, state of system, state variables thermodynamic process. Brief resume of thermodynamics, combined form of first and second law, concept of entropy, work and free energy function. Variation of free energy change with temperature and pressure. Maxwell relation, thermodynamic equation of state. Gibbs Helmholtz equation and its application. Partial molar properties-partial molar volume partial molar free energy-chemical potential and its significance. Third law of thermodynamics. Concept of residual entropy. <b>Real gases:</b> Definition of Fugacity, the relation between fugacity and pressure. Concept of activity and activity coefficient.</p>	16 Hours
UNIT-II	<p><b>A] Elementary Quantum Chemistry</b> Brief resume of blackbody radiation (Classical and Planck quantum theories and atomic spectra Bohr model and its limitations, Term Symbols). Photoelectric and Compton affects, de-Broglie hypothesis, Heisenberg's uncertainty principle, Postulates of quantum mechanics, operator concept, Eigen values and Eigen function, Schrödinger's wave equation-elementary application to particle in one dimensional box.</p> <p><b>B] Polymer Chemistry:</b> Types of polymers with examples. Molecular weight distributions: Number average and weight average molecular weight. Determination of average molecular weight - end group analysis, viscosity method, ultracentrifugation method. Brief introduction to chain and step (condensation) polymerization, chemical and X-ray diffraction analysis of polymers, polymerization in homogeneous systems.</p>	16 Hours
UNIT-III	<p><b>Chemical Dynamics</b> A brief review of basic concepts and terminology in reaction kinetics. Methods of determining rate laws. Arrhenius equation. Collision state theory for bimolecular reaction rates. Transition state theory. Comparison between collision and transition state theories. Lindeman theory of unimolecular reaction rates. Concept and significance of energy of activation. Dynamics in solutions-ionic reactions, effect of ionic strength, primary and secondary salt effects. Study of Fast reactions-study of kinetics by stopped flow technique relaxation method, Flow method.</p>	16 Hours
UNIT-IV	<p><b>Electrochemistry:</b> Electrolytic solutions, strong electrolytes, ionic-atmosphere, relaxation and electrophoretic effects, quantitative treatment of Debye -Huckle theory and its extension by Onsagar. Activity and activity coefficients, mean ionic activity coefficient, dependence of activity coefficients on ionic strength (Debye-Huckel limiting law), Debye-Huckel equation for appreciable concentration [Debye - Huckel - Bronsted equation].</p> <p>Polarization and over voltage, Half cell reactions, reversible electrodes, standard electrode potentials, electrochemical series, Nernst equation. Electrochemical energy systems - introduction, fundamentals of batteries, dry cell, alkaline MnO<sub>2</sub> batteries and other secondary batteries, Lead acid and alkaline storage batteries. Fuel cells - types, electrochemistry of fuel cells.</p>	16 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. B.R. Puri, L.R. Sharma, M.S. Pathania in Principles of Physical Chemistry (Comprehensive UGC Syllabus), 46<sup>th</sup> Edition, Vishal Publishing House, Jalandhar, India, 2012</li> <li>2. Donald A. McQuarrie, John D. Simon in Physical Chemistry - A Molecular Approach, , 3<sup>rd</sup> Edition (Viva Student Edition), Viva Books Pvt. Ltd., New Delhi, 2011.</li> <li>3. N.B. Singh, S.S. Das, R.J. Singh in Physical Chemistry, 2<sup>nd</sup> Edition, New Age International Publishers, New Delhi, 2007</li> <li>4. S.P. Agarwal and Rajesh Khanna in Physical pharmacy, 2<sup>nd</sup> edition, CBS Publishers and distributors PVT .Ltd New Delhi, YEAR 2006</li> <li>5. Peter Atkins, Jolie De Paula, , in Physical Chemistry, 8<sup>th</sup> Edition International Student Edition, Oxford University Press, New York, 2010.</li> <li>6. Ira N Levine in Physical Chemistry, 5<sup>th</sup> Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.</li> <li>7. Francis W. Sears Gerhard L. Salinger in Thermodynamics, Kinetic Theory, and Statistical Thermodynamics, , 3<sup>rd</sup> Edition, Nervosa Publishing House, New Delhi, 1998.</li> </ol>	



SECOND SEMESTER

PC.HC.2.02: ADVANCED ORGANIC CHEMISTRY		64 Hours
UNIT-I	<p><b>A] Pericyclic Reactions:</b> Molecular orbital symmetry, Frontier orbital of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system, classification of pericyclic reactions. Woodward-Hofmann correlation diagrams. FMO and PMO approach, Electrocyclic reactions, conrotatory and disrotatory motions, <math>4n</math>, <math>4n+2</math> systems, 2+2 addition of ketenes. 1,3-Dipolar cycloadditions and cheletropic reactions. Sigmatropic rearrangements-suprafacial and antarafacial shifts of hydrogen, sigmatropic shifts involving carbon moieties, 3,3 and 5,5 sigmatropic rearrangements, Claisen, Cope and aza-Cope rearrangements.</p> <p><b>B] Photochemistry:</b> Laws of photochemistry, quantum yield, factors affecting quantum yield, Jablonski diagram, bonding and anti-bonding orbitals, singlet and triplet states, relative energies of excited state. Photoreduction of ketones, photooxidation, photoisomerisation, photosensitization. Photolysis-Norrish type-I and type-II reactions. Di-<math>\pi</math>-methane rearrangement. Paterno-Buchi reaction and photochemistry of arenes.</p>	16 Hours
UNIT-II	<p><b>A] Chemistry of Heterocyclic Compounds:</b> Introduction, IUPAC nomenclature of heterocyclic ring systems (containing 3-7 membered rings, upto 3 heteroatoms), Aromaticity of heterocycles, Pyrrole, Furan, Thiophene and Pyridine-methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic and nucleophilic substitutions, acidity and basicity of pyrrole and pyridine.</p> <p><b>B] Introduction to condensed five and six membered heterocycles.</b> Preparation and reactions of indole, benzofuran, benzothiophene, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler Napierlaski synthesis. Mechanism of electrophilic substitution reactions of these heterocycles.</p>	16 Hours
UNIT-III	<p><b>Molecular Rearrangements:</b> Classification and general mechanistic treatment of nucleophilic, electrophilic and free radical rearrangements:</p> <p><b>A] Rearrangements involving migration to electron deficient carbon:</b> Wagner-Meerwein, Pinacol-Pinacolone, Wolff, benzil-benzilic acid rearrangements.</p> <p><b>B] Rearrangements involving migration to electron deficient nitrogen:</b> Beckmann, Hoffmann, Curtius, Lossen and Schmidt rearrangements.</p> <p><b>C] Rearrangements involving migration to electron deficient oxygen:</b> Bayer-Villiger oxidation, Dakin reaction and hydroperoxide rearrangements.</p> <p><b>D] Rearrangements involving migration to electron rich carbon:</b> Fevorskii, Sommelet-Houser, Naber rearrangements.</p> <p><b>E] Aromatic Rearrangements:</b> Fries, and Claisen rearrangements</p>	16 Hours
UNIT-IV	<p><b>A] Disconnection approach:</b> An introduction to synthons and synthetic equivalent disconnection approach, functional group inter conversions. Importance of the Order of events in organic synthesis. One group C-X and two group C-X disconnections. Protecting groups: Principle of protection of alcoholic, amino, carbonyl and carboxyl groups. Chemo selective, Regioselective, and Stereo selective reactions.</p> <p><b>B] Coupling reactions:</b> Hiyama cross-coupling reaction, Kumada cross-coupling reaction, McMurry coupling reaction, Negishi cross-coupling reaction, Stille coupling, Suzuki - Miyaura coupling, Ullmann coupling.</p>	16 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. F. A. Carey and Sundberg in Advanced Organic Chemistry - Part A &amp; B, 3<sup>rd</sup> edition, Plenum Press, New York, 1990.</li> <li>2. H. Pine, Hendrickson, Cram and Hammond in Organic Chemistry, Mac Grow Hill, New York, 1987.</li> <li>3. I. L. Finar in Organic Chemistry, ELBS Longmann, Vol. I &amp; II, 1984.</li> <li>4. F. A. Carey and Sundberg, in Advanced Organic Chemistry - Part A &amp; B, 3<sup>rd</sup> edition, Plenum Press, New York, 1990.</li> <li>5. B. M. Trost in Comprehensive Organic Synthesis - and I. Fleming series, Pergamon Press, New York, 1991.</li> <li>6. S. K. Ghosh in Advanced General Organic Chemistry, Book and Allied (P) Ltd, 1998.</li> </ol>	



SECOND SEMESTER

PC.HC.2.01: ADVANCED INORGANIC CHEMISTRY		64 Hours
UNIT-I	<p><b>Symmetry and Group Theory:</b> Introduction to symmetry with examples, molecular geometry, polyhydrides, prismanes and symmetry operations, Symmetry elements: Rotational axis of symmetry, plane of symmetry, improper rotational axis of symmetry, inversion center or center of symmetry and identity elements. Important relations of symmetry elements, deducing the implied presence of other symmetry elements - <math>C_n</math> (<math>n = \text{even or odd}</math>), <math>S_n</math> (<math>n = \text{even}</math>) and <math>S_n</math> (<math>n = \text{odd}</math>). Mathematical requirements for a point group - closure rule, associative rule, identity rule and inverse rule. Molecular point group-Nomenclature of the point group and identification of the molecular point group -molecules of low symmetry (MLS), Molecules of high symmetry (MHS) and molecules of special symmetry (MSS), Groups, subgroups and classes.</p>	16 Hours
UNIT-II	<p><b>Organometallic Chemistry:</b> Introduction, 16 and 18 electron rule, classification of organometallic compounds by bond type, nomenclature.</p> <p><b>Chemistry of organometallic compounds:</b> synthesis and reactions of organozinc and organolithium reagents (<math>n\text{-BuLi}</math>, <math>\text{PhLi}</math>).</p> <p><b>Metal Carbonyls Complexes:</b> Preparation, Structure, chemical bonding in metal carbonyls, physicochemical evidence related to M-CO bonding. Preparation of anionic metal carbonyl complexes and substituted metal carbonyl complexes.</p> <p><b>Metal nitrosyls:</b> Preparation, linear and bent nitrosyls.</p> <p><b>Cyclopentadienyl Metal Complexes:</b> Preparation, structures of Cyclopentadienyl Metal Complexes. Reactions and aromaticity of ferrocene. Catalysis by organometallic compounds-alkene hydrogenation and hydroformylation.</p>	16 Hours
UNIT-III	<p><b>Chemistry of Non-Transition Elements:</b> General discussion on the properties of non-transition elements. Special features of individual elements (C, N, O and halogen family). Polymorphism of carbon. Synthesis, properties and structures of boranes (diboranes), carboranes, borazines, silicones, phosphazenes. Oxy acids of nitrogen, phosphorous, sulphur, and halogens. Inter halogen pseudohalides.</p> <p><b>Role of Metal Ions in Biological System:</b> Essential and beneficial metal ions: general role of metal ions in biological systems. Transport across the membrane: Structure of biological membrane, active transport across biological membrane, <math>\text{Na}^+/\text{K}^+</math>-transporting ATPase, macrocyclic crown ether compounds, and ionophores.</p>	16 Hours
UNIT-IV	<p><b>Oxygen Carriers:</b> Introduction to porphyrin system, substituent effects on porphyrin rings, Hemoglobin(Hb) and Myoglobin(Mb) structure, stereochemistry and oxygenation of Hb and Mb, cooperativity, Bohr's effect. Non-heme oxygen carriers- hemerythrin and hemocyanin. Synthetic oxygen carriers.</p> <p><b>Electron Carriers Iron -sulphur proteins (ferridoxins and rubredoxins).</b></p> <p><b>Metals and Chelation in Medicine:</b> Metal ion deficiency and treatment (Fe, Zn, Cu and Mg), dependence of biological growth on the concentration of essential toxic element. Metal ion toxicity Metal ion deficiency and treatment (Fe, Zn, Cu and Mg), dependence of biological growth on the concentration of essential toxic element. Metal ion toxicity Toxic effects of metals: Toxicity of iron, copper and Wilson disease, As poisoning and Hg toxicity. Metals as carcinogens. Metal Chelation and the activity of the multipurpose drug - aspirin. Anticancer activity of Platinum complexes and its toxic effects</p>	16 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi in <i>Inorganic Chemistry - Principles of Structure and Reactivity</i>, 4<sup>th</sup> Edition, Pearson Education, Indian Edition, New Delhi, India, 2013.</li> <li>2. Peter Atkins, Tina Overton, Jonathan Rourke, Mark Weller, Fraser Armstrong in <i>Inorganic Chemistry</i>, 5<sup>th</sup> Edition, Oxford University Press, UK, 2013.</li> <li>3. James E. Huheey, Ellen A. Keiter, Richard L. Keiter in <i>Inorganic Chemistry- Principles of Structure and Reactivity</i>, 4<sup>th</sup> Edition, Pearson, Indian Edition, New Delhi, India, 2004.</li> <li>4. Gary L. Miessler, Donald A. Tarr in <i>Inorganic Chemistry</i>, 3<sup>rd</sup> Edition, Pearson Education, New Delhi, India, 2004.</li> <li>5. Keith F. Purcell, John C. Kotz in <i>Inorganic Chemistry</i>, First Indian Reprint, Cengage Learning India Pvt. Ltd., New Delhi, India 2010.</li> <li>6. J.D. Lee in <i>Concise Inorganic Chemistry</i>, 5<sup>th</sup> Edition, Blackwell Science Ltd., London, 2003.</li> <li>7. Satya Prakash, G.D. Tuli, S.K. Basu, R.D. Madan, S. Chand in <i>Advanced Inorganic Chemistry, Volume-I, and Company</i>, New Delhi, India, 2008.</li> </ol>	



SECOND SEMESTER		64 Hours
PC.HC.2.03: ADVANCED PHYSICAL CHEMISTRY		
UNIT-I	<p><b>CATALYSIS , PHASE EQUILIBRIA AND SURFACE CHEMISTRY</b></p> <p><b>A] Catalysis:</b> Introduction, characteristics of catalytic reactions, acid-base catalysis, mechanism and kinetics of enzyme-catalyzed reactions, Michaelis-Menten equation, effect of temperature, pH and concentration on enzyme catalysis. Heterogeneous catalysis: surface reactions, kinetics of surface reactions, unimolecular and bimolecular surface reactions, pH-dependence of rate constants of catalyzed reactions, oscillatory reactions and their applications.</p> <p><b>B] Phase equilibria:</b> Introduction, derivation of phase rule, applications of phase rule to one-component systems (water and sulphur systems). Two-component systems (potassium iodide-water system and ferric chloride-water system), three-component systems (two solids + one liquid system, and three liquid systems).</p> <p><b>C] Surface Chemistry:</b> Adsorption by solids, types of adsorption isotherms, chemisorption, adsorption of gasses by solids, factors influencing adsorption, Freundlich and Langmuir adsorption theories, BET theory of multilayer adsorption (Derivation of BET equation), surface area measurement, types of adsorption isotherms, adsorption from solution, Gibbs adsorption isotherm, insoluble surface films on liquids</p>	16 Hours
UNIT-II	<p><b>Colloids:</b> Types of colloids, properties of colloids-Tyndall effect, Brownian movement, Pharmaceutical applications of colloids.</p> <p><b>Coarse dispersions:</b> Suspension, classification-flocculated, deflocculated suspension. Controlled flocculation, physical stability of suspensions. Emulsions, types of emulsions, theories of emulsification, emulsifying agents-mechanism of action of emulsifying agents, factors to improve physical stability of emulsions.</p> <p><b>Surface and interfacial tension:</b> Measurement of surface and interfacial tension-Capillary and Drop method spreading coefficient, and its applications. Surfactants-classifications, hydrophilic-lipophilic balance. Solubilization, factors affecting solubilisation, micelle formation, factors affecting micelle formation, determination of critical micelle concentration, detergency and wetting agents. Contact angle, flocculating agents, deflocculating agents, foaming and antifoaming agents. Pharmaceutical applications of surfactants.</p>	16 Hours
UNIT-III	<p><b>Diffusion &amp; Dissolution:</b> Concept and importance of diffusion. Steady state diffusion. Ficks first and second law of diffusion (statement). Types of Diffusion. Diffusion cell. Concept &amp; importance of dissolution. Dissolution rate, Factors affecting the Dissolution rates, Dissolution apparatus. Historical development &amp; USP dissolution test. Dissolution model like Hixson-Crowell, Higuchi's Model. Drug release modeling through polymer matrix &amp; laminates. Concept of membrane controlled delivery &amp; its importance in dosage form design.</p>	16 Hours
UNIT-IV	<p><b>Preformulation studies:</b> Factors affecting dissolution, diffusion - pH, pka, pKw, particle size, solubility, etc. Methods to increase solubility of poorly soluble drugs, drug release mechanisms. Factors affecting / necessitating Preformulation of drug.</p> <p><b>Micromeritics:</b> Introduction, particle size distribution, surface area, Method of determining surface area-adsorption. Air permeability method, derived properties of powder, flow properties of powder, particle size, nature of particles, moisture contents angle of response, factors affecting powders. Different methods of particle size determination-Microscopic, sieving, sedimentation, coulter electrical method, Low angle light scattering method.</p>	16 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. S.P. Agarwal and Ragesh Khanna in physical pharmacy by, 2<sup>nd</sup> Edition, CBS publishers and Distributors.</li> <li>2. N.B. Singh, S.S. Das, R.J. Singh in Physical Chemistry, 2<sup>nd</sup> Edition, New Age International Publishers, New Delhi, 2007.</li> <li>3. Atkins' Physical Chemistry, Peter Atkins, 8<sup>th</sup> Edition, Jolio De Paula, International Student Edition, Osford University Press, New York, 2010.</li> <li>4. Ira N Levine in Physical Chemistry, 5<sup>th</sup> Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.</li> <li>5. R. Stephen Berry, Stuart A. Rice, John Ross in Physical Chemistry , 2<sup>nd</sup> Edition, Oxford University Press, New York, 2007.</li> </ol>	



SECOND SEMESTER		
PC.HC.2.04: ADVANCED ANALYTICAL CHEMISTRY AND NANO CHEMISTRY		64 Hours
UNIT-I	Molecular spectroscopy: Characterization of electromagnetic radiation. quantization of energy level, microwave spectroscopy, classification of molecules based on their moment of inertia. Rotation of rigid diatomic and rotational energy levels. Isotopic effect on rotational spectra, rotational spectra of non-rigid and linear polyatomic molecules. Vibrational Spectra: Vibrational spectra of diatomic molecules, simple harmonic oscillators models. Vibrational energy levels and vibrational spectra. The anharmonic oscillator model. Hot bands, fundamental bands and overtones. Vibration and rotation spectra, PQR branches, break down of Born-Openheimer approximation. Electronic spectra, electronic transition in diatomic molecules, $V'$ and $V''$ progression, Frank-Condon principle and pre-dissociation.	16 Hours
UNIT-II	Raman spectroscopy: Introduction, Raman and Rayleigh scattering, Stokes and anti Stokes lines, polarization of Raman lines, depolarization factor, polarizability ellipsoid. Theories of Raman spectra-classical and quantum theory. Rotation, vibration and rotation-vibration Raman spectra. Comparison of Raman and IR spectra, rule of mutual exclusion principle. Advantages of Raman spectra. Molecular data bond length and vibration determined by Raman spectroscopy. X-ray crystallography: Fundamentals of X-ray crystallography, law of interfacial angles, laws of symmetry, Miller indices, crystal systems, Bravais lattice, X-ray diffraction, Bragg equation, Bragg X-ray spectrometer, Experimental methods-powder and rotating crystal method.	16 Hours
UNIT-III	Mossbauer spectroscopy: Theoretical basis. Interpretation of Mossbauer spectra- isomer shift-Quadrupole splitting and magnetic hyperfine structure, time and temperature effects. Instrumentation. Applications-structure deduction- $I_2Br_2Cl_4, Fe_3(CO)_{12}$ Electron Spin Resonance Spectroscopy: Basic principles- intensity-width-position and multiple structure. General rules for the interpretation of the spectra. Zero field splitting and Kramer's degeneracy rule. Factors affecting the magnitude of 'g' value. Double resonance-ENDOR and ELDOR. . Applications-study of free radicals-structure determination- biological study- coordination compound and analytical applications	16 Hours
UNIT-IV	Nanochemistry: Introduction: Fundamentals and importance. Carbon nano particles: Introduction, carbon molecules, nature of the carbon bond, new carbon structures. Carbon clusters: small carbon clusters, $C_{60}$ ; Discovery, structure, crystal, alkali doping, super conductivity, fullerenes, other bulky balls. Carbon nano tubes: Fabrication, structure, electrical properties, vibrational properties, mechanical properties, application of nano materials. Methods of preparation: chemical vapour deposition. Applications of nanomaterials in medicine: immunogold labelling, applications in medical diagnosis, nanobased drug delivery.	16 Hours
	<b>References</b> 1. C.N Banwell and E.M. Mc in Fundamentals of molecular spectroscopy by Cash-4 <sup>th</sup> edition, tata Mc. Graw Hill, New delhi, 1998. 2. G. M. Barrow by Introduction to molecular spectroscopy, Mc Graw Hill, New york (International student edition) (1972). 3. B. P. Straughan and S. Walker, Spectroscopy Vol I and II , John wiley and sons Inc, New York. (1976). 4. D. N. Sathyanarayana by Vibrational spectroscopy, Theory and Applications, New Age International Publications, new Delhi, (1996). 5. H.H Willard, L.L. Merritt and J.A Dean, Instrumental methods of analysis, 7 <sup>th</sup> edition, (1988). 6. R.S Drago, Physical methods Inorganic chemistry, Affiliated East-West Press Pvt. Ltd. (student edition) (1978). 7. D A. Skoog, F J. Holler and T.A. Nieman Principles of instrumental Analysis. Fifth edition, Saunders college Publishing, Philadelphia. 8. Gurdeep and Chatwal, Instrumental methods of chemical analysis,. Himalya Publishers.	



SECOND SEMESTER		32 Hours
PC.2.05: ELECTIVE : DRUG DISCOVERY AND DOSAGE FORMS		
UNIT- I	<p><b>Drug discovery through natural product and drug discovery enzyme inhibition</b></p> <p><b>A. Drug discovery through natural product:</b> Introduction preparation of Initial extracts and Preliminary biological screening, Methods for compound structural elucidation and identification. and Compound development, a brief explanation on the development of natural product drug (Taxol).</p> <p><b>B. Drug discovery through Enzyme Inhibition:</b> Overview of Enzyme as a catalytic receptors, General concept of enzyme inhibition Reversible enzyme inhibition ex-AZT, Physostigmine. Irreversible enzyme inhibition-Affinity label and active site directed irreversible enzyme inhibitors ex-TPCK Mechanism based irreversible enzyme inactivators- Clavulanic acid and Gabaculin.</p>	16 Hours
UNIT-II	<p><b>Dosage Forms and Routes of Drug Administration:</b> Different dosage forms - Oral solids, oral liquids, solution properties; suspension, emulsion, parenteral, aerosols, inhalation products, Topical semi solids, ophthalmic products.</p> <p><b>Routes of Drug Administration: Advantages and disadvantages</b></p> <ol style="list-style-type: none"> <li>1. Local application</li> <li>2. Oral or enteral routes</li> <li>3. Parenteral route: Different types of parenteral routes of drug administration: inhalation, injections, transcutaneous, trans-mucosal, etc.</li> </ol>	16 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. S.D. Satoshkar, Bhandarkar and Nirmala Rege, Pharmacology and Pharmacotherapeutics, 2015, revised 21st Edition, Elsevier Health Sciences, Netherlands.</li> <li>2. M. N. Ghosh and Vallabh Prakash, Practical Pharmacology, 2008, sixth edition, Hilton and Company, Kolkata, India.</li> <li>3. Hans Gerhard Vogel, Drug Discovery and evaluation; Pharmacological assay, 2008, 3rd Edition, Vol-2. Springer- Verlag Berlin Heidelberg, Germany</li> <li>4. P.N. Benett and M.J. brown, Clinical pharmacology, 2012, 11th Edition, Elsevier Ltd.</li> <li>5. D. G. Graham-Smith and J. K. Aronson, Oxford text book of Clinical Pharmacology and Drug Therapy, 2002, 3rd Edition, Oxford University Press, U.K.</li> <li>6. Rama Rao Nadendla , Principle of Organic Medicinal Chemistry, 2005</li> </ol>	



THIRD SEMESTER		
PC.HC. 3.01: SPECTROSCOPIC TECHNIQUES		
UNIT-I	<p><b>UV-Spectroscopy:</b> Brief review of electromagnetic spectrum, Interaction of electromagnetic radiation (UV-Visible) with matter and its effects. UV- Visible range, energy, wavelength, frequency and color relationships. The Nature of electronic excitations, Modern Instrumentation and its working principle, Beer's Law, Lamberts law, Chromophores, auxochromes, Shift and their interpretation (including solvent effect). Colorimetry, Effect of solvent and structure on <math>\lambda_{max}</math>, prediction of <math>\lambda_{max}</math> for polyenes, alpha, beta unsaturated aldehydes and ketones, aromatic systems and their derivatives. (Woodward's-Fieser's rule). Absorption spectra of organic compounds and illustrating the phenomenon and its utilization in qualitative and quantitative studies of drugs.</p> <p><b>Optical Rotatory Dispersion:</b> Fundamental principles of ORD. Cotton effect curves, their characteristics and interpretation. Octan trule and its application with examples. Circular dichroism and its relation to ORD.</p>	64Hours 16 Hours
UNIT-II	<p><b>IR-Spectroscopy:</b> Introduction, principle and Instrumentation, Types of vibrations; interaction of I.R radiation with organic molecules, selection rules, functional group frequencies and their dependence on chemical environment (bond order, conjugation, hydrogen bonding, ring size, overtones and Fermi resonance). Interpretation of IR spectrum. Practical details of obtaining spectra, including sample preparation for spectroscopy (nujol mull and KBr disc method), qualitative interpretation of I.R spectra, FT-IR and instrumentation.</p>	16 Hours
UNIT-III	<p><b>NMR Spectroscopy:</b> Principles of NMR, theory: Types of nuclei (classical and quantum), Magnetic properties of nuclei; Excitation of spin, <math>\frac{1}{2}</math> nuclei, relaxation process, Instrumentation and its working principle: sensitivity, solvent selection, Chemical shift, factors influencing chemical shift, mechanism of shielding, spin-spin coupling, First order spin systems, coupling constant, Application of signal split and coupling constant data for interpretation of spectra. Brief outline of principles of FT-NMR with reference to <math>^{13}\text{C}</math> nucleus. Spin-spin lattice relaxation phenomenon. Free induction decay (FID) proton noise decoupling signal. Nuclear overhauser enhancement <math>^{13}\text{C}</math> NMR spectra, their presentation, characteristics, interpretation, examples and applications. Introduction to 2D-NMR techniques.</p>	16 Hours
UNIT-IV	<p><b>Mass Spectrometry:</b> Basic principles and brief outline of instrumentation. Ion formation and types, molecular ion, Meta stable ions, molecular ion peak, base peak, Meta stable ion peak, Mass analyzers, fragmentation processes. FAB, MALDI, Fragmentation patterns and fragmentation characteristics in relation to parent structure and functional groups. McLafferty rearrangement, Retro Diels alder reaction, ortho effect, structural elucidation of some organic compounds, Relative abundance of isotopes and their contribution of characteristic peaks. Mass spectrum and its characteristics. Presentation and interpretation. Application of mass spectrometry in quantitative and qualitative analysis. Determination of molecular formula and molecular weight.</p>	16 Hours
	<p>References</p> <ol style="list-style-type: none"> <li>1. RM.Silverstein and FXWebster, David J Kiemle, Spectrometric identification of Organic compounds, Seventh Ed, John Wiley &amp; Sons, NewYork, 1963.</li> <li>2. William Kemp, Organic Spectroscopy, 3<sup>rd</sup> Ed, Palgrave Publishers Ltd. 175 fifth Avenue, New York. 1991.</li> <li>3. D. L. Pavia, G. M. Lampman, G. S. Kriz, and J A Vyvyan, Introduction to spectroscopy- A guide for students of Organic chemistry, , Fourth Ed. Fort Worth Harcourt college publishers, Washington. (Latest edition), 2008.</li> <li>4. D.H.Williams and I. Fleming, Spectroscopic methods in Organic chemistry, 6<sup>th</sup>Ed, McGraw Hill Education Pvt. Ltd, Bengalure, Karnataka, India, 2005.</li> <li>5. P. S. kalsi, Spectrascopy of organic compounds, 6<sup>th</sup> Ed, New Age International (P) Ltd, Daryagunj, New Delhi, India, 2004.</li> <li>6. Kaur H, Spectroscopy, Praghathi Prakashan Publishers, Western Kutchery Road, Meerut, India, 2009.</li> </ol>	



THIRD SEMESTER		
PC.HC. 3.02: BIOORGANIC CHEMISTRY		64 Hours
UNIT-I	<p><b>Chemistry of amino acids and peptides:</b> <i>Amino acids:</i> Introduction, classification, isoelectric point. Synthesis of amino acids-Streckers synthesis, Gabriel phthalamide synthesis. Erlynmeyer's synthesis, Knoop synthesis. Chemical reaction of alpha amino acids: reactions involving a)aminogroup b)carboxylicacid and c)bothcarboxylic and aminogroup. <i>Peptides:</i> Introduction, peptide linkage, Major methods of peptide synthesis: synthesis of following di and tri peptides by using Merrifield resin. a) gly-gly b) gly-ala c) gly-val d) gly-gly-gly e) gly-ala-ala f) ala-ala-gly. Stereochemistry features and confirmation features. Determination of primary structure of protein. Blocking agents and deblocking agents used in amino group protection and de protection. Reagents and reaction used in activation of carboxylic group of amino protected aminoacids.</p>	16 Hours
UNIT-II	<p><b>Alkaloids And Nucleic acids</b></p> <p><b>A) Alkaloids:</b> Introduction, Occurrence, Structure elucidation and synthesis of following Alkaloids: Morphine, Nicotine, papaverine. Phytochemical tests for alkaloids. <b>Glycosides:</b> Introduction, General characters and classification of glycosides. Study of general methods of isolation and uses of the following: Cardiac glycosides, Anthracene glycosides and Cyanogenetic glycosides. <b>Anthocyanins:</b> Introduction, general nature of anthocyanin. Occurrence, structure and synthesis of anthocyanidins and Flavones. Phytochemical tests for flavonoids.</p> <p><b>B)Nucleic acids:</b> Classification of nucleic acids, structure of nucleosides, nucleotides and nucleic acids, nucleosides containing pyrimidine and purine bases, sequence of nucleic acids, Crick-Watson model of DNA, structure of RNA (m-RNA, t-RNA and r-RNA).</p>	16 Hours
UNIT-III	<p><b>Steroid Hormones:</b> Introduction, nomenclature, Structure and biosynthesis of cholesterol, Female and male sex hormones- structures, their significance, development of antifertility agent. Biological importance of bile acids, estrone, progesterone, testosterone, androsterone and corticosterone.</p> <p><b>Prostaglandins:</b> Introduction, Occurrence, Nomenclature, classification, synthesis and structure elucidation of PGE1, Synthesis of PGE series. Biological significance of prostaglandin. <b>Essential Oils: A]</b> Introduction, Definition, chemical nature, Classification, General methods of extraction, chemical constituents and uses of Clove oil, Cinnamonoil, Sandalwood oil, Methods of production and analysis. <b>B] Terpenoids:</b> General introduction, classification, isolation, purification and structural elucidation of Menthol and Camphor. Biological importance of terpenoids.</p>	16 Hours
UNIT-IV	<p><b>Enzymes:</b> Classification, Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites, stereo specificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. <i>Enzyme Kinetics:</i> Michaelis - Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions.</p> <p>Enzyme inhibition-Overview of enzymes as catalytic receptors, types of inhibitors - competitive, noncompetitive and uncompetitive, their mode of action. Isoenzymes, General concept of enzyme inhibition-reversible enzyme inhibition eg. Azidothymidine, physostigmine and 5-fluorouracil, Irreversible enzyme inhibition- Affinity labels and active site directed irreversible enzyme inhibitors-TPCK, mechanism based irreversible enzyme inactivators - Clavulanic acid and Gabaculin.</p>	16 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>David W. Martin, Peter A. Mayes, Victor W. Rodwell, Haper's review of biochemistry, Lange Medical Publications, Los Altos, California, 1987.</li> <li>A L Lehninger, D L Nelson and M M Cox, Principles of Biochemistry, Second Edition, Worth, New York, 1993.</li> <li>Conn E E, Stumpf P K. outlines of Biochemistry, Forth edition, John Wiley, New York, 1987.</li> <li>Gurudeep R Chatwal, The Chemistry of Organic Natural Products, Volume 2, Himalaya Publishing House, Bengaluru, Karnataka, India, 1983.</li> <li>I L Finar, Textbook Organic chemistry, volume 2, fourth edition, Longmans Green and Co. Harlow, United Kingdom, 1964.</li> <li>Nichols Price and Lewis Stevens, Fundamentals of Enzymology: The Cell and Molecular biology of Catalytic Proteins, third edition, Oxford university Press, USA, 2000.</li> <li>Malcom Dixon and Edwin C Webb, Enzymes, Academic press, New York, 1980.</li> <li>D. W. Moss, Isoenzymes, PP 204, Chapman and Hall Ltd. London. U.K, 1982.</li> </ol>	



## THIRD SEMESTER

PC. SC. 3.21: SEPARATION TECHNIQUES		48 Hours
UNIT-I	Paper, Thin layer chromatography and Column chromatography: Introduction, Terminology, Classification of chromatographic methods. Paper chromatography: Introduction, principle, methods: ascending, descending, ascending-descending, 2D, radial and applications. Thin Layer chromatography: Introduction, principle, types of adsorption, preparation techniques and applications, Types of adsorbent for TLC, mobile phase selection, reversed phase TLC, 2D- TLC, quantitative methods in TLC. Detection methods, comparison of paper chromatography and TLC.	12 Hours
UNIT-II	Column chromatography and HPTLC: Introduction, adsorption phenomenon, differential migration, types of adsorbents, such as nature of adsorption forces: Vander Waals forces, inductive (dipole) forces, hydrogen bonding forces, solvent system (mobile phase solvent system-elutotropic series, choice of solvents as eluents for column chromatography), Packing techniques (wet packing techniques and dry packing techniques). HPTLC: Introduction, Instrumentation and applications.	12 Hours
UNIT-III	Gas chromatography: Principle and Instrumentation, types of column, packed and capillary column. Column efficiency parameters, the vandeemeter equation. Resolution, liquid stationary phases, derivatization methods of GC including Acylation, Perfluoro acylation, Alkylation and Esterification. Detectors (TCD-thermal conductivity detector, FID-flame ionization detector and ECD-electron capture detector), examples of GC applications in pharmaceutical analysis. Interfacing gas chromatography with mass spectrometry.	12 Hours
UNIT-IV	High Performance Liquid Chromatography (HPLC): Principle, instrumentation in HPLC, Reversephase HPLC, packing materials (normal and reversed phase), column selection (standard column (analytical, preparative), narrow bore, micro bore columns, short column, guard columns). mobile phase selection, efficiency, retention, resolution and selectivity parameters, detectors in HPLC (UV-visible absorbance detector, refractive index detector, electrochemical detector, optical activity detector, mass detector). Comparison of GC and HPLC.	12 Hours
	<b>References</b> 1. A H Beckett and J B. Stanlake. Practical Pharmaceutical Chemistry, Volume 52, First Ed, The Athlone Press, University of London, 2 Gower Street, London, SC, May 1963. 2. K. A. Connors, A Text book of pharmaceutical analysis third Ed, John Wiley and Sons, Inc., Ansari Rd, Daryaganj, New Delhi, India, - 1982. 3. E B Hassan and T Higuchi, Pharmaceutical Analysis Vol 51, Issue I, Inter Science Publishers, Inc, 250 Aventure, New York, N.Y, 1961. 4. P.D. Sethi Quantitative analysis of drugs in. pharmaceutical formulations, third edition, 1997. 5. D A Skoog and D M West. Fundamentals of Analytical Chemistry, Fourth Ed, Saunders College Publishing, New York, N.Y, 1983. 6. Gary D Christian Analytical Chemistry, 6 <sup>th</sup> Ed., John Wiley and Sons, Inc. in. University of Washington. USA, 2004.	



**THIRD SEMESTER**

<b>PC. 3.03: ELECTIVE : DRUG DESIGN AND METABOLISM</b>		<b>32 Hours</b>
<b>UNIT-I</b>	<p><b>Drug Discovery design and Development:</b> principles of drug design, Drug discovery without lead (Pencillins) lead discovery (random screening, non-random screening), drug metabolism studies, clinical observation, rational approach to lead discovery.</p> <p><b>Lead modification:</b> identification of the active part (pharmacophore), functional group modification, SAR, structural modification to improve potency and TI (homologation, chain branching, ring chain transformation, bioisosterism).</p>	<b>16 Hours</b>
<b>UNIT-II</b>	<p><b>Physicochemical Properties of Drugs and Drug Metabolism</b></p> <p>Physicochemical properties of drug molecules in relation to biological activity- solubility, partition coefficient, hydrogen bonding, protein binding, chelation, pKa values, isosterism, geometrical and optical isomerism, steric effect and ionization.</p> <p>Drug metabolism: Introduction, sites of drug biotransformation, General Pathways of drug metabolism Phase-I metabolism Oxidation, Reduction, Hydrolysis</p> <p>Phase-II metabolism Glucouranic acid conjugation, amino acid conjugation, sulphate conjugation, methylated conjugation and acetylated conjugation, role of Cytochrome P-450 in drug metabolism, factors affecting drug metabolism.</p>	<b>16 Hours</b>
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. S.D. Satoshkar, Bhandarkar and Nirmala Rege, Phamacology and Pharmacotherapeutics, 2015, revised 21st Edition, Elsevier Health Sciences, Netherlands.</li> <li>2. M. N. Ghosh and Vallabh Prakash, Practical Pharmacology, 2008, sixth edition, Hilton and Company, Kolkata, India.</li> <li>3. Hans Gerhard Vogel, Drug Discovery and evaluation; Pharmacological assay, 2008, 3rd Edition, Vol-2. Springer- Verlag Berlin Heidelberg, Germany</li> <li>4. P.N. Benett and M.J. brown, Clinical pharmacology, 2012, 11th Edition, Elsevier Ltd.</li> <li>5. G. Graham-Smith and J. K. Aronson, Oxford text book of Clinical Pharmacology and Drug Therapy, 2002, 3rd Edition, Oxford University Press, U.K.</li> <li>6. Rama Rao Nadendla , Principle of Organic Medicinal Chemistry, 2005.</li> </ol>	



FOURTH SEMESTER		
PC.HC. 4.01: MEDICINAL CHEMISTRY-I		64Hours
UNIT-I	<p><b>Local Anti-infective agents:</b> Introduction, classification, mechanism of action, Synthesis and SAR of nitrofurazone and furazolidos.</p> <p><b>Sulfonamides:</b> Introduction, classification, mechanism of action, Synthesis and SAR of sulfisoxazoles and sulfamethoxazoles</p> <p><b>Antibiotics:</b> Introduction, classification, mechanism of action, Synthesis and SAR of Penicillin G, cephalosporins and tetracyclins.</p>	16 Hours
UNIT-II	<p><b>Antitubercular and antileprotic agents:</b> Introduction, classification, mechanism of action, Synthesis of isoniazid, ethambutal, clofazimine, dapsone.</p> <p><b>Analgesic and anti-inflammatory agents:</b> Introduction, classification, mechanism of action, Synthesis of Ibuprofen, phenylbutazone, acetaminophen, diclofenac sodium.</p> <p><b>Anticancer/antiviral, hypoglycemic agents:</b> Introduction, classification, mode of action, Synthesis of 5-fluorouracil, azidothymidine, Tolbutamide and tolazamide.</p>	16 Hours
UNIT-III	<p><b>Antihistamine:</b> Introduction, classification, mode of action, Synthesis of Phenarimine maleate, pyrilamine, ranitidine, cimetidine.</p> <p><b>Cardiovascular Agents:</b> Introduction, classification, mechanism of action, Synthesis of Antiarrhythmic agents verapamil, Antihypertensive agent clonidine and hydralazine derivatives</p> <p><b>Psychopharmacological agents:</b> Introduction, classification, mechanism of action, Synthesis of Benzodiazepines: diazepam, Phenothiazines: chlorpromazine, Amitriptyline.</p>	16 Hours
UNIT-IV	<p><b>Antimalarials:</b> Introduction, classification, mechanism of action, Synthesis of Chloroquine, mefloquine, primaquine. SAR of antimalarial agents.</p> <p><b>Antiamoebic agents:</b> Introduction, classification, mechanism of action, Synthesis of Metronidazole and iodoquinol.</p> <p><b>Anticonvulsant:</b> Introduction, classification, mechanism of action, Synthesis of Phenytoin sodium, carbamazepine.</p> <p><b>Sedatives and hypnotics:</b> Introduction, classification, mechanism of action, Synthesis of Phenobarbital, Chlordiazepoxide.</p> <p><b>General anesthetics:</b> Introduction, classification, mechanism of action, Synthesis of Halothane, Methahexital sodium.</p>	16 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. Thomas L Lemke, David A Williams, Victoria F Roche, S. W Zito, Foye's Principles of medicinal Chemistry, seventh edition, Lippincott Williams and Wilkins, Wolters Kluwer business, Baltimore, USA, 2012.</li> <li>2. M. S. Chorgade, John Wiley and Sons, Drug discovery and development, vol-2, New Jersey, US.</li> <li>3. Wilson and Gisvold's: Text Book of Medicinal Chemistry, Lippincott Williams and Wilkins, Wolters Kluwer, Philadelphia, 2010.</li> <li>4. C. Hanch, Comprehensive Medicinal Chemistry - series- 1-VI (Academic Press).</li> <li>5. Donald Abraham, Burgess Medicinal chemistry and drug discovery, Volume-1 to Volume 6, John Wiley and Sons, New Jersey, US, 2016.</li> </ol>	



THIRD SEMESTER

PC. SC. 3.22: PHARMACEUTICAL ANALYSIS		48Hours
UNIT-I	<p><b>AUTOMATIC METHODS AND THERMAL METHODS OF ANALYSIS.</b></p> <p><b>Automatic methods of analysis:</b> specifications and performance of automated methods, automation strategy, advantages and disadvantages of automated techniques, infrared process analyzers, selection of on-line analyzers, on-line potentiometric analyzers, chemical sensors (optodes and microsensors), automatic chemical analyzers, discrete analyzers, continuous analyzers (single channel and multi channel), continuous flow methods, flow-injection analysis, centrifugal analyzers, automatic elemental analyzers, laboratory robots.</p> <p><b>Thermal methods of analysis:</b> Introduction, thermo gravimetric methods, thermogram, factors affecting thermogram, thermo gravimetric analysis (TGA) - instrumentation and applications (TGA analysis of polymers and inorganic compounds), static and dynamic thermo gravimetry. Differential thermal analysis (DTA) - theory, instrumentation and applications (DTA analysis of polymers and inorganic compounds). Differential scanning calorimetry (DSC): theory, instrumentation and applications, factors affecting DTA and DSC.</p>	12 Hours
UNIT-II	<p><b>A) Capillary supercritical fluid and Gel chromatography:</b> General introduction, theory &amp; working of capillary supercritical fluid &amp; principle, instrumentation of Capillary supercritical fluid chromatography</p> <p><b>Gel chromatography:</b> General Introduction, Principle, experimental techniques, gels used for separation by exclusion chromatography application of gel chromatography</p> <p><b>Size exclusion chromatography:</b> General introduction Theory Distribution co-efficient (<math>K_D</math>) performance, materials, working principle of SEC apparatus, Application of sample detectors &amp; application of size exclusion chromatography in pharmaceutical analysis.</p> <p><b>B) Cyclic voltammetry:</b> Basic principles, cyclic voltammogram of <math>K_4[Fe(CN)_6]</math> system, irreversible and quasi-reversible curves, instrumentation and applications.</p> <p><b>Electro gravimetry:</b> Theory, electrode reactions, over-voltage, characteristics of a good deposit, completeness of deposition, separation of metals at controlled cathode potential. Estimation of copper and nickel in Cu-Ni alloy.</p>	12 Hours
UNIT-III	<p><b>Definition, principle, and application of the following techniques: Ion-Exchange chromatography (IEC):</b> Ion-exchangers, cation-exchange resins, anion-exchange resins, ion-exchange mechanism, factors affecting ion-exchange equilibrium, ion-exchange capacity, affinity scale, instrumentation, techniques for ion-exchange, liquid ion-exchanger, applications of IEC, experimental IEC, Supercritical fluid chromatography: <b>Affinity chromatography:</b> Introduction, classification, Selection of matrix, role of spacerseg. Affinity ligands, applications of affinity chromatography in the separation of biomolecules. <b>Exclusion chromatography.</b></p>	12 Hours
UNIT-IV	<p><b>Electrophoresis:</b> Overview, basis for electrophoretic separations, Moving boundary electrophoresis, Zone electrophoresis, isotachopheresis, isoelectric focusing and immuno electrophoresis, and Continuous electrophoresis (preparative), applications. <b>Capillary electrophoresis:</b> Introduction, Principle, Instrumentation and applications.</p>	12 Hours
	<p>References</p> <ol style="list-style-type: none"> <li>1. A H Beckett and J B. Stanlake. Practical Pharmaceutical Chemistry, Volume 52, First Ed, The Athlone Press, University of London, 2 Gower Street, London, SC, May 1963.</li> <li>2. K. A. Connors, A Text book of pharmaceutical analysis- third Ed, John Wiley and Sons, Inc., Ansari Rd, Daryaganj, New Delhi, India, 1982.</li> <li>3. E B Hassan and T Higuchi, Pharmaceutical Analysis. Vol 51, Issue I, Inter Science Publishers, Inc, 250 Avenue, New York, N.Y, 1961.</li> <li>4. P.D. Sethi Quantitative analysis of drugs in pharmaceutical formulations, third edition, 1961.</li> <li>5. D A Skoog and D M West. Fundamentals of Analytical Chemistry, Fourth Ed, Saunders College Publishing, New York, N.Y, 1983.</li> <li>6. Gary D Christian Analytical Chemistry, 6<sup>th</sup> Ed., John Wiley and Sons, Inc. in. University of Washington. USA, 2004.</li> </ol>	



**THIRD SEMESTER**

<b>PC.SC. 3.23: DRUG DISCOVERY AND DEVELOPMENT</b>		<b>48Hours</b>
<b>UNIT-I</b>	<b>Drug discovery from natural products and through enzyme inhibition:</b> Introduction, drug discovery and design a historical outline, Sources of drugs and lead compounds, Classification of drugs, Route of administration, the pharmaceutical phase, Introduction to drug action: ADME process. Bioavailability of drug, the pharmacodynamic phase. Introduction to medicinal plants: preparation of initial extracts and preliminary biological screening, methods for compound structure elucidation and identification, compound development, a brief explanation on the development of natural product drugs.	<b>12 Hours</b>
<b>UNIT-II</b>	<b>Drug design:</b> General approach to discovery of new drugs - lead discovery - lead modification -physiochemical principles of drug action - drug stereo chemistry -drug action - 3 Ddatabase search - computer aided drug design - docking - molecular modeling in drug design - structure based drug design - pharmacophores - QSAR.	<b>12 Hours</b>
<b>UNIT-III</b>	<b>Drug Design and relationship of functional groups to Pharmacologic activity:</b> Introduction to drug discovery: Introduction, stereochemistry and drug design: structurally rigid groups, confirmation, configuration. Solubility and drug design: The importance of water solubility, solubility and drug structure, salt formation. The incorporation of water solubilizing groups in structure:The type of group. Reversibility and irreversibility attached groups, the position of water solubilizing group, methods of introduction of solubilizing groups. Introduction, relationship between molecular structure and biological activity, selectivity of drug action and drug receptors. Discovery and structural modification of lead compounds. Drug Discovery through random screening of synthetic compounds. Refinement of lead structure. Functional group modification.	<b>12 Hours</b>
<b>UNIT-IV</b>	<b>Vitamins:</b> Introduction, classification, Properties, biological significance of vitamins. Synthesis and Biological importance (Occurrence, Chemical properties, Deficiency and Excess defect), of following Vitamins: Retinal, Thiamine (B1), Ascorbic acid, Pantathionic acid, Vitamin K. <b>Lipids:</b> nomenclature, classification, purification, structure and synthesis of lipids, phospholipids, sphingolipids. Biological importance of lipids: Lecithin, sphingolipids, oils and fats.	<b>12 Hours</b>
	<b>References</b> 1. Thomas L Lemke, David A Williams, Victoria F Roche, S. W Zito, Foye's Principles of medicinal Chemistry, 2012, seventh edition, Lippincott Williams and wilkins, wolters Kluwer business, Baltimore, USA. 2. John Marlowe Beale, John H. Block, Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 2011, 12 <sup>th</sup> Edition, Lippincott Williams and wilkins, wolters Kluwer business, Baltimore, USA. 3. John B. Taylor and David J. Triggler, Comprehensive Medicinal chemistry I-VI, 2006, Elsevier, Netherlands. 4. Gareth Thomas, Fundamentals of Medicinal Chemistry, 2007, Second edition, John Wiley and Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England. 5. Stuart Warren and Paul Wyatt, Organic Synthesis, The Disconnection approach, 2008, 2 <sup>nd</sup> Edition, John Wiley and sons, New jersey, USA.	



FOURTH SEMESTER		64Hours
<b>PC.HC: 4.02: MEDICINAL CHEMISTRY-II</b>		
<b>UNIT-I</b>	<p>A) a) Basic considerations, historical evolution, b) Fundamental aspects of drugs: Forms, application, biological action, placebo effect, metabolism, drug interactions, adverse effects, c) classification of drugs d) nomenclature of drugs e) drug combinations f) the selection of essential drugs. Physicochemical properties of drug molecules in relation to biological activity; solubility, partition coefficient, hydrogen bonding, protein binding, chelation, <math>p^{ka}</math> values, isomerism geometrical and optical isomers, steric effect, ionization.</p> <p>B) SAR and QSAR: SARs, Changing size and shape, introduction of new substituents-the introduction of a group in an unsubstituted position, the introduction of a group by replacing the existing group. QSAR- Lipophilicity, partition coefficient (log P), lipophilic substitution constants (<math>\pi</math>). Electronic effect (Hammett constant-<math>\sigma</math>), steric effect, Taft's steric parameter (<math>E_s</math>), Hansch analysis and application, Craig's plot, Free-Wilson analysis and application.</p>	12 Hours
<b>UNIT-II</b>	<b>Prodrugs:</b> Enzyme activation of drugs, Utility of prodrugs, types of prodrugs, mechanism of drug activation - Carrier linked prodrugs, carrier linkages for various functional groups, carrier linked bipartite prodrugs. Bioprecursor prodrugs (Proton activation, hydrolytic activation, elimination activation, oxidative activation, reductive activation, nucleotide activation, phosphorylation activation, sulfation activation, decarboxylation activation).	12 Hours
<b>UNIT-III</b>	<b>Selective examples of drug action at some common target areas:</b> Introduction, Examples of drugs that disrupt cellmembranes and walls-Antifungal agents, Azoles, Allyl amines, Phenols, Antibacterial agents- Ionophoric antibiotic action, Cell wall synthesis inhibition, Drugs that target enzymes-Reversible inhibitors, Irreversible inhibition, Transition state inhibitors, Drugs that target receptors-Agonists, Antagonists, Partialagonists. Drugs that target nucleic acids- Anti metabolites, Enzyme inhibitors, Intercalation agents, Alkylating agents, Antisense drugs, Chain cleaving agents, Antiviral drugs-Nucleic acid synthesis inhibitors, Host cell penetration inhibitors, Inhibitors of viral protein synthesis.	12 Hours
<b>UNIT-IV</b>	<b>Combinatorial Chemistry and Drug metabolism:</b> Introduction, the design of combinatorial synthesis, the general techniques used in combinatorial synthesis, the solid support method, parallel synthesis, Furka's mix and split techniques, Encoding methods-Sequential chemical tagging method, stills binary core tag system, computerized tagging, combinatorial synthesis in solution, screening and deconvolution. <b>Drug metabolism:</b> Introduction, sites of drug biotransformation, phase-I and phase-II reactions, role of Cytochrome P-450, Factors affecting drug metabolism.	12 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>1. Y.C. Martin, Qualitative drug Design: A critical Introduction, 2<sup>nd</sup> Edition, CRC press, May 6, 2010.</li> <li>2. Crowin and Hansch, Comprehensive Medicinal Chemistry, Vol-6, Pergamon Pr; July-1990.</li> <li>3. Donald j. Abraham, David P. rotella, Burger's Medicinal Chemistry, Drug Discovery and Development, 7<sup>th</sup> Edition, Vol-8, Wiley, 2010.</li> <li>4. H. John Smith, Hywel Williams Introduction to the Principle of Drug Design and action, 4<sup>th</sup> Edn, CRC press, 2005.</li> <li>5. Thomas L. Lemke, David A. Williams, Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins, 2008.</li> <li>6. Richard B. Silverman and Mark W. Holladay, The organic Chemistry of Drug Design and Drug Action, 3<sup>rd</sup> Edn, Elsevier Inc, 2015.</li> </ol>	



**FOURTH SEMESTER**

**PC.SC. 4.21: GENERAL PHARMACOLOGY**

**48 Hours**

<b>UNIT-I</b>	<b>General pharmacology:</b> Introduction, definition, sources and active ingredients of drugs, routes of drug administration, Drug distribution, fate of drug, drug excretion, plasma half life and its significance, methods of prolonging the duration of action of a drug, special drug delivery system. Factors modifying drug effects, drug toxicity, acute, sub-acute, and chronic toxicity. LD50, ED50, tolerance, habituation, and addiction. Drug response relationship, drug interaction - basic concept of drug interaction (both in vitro and in vivo), preclinical and clinical evaluations.	<b>12 Hours</b>
<b>UNIT-II</b>	<b>Sterilization and Screening methods:</b> Sterilization, types of sterilization methods General principles of screening of drugs, general screening methods, clinical trials. Experimental animals used in pharmacological assays, in vitro, in vivo studies. Bioassay, scope, principles involved in bioassay. Screening for analgesic, antiinflammatory, antiimplantaion, anthelmintic, antidiabetic and antiulcer, Methodology for microbial assay of Penicillin and Miconazole. Enzyme inhibition studies: DNA gyrase, COX inhibition studies.	<b>12 Hours</b>
<b>UNIT-III</b>	<b>Drug receptor Interaction and Adverse Drug receptor:</b> Introduction, history, affinity- the role of chemical bonding, conformation, stereochemistry of labetalol. Drug receptors, Drug action, sites of drug action, Mechanism of drug action, drug receptors, and types of receptors- ligand gated ion channels, voltage gated ion channels, G-protein coupled receptors; intracellular receptors, dose response relationship, adverse drug relationship. Drug allergy.	<b>12 Hours</b>
<b>UNIT-IV</b>	<b>Immunology and Microbiology:</b> Microbial Drug Development - Introduction to Microbiology and classification of Microbes. Characterisation and Screening of Microbes fermentation process, Microbial growth, kinetics, Isolation and Improvement of Individual micro-organism, fermenter designing, Media designing, antimicrobial assays; Down Stream process and effluent treatment (Microbial and Chemical) Immunology and Immuno pharmacology-Overview of the immune system and its role, Adaptive and innate Immunity. Immune response and the underlying mechanisms, Regulation of immune response. Hypersensitivity, immunodeficiency, Autoimmunity, Immunization, Immuno suppressants, Immuno modulators, Immunological techniques: Agglutination, Precipitation, RIA and ELISA.	<b>12 Hours</b>
<b>References</b>		
<ol style="list-style-type: none"> <li>1. R.S. Satoskar, N. Rege, S.d.Bhandarkar, Pharmacology and Pharmacotherapeutics, 24<sup>th</sup> Edition, Elsevier India, 2015.</li> <li>2. M.N. Ghosh, Fundamentals of Experimental Pharmacology Paperback, 6<sup>th</sup> edn, HILTON and COMPANY, 2008.</li> <li>3. H. G. Vogel, Drug Discovery and Evaluation: Pharmacological assays, Vol 2, 3<sup>rd</sup> edition, Springer, 2008.</li> <li>4. Robert E. Notari, Biopharmaceutics and clinical pharmacokinetics, 4<sup>th</sup> Edition, Marcel Dekkar, Inc, New York, 1987.</li> <li>5. G.R. Chatwal, Biopharmaceutics and pharmacokinetics, 2<sup>nd</sup> Edition, Himalaya Publishing House, 2014.</li> <li>6. S.N. Jogdand, Biopharmaceutics, Himalaya Publishing House, 2006.</li> <li>7. Walter Land, Pharmaceutical codex- principles and practice of pharmaceutic, XI Edition, London: The Pharmaceutical Press, 1994.</li> <li>8. Gareth Thomas, Medicinal Chemistry: An introduction, Wiley India Exclusive, 2015.</li> </ol>		



## FOURTH SEMESTER

PC.SC.4.23: BIOPHARMACEUTICS		48Hours
UNIT-I	<p><b>Preformulation</b></p> <p><b>Absorption of Drugs:</b> 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, Methods of determining absorption: In-vitro, in-situ and In-vivo methods.</p> <p><b>Bioavailability:</b> Objectives and considerations in bioavailability studies, Concept of equivalents, measurement of bioavailability, Determination of the rate of absorption, Bioequivalence and its importance, bioequivalence studies.</p> <p><b>Dosage Regimen:</b> Multiple dosing with respect to IV and oral route, Concept of loading dose, maintenance dose, Accumulation index, Adjustment of dosage in renal and hepatic impairment, Individualization of therapy, Therapeutic Drug Monitoring.</p>	12 Hours
UNIT-II	<p><b>Scale up Pilot Plant Scale up Techniques, Pharmaceutical Production Planning and Control:</b> Significance of pilot plant scale up study, Large scale manufacturing techniques (formula, equipment, process, stability and quality control) of solids, liquids, semisolid and parental dosage forms, General principles, Types of production systems, calculation of standard costs, production or process planning, Routing, Loading, Scheduling, Dispatching of records, Production control.</p> <p><b>Pharmaceutical Pre-approval inspections, Post operational activities:</b> Evaluation of FDA, Pre-new drug application approval inspection, FDA risk based approach to inspections, Critical role Pharmaceutical scientist in product development and preparing for pre- approval inspection, Training requirements in product development, System based pre-approval inspection, cGMP risk assessment, and Management strategy, concepts in quality by design for drug development manufacture, Equipment cleaning during pharmaceutical product development and its importance to pre-approval inspection, Distribution, Recalled products, Returned products, Complaints and adverse effects, Drug product salvaging documents and formats.</p>	12 Hours
UNIT-III	<p><b>Pharmaceutical Laws and Acts:</b> An introduction of following laws with regard to drug product design, manufacture and distribution in India (with latest amendments):</p> <ol style="list-style-type: none"> <li>Drugs and Cosmetics Act 1940 and its rules 1945</li> <li>National Pharmaceutical Pricing Authority (NPPA)</li> <li>Intellectual property rights-Indian patent Act and its rules, Law of Copy right and Designs, Law of Trademark and Geographical indications</li> <li>Patent Procedure in India</li> </ol> <p><b>Registration Requirements:</b> Forms, Clinical Trial Registration, Test License, Commercial Import License, Sale License, Manufacture License, Certificate of pharmaceutical Product (CoPP)</p> <p><b>Regulatory requirements:</b> For import and product registration of New Drugs, DCGI &amp; RCGM requirements, Generics, Medical Devices, Biologics, Herbals, Cosmetics &amp; Fixed Dose Combinations, Export of drugs, traditional drugs, narcotics etc.</p>	12 Hours
UNIT-IV	<p><b>Pharmaceutical Regulations:</b> USA Organization and structure of FDA. Federal register and CFR, History and evolution of FDC act, Hatch Waxman act and Orange book, Regulatory Approval Process for IND, NDA, ANDA. Regulatory requirements for Orphan drugs and Combination Products, SUPAC &amp; PMS. Changes to an approved NDA / ANDA.</p> <p><b>European Union:</b> Organization of EMA &amp; Marketing Authorization procedures in EU (CP, DCP, MRP, NP). Eudralex directives for human medicines, Variations &amp; extensions, IMPD. Requirements for BA/BE studies, Compliance of European Pharmacopoeia (CEP)/ Certificate of Suitability (CoS)</p> <p><b>Emerging Markets:</b> Overview, Regulatory Requirements for generic drug registration, new drugs and post approval requirements in BRICS countries (Brazil, Russia, India, China, South Africa) and Egypt.</p>	12 Hours
	<p><b>References</b></p> <ol style="list-style-type: none"> <li>Arun Bhatt, Clinical Trials and Good Clinical Practice in India, Arun Bhatt, 1<sup>st</sup> edition, D. K. Publications, Mumbai, 2006.</li> <li>David B. Troy, Paul Beringer, Remington: The Science and Practice of Pharmacy, Lippincott Williams &amp; Wilkins, Vol. I &amp; II, 21<sup>st</sup> edition, New Delhi, 2006.</li> </ol>	



FOURTH SEMESTER		
PC.SC.4.22: DOSAGE FORMS AND REGULATORY ASPECTS		48 Hours
UNIT-I	Dosage forms and regulations: Different dosage forms: Oral solids, oral liquids, solution properties, suspensions, emulsions, parenterals, aerosols, inhalation products, topical semisolids, typical lipids, and powders, ophthalmic products, rectal and vaginal products. Oral solids: Tablets, types of solids, methods of tablet production – wet granulation, coating of tablets. Quality control methods and measurement of tablet properties. Oral liquids: Introduction, types, oral suspensions and oral emulsions.	12 Hours
UNIT-II	Stability of medicinal products: Chemical stability: Hydrolysis, dehydration, oxidation, isomerisation, racemisation, polymerization, photochemical reactions, factors affecting chemical stability. Physical stability: Volatility, change in the water content of solids, changes in the crystal properties, physical changes in emulsions and suspensions. Stability of medicines in pharmaceutical practice, e.g. glycerol trinitrate tablets. Physical characteristics: Particle size, shape, surface area, Solubilization, surfactants and its importance, temperature, pH, co-solvency; Techniques for the study of crystal properties and polymorphism. Chemical characteristics: Degradation, Hydrolytic, oxidative, reductive, photolytic degradations; Biopharmaceutics characteristics: Solubility, dissociation, Dissolution rate, diffusibility, and drug stability in GI tract. Physicochemical characteristics of new drug molecules with respect to different dosage forms.	12 Hours
UNIT-III	Current good manufacturing practice, Clinical trials: Introduction, requirements of good manufacturing practice and quality management, guide lines to manufacturing practice for medicinal products, premises and equipments, documentation and production and quality control. Process development: Introduction, solid dosage forms and granulation and safety, plan for process development – equipments, validation batch record. Regulatory aspects of process development: In process tests, validation of equipments and definition of batch size, packing, clinical trials and SOPs.	12 Hours
UNIT-IV	Novel Drug Delivery Systems: Fundamentals of Novel Drug Delivery: Rationale of sustained/controlled release (CR), physicochemical and biological factors influencing design and performance of CR products. Pharmacokinetic and Pharmacodynamic basis of NDDS. Bioavailability assessment of CR systems. Regulatory requirements. Theory of mass transfer. Fick's law and its application in NDDS. Polymers in CR: classification, properties biocompatible & biodegradable polymers. Modeling of drug release from porous polymer; drug release from non-porous and hydrophobic polymers. Diffusional release and dissolution controlled release from monolithic devices, microporous systems. Oral Controlled Drug Delivery Systems, Mucosal Drug Delivery System, Ocular Drug Delivery Systems, Parenteral Drug Delivery systems, Transdermal Drug Delivery systems.	12 Hours
	<b>References</b> 1. David B. Troy, Paul Beringer, Remington: The Science and Practice of Pharmacy, Lippincott Williams & Wilkins, Vol. I & II, 21 <sup>st</sup> edition, New Delhi, 2006. 2. Arun Bhatt, Clinical Trials and Good Clinical Practice in India, Arun Bhatt, 1 <sup>st</sup> edition, D.K. Publications, Mumbai 2006. 3. K.N. Jayaveera, Y. Sudhakar, Novel drug delivery systems and regulatory affairs, S. Chand publications Pvt. Ltd, new Delhi, 2014. 4. D.T. Baviskar, D.K. Jain, Novel Drug Delivery Systems, Nirali Prakashan, Oct-8,2012.	



Practical Syllabus of M.Sc., Pharmaceutical Chemistry,

Semester-I

Practical-I, PC: 1.05: Inorganic Chemistry

A] Complexometric titrations

1. Determination of temporary, permanent and total hardness of water.
2. Estimation of Ca ions.
3. Estimation of Mg ions.

B] Redox titrations

1. Estimation of Fe (II) ions.
2. Estimation of Fe (III) ions.
3. Estimation of Cu from copper sulphate solution.

C] Preparation of metal complexes

Preparation of coordination compounds

1. Preparation of chloropentammine cobalt (III) chloride
2. Preparation of potassium trisoxalato ferrate (III) tri hydrate c complex
3. Preparation of mercury (II) tetrathiocyanato cobaltate complex
4. Preparation of hexaminecobalt (III) chloride

Analysis of coordination compounds for metal and ligands contents:

1. Analysis of chloropentammine cobalt (III) chloride
2. Analysis of potassium trisoxalato ferrate (III) trihydrate complex

Books recommended:

1. Vogel's qualitative inorganic analysis. Revised by G. Suchla Longarman group Ltd.
2. Inorganic quantitative analysis - A.I. Vogel. ELBS.
3. Fundamentals of analytical chemistry- D.A. Skoog, D.M. West and F.T. Holler, sauder college publication.
4. Advanced inorganic chemistry- F.A. Cotton and Wilkinson. John Wiley.
5. Concise inorganic chemistry- J.D. Lee.

Practical-II, PC: 1.06: Organic chemistry

Qualitative organic analysis of binary mixture.

Acid+ Base, Acid+Neutral, Base+Neutral, phenol+ neutral, Acid + Phenol and Base + phenol.

Books Recommended

1. Quantitative chemical semi micro analysis - V.N. Alexeyo
2. Practical chemistry - Dr. O.P. Pandey, D.N. Bajpai and Dr. S. Giri



### Practical-III, PC: 1.07: Physical Chemistry

1. Acid catalysed hydrolysis of methyl acetate.
2. Determination of rate constants of hydrolysis of ester (ethyl acetate/methyl acetate) catalyzed by 0.5N HCl and determine the energy of activation of the reaction.
3. Effect of ionic strength on rate of per sulphate-Iodide reaction.
4. Determination of molecular weight of a polymer by using viscometer.
5. Adsorption characteristic of acetic acid on charcoal.
6. Determination of strength of strong acid (HCl) using standard NaOH by conductometric titration.
7. Determination of percentage composition of a given acid mixture (HCl+CH<sub>3</sub>COOH) by conductometric titration.
8. Determination of the pH of the given acid using NaOH by pH titration.
9. Determination of pK<sub>a</sub> value of weak acid (formic acid) by potentiometric method.
10. Determination of strength of weak acid (CH<sub>3</sub>COOH) by using standard NaOH solution by conductometric titration.

### Books Recommended

1. Practical physical chemistry - B. Vishwanathan and P.S. Raghavan
2. Advanced practical physical chemistry - Dr. J.B. Yadav
3. Physical chemistry - P.W. Atkins.
4. Practical physical chemistry - Findlay.
5. Advanced experimental chemistry by Dr. J.N. Gurthu R Kapoor
6. Experimental inorganic chemistry (first edition) by Ayodhya Singh.
7. An introduction to practical physical chemistry by K.K. Sharma, D.S. Sharma.
8. Practical physical chemistry by Khosla and others:

### Semester- II

#### Practicals-I, PC: 2.06: Advanced Inorganic chemistry

Inorganic Qualitative Analysis of two acidic and two basic radicals.

#### Books Recommended:

1. Practical chemistry - Dr. O.P. Pandey, D.N. Bajpai and Dr. S. Giri
2. Inorganic Qualitative analysis by A.I. Vogel.

#### Practicals - II, PC: 2.07: Advanced organic chemistry

#### Synthesis of organic compounds:

1. Acetylation of aniline (N-acetylation)
2. Benzoylation of phenol (O-Benzoylation)
3. P-nitroacetanilide from acetanilide
4. Hydrolysis of p-nitro acetanilide to p-nitro aniline
5. P-bromoacetanilide from acetanilide (nucleous bromination)
6. Synthesis of heterocyclic compounds related to syllabus.



**Estimations of following mixture:**

Estimation of acid and amide

Estimation of acid and ester

**Books recommended:**

1. Advanced organic chemistry - reactions, mechanism and structure - Jerry March
2. Practical organic chemistry - A.I. Vogel
3. Practical organic chemistry - Ahluwalia
4. Organic chemistry vol-I and vol-II - I.L.Finar.
5. Practical organic chemistry - Vishnoli
6. Reactions, rearrangement and reagents - S.N. Sanyal.

**Practicals - III, PC: 2.08: Advanced Analytical Chemistry**

**A] Analysis of biologically important samples.**

1. Glucose by a) DNS method, b) Fehling's solution method.
2. Estimation of the following compounds by spectrophotometer.
  - a) Cholesterol, b) uric acid, and c) creatinine.

**B] Isolation of following constituents from the Natural sources:**

- a) Caffeine from tea powder.
- b) Piperine from black pepper.
- c) Nicotine from tobacco.
- d) Other constituents from natural sources.

**Books Recommended:**

1. Inorganic quantitative analysis- A.I. Vogel, ELBS.
2. Practical of organic chemistry- Vogel.
3. Practical organic chemistry - Vishnoli
4. Practical chemistry - Dr. O.P. Pandey, D.N. Bajpai and Dr. S. Giri

**SEMESTER - III**

**Practical-I, PC: 3.04: Synthesis of drugs and drug intermediates-I**

**A] Synthesis:**

1. Aspirin
2. Paracetamol
3. Iodoform
4. Coumarin derivative
5. Benzimidazole
6. Benzotriazole
7. Synthesis of pharmaceutically important molecules

**B] Identification of pharmaceuticals by the analysis of their spectral data:**

Give the photocopies of UV, IR, NMR and Mass data of standard compounds for the elucidation of structure.



**Books Recommended:**

1. A.I. Vogel, Practical Organic Chemistry, 1989, fifth edition, longman scientific and technical, Harlow, U.K.
2. V. K. Ahluwalia, R Agarwal, Comprehensive Practical Organic Chemistry : Preparaton and Qualitative Analysis, 2001, Uniersity Press.
3. I.L. Finar, Textbook of Organic Chemistry, 1964, volume 2, fourth edition, Longmans Green and Co. Harlow, United Kingdom.
4. N. k. Vishnoi, Advanced Practical Organic Chemistry, 2009, third edition, Vikas publishing house, Noida, UP, India.
5. S.N. Sanyal, Rections, rearrangement and reagents, 2004, Bharathi Bhavan Publications.
6. R.M. Silverstein and F X Webster, david J Kiemle, Spectroscopic Identification of Organic Compounds, 1963, Seventh Edition, John Wiley and Sons, New York.
7. Jerry March, Advanced Organic Chemistry- reactions, mechanism and structure, 2006, sixth edition, Wiley India pvt. Ltd.

**Practical-II, PC: 3.05: Separation techniques:**

**1. Analytical thin layer chromatography: Qualitative separation of given mixture containing following compounds.**

- a) Phenol and Resorcinol
- b) O-nitro aniline and p-nitro aniline.
- c) Aspirin and acetaminophen and
- d) Sulphaisoxazole and Sulphamethoxazole.

**2. Preparative thin layer chromatography- Quantitative separation of given mixture of compounds.**

**3. Paper chromatography: Qualitative separation of given mixture containing amino acids Glycine, Tyrosine, Tryptophan and Histidine.**

**4. Column chromatography- Separation of given mixture and quantification of the Compounds.**

**Books Recommended:**

1. A. H. Beckett and J. B. Stenlake, Practical pharmaceutical chemistry, May 1963, volume 52, 1 Edition, The Athlone Press, University of Landon, 2 gower Street, London.
2. Gurudeep R Chatwal and Shamk Anand, Instrumental Methods of Chemical Analysis, 2015, Himalaya Pub House, New Delhi.
3. R.A.Day. Jr, and A.L.Underwood m K Anand, Quantitative analysis, 1991, sixth edition, Pearson, London, England.
4. Gurudeep R Chatwal, Analytical Chromatography, 2006, revised edition, Himalaya Publishing House, pvt, Ltd. Banglore, India.

**Practical- III, PC: 3.06: Assay of drugs by titrimetric and instrumental methods - I**

1. Assay of Aspirin
2. Assay of Analgin
3. Assay of Ibuprofen
4. Assay of Paracetamol
5. Calcium gluconate
6. Assays of new biologically important molecules

**Books Recommended:**

1. R.C. Denny, J.D. Barnes, M.J.K. Thamas and others, Vogel's text book of quantitative chemical analysis, 2000, sixth edition, Prentice hall, New Jersey, United States.
2. A. H. Beckett and J.B. Stenlaker, Practical Pharmaceutical Chemistry, May 1963, volume 52, 1 Edition, The Athlone press, University of London, 2 Gower Street, London.
3. Dr. O.P. Pandey, D.N. Bajpai and Dr. S. Giri, Practical Chemistry, 2014, Revised Edition, S. Chand and Company Ltd. New Delhi, India.
4. Anees A. Siddique, Lab manual - selected experiments of pharmaceutical analysis, 2016, CBS Publishers and Distributors, Daryaganj, new Delhi, India.
5. Sethi. P.D, Quantitative Analysis of Drugs in Pharmaceutical Formulations, 1997, third Editin, CBS Publishers, New Delhi, India.



## SEMESTER- IV

### Practical -I, PC: 4.03: Synthesis of Drugs and Drug intermediates-II

1. 2-hydroxy naphthaldehyde
2. Schiff base
3. Chalcone
4. 3-acetyl coumarin
5. Sulphonamide drugs
6. Other important compounds.

#### Books Recommended:

1. A. I. Vogel, A. r Tatchell, B. Furnis, A.J. Hannaford, P.W. G. Smith, Vogel's Textbook of Practical organic chemistry, fifth edition, by Prentice Hall, published on feb-19,1996.
2. V.K. Ahluwalia, S. Dhingra Practical Organic Chemistry, Universities Press, Jun-1,2004.
3. I.L. Finar, Orgnic Chemistry vol 2 (3rd.ed. ) Longmans Green and Co. 1964 Acrobat.
4. N.K. Vishohi, Advanced Practical Organic Chemistry, Vikas Publishing House Pvt. Limited, Apr-1-1996.
5. S.N. sanyal, Reactions, rearrangement and reagents, Publisher: Bharati Bhavn, 2004.
6. R.M. Silverstein, F.X. Webster, D.J. Kiemle, D.L. Beyce, Spectroscopic identification of organic compounds, sixth edition, John Wiley and sons, 29-sep-2014.
7. Michael Smith, Jerry March, Advanced Organic Chemistry, reactions, mechanism and structure, John Wiley and sons, Inc, 2007.

### Practical-II, PC: 4.04: Assay of drugs by titrimetric and instrumental methods - II

1. Isoniazid
2. Ascorbic acid
3. Hexamine
4. Ampicillin
5. Amoxycillin
6. Aspirin
7. Paracetamol
8. Other drugs of interest.
9. Demonstration: Estimation of potassium in agricultural water supply by flame photometry.

#### Books Recommended:

1. R.C. Denny, J.D. Barnes, M.J.K. Thomas, J. Mendham, Vogel's text book of quantitative chemical analysis, sixth edition, Prentice Hall, April-7, 2000.
2. A.H. Beckett, J.B. Stenlake, Practical pharmaceutical chemistry, fourth edition, part-II, A and C Block,1988.
3. O.P. Pandey, D.N. Bajpai and Dr. S. Giri, Practical Chemistry, S. Chand Limited,2005.
4. Anees A. Siddique, Lab manual-selected experiments of pharmaceutical analysis, CBS Publishers and Distributors Pvt. Ltd,2016.
5. P.D. Sethi, Quantitative analysis of drug in pharmaceutical formulations, third edition, Feb-15, 2007.

### Practical-III, PC: 4.05: Project Work

Project work Involving appropriate or relevant work in the field of Pharmaceutical Chemistry. Work is assigned to research project and submit the results at the end of the semester in the form of a dissertation which will be valued for 100 marks (75 for dissertation and 25 for Viva voce). Project work involving multistage synthesis or isolation of active molecules present in medicinal plants or pharmacokinetic studies or evaluation of biological activities.



  
**KUVEMPU UNIVERSITY**  
**THEORY QUESTION PAPER PATTERN**  
**M.Sc. Pharmaceutical Chemistry (CBCS Scheme)**

PAPER CODE AND TITLE:

**Note: Answer all the questions from Part-A, any three from Part-B and from the Part-C  
any four of the remaining**

**Max Marks = 75**

**1. Answer the following question** **PART-A**

**10 x 2 = 20**

- (a)
- (b)
- (c)
- (d)
- (e)
- (f)
- (g)
- (h)
- (i)
- (j)

**PART-B**

**2. Write short notes on any THREE of the following**

**3 x 5 = 15**

- (a)
- (b)
- (c)
- (d)

**PART-C**

**3.**

- (a)
- (b)

**5 + 5 = 10**

**4.**

- (a)
- (b)

**5 + 5 = 10**



5.

- (a)
- (b)

5 + 5 = 10

6.

- (a)
- (b)

5 + 5 = 10

7.

- (a)
- (b)

5 + 5 = 10

Note: Equal weightage should be given to all the units



# SYLLABUS FOR M.Sc. BIOCHEMISTRY

## SEMESTER: IV

### Paper XIII

72 Hrs

#### B.C-4.1: CELL SIGNALLING (HARD CORE)

**Unit I Introduction and components of biosignaling:** Definition of Cell Signaling, general principles of cell signaling and communication; various forms of communication between cells; signaling process and its stages – Signal recognition, transduction and cellular effect; Types of cell signaling – Autocrine signaling, Direct contact signaling, Paracrine signaling, Synaptic signaling, Endocrine (Distance) signaling. First messengers, glands and types of secretions, Ligands, Agonists, Antagonists, Receptors for first messengers, Second messengers, soluble second messengers, Membrane bound second messengers. Receptor down regulation, Receptor up regulation.

08Hrs

**Unit II GPCR/7-pass receptors and the catabolic response:** Structure of a typical GPCR, 7-pass receptor phylogeny, Functional mechanisms of 7-pass receptors, Gas-coupling receptors- glucagon- and  $\beta$ -adrenergic receptors - Stimulation of cAMP Production.  $G_{\alpha q}$ - coupling receptors-bombesin and  $\alpha_1$ - adrenergic receptors - stimulation of calcium release from the endoplasmic reticulum.  $G_{\alpha i}$ -coupling receptors - somatostatin and  $\alpha_2$ - adrenergic receptors - inhibition of adenylyl cyclase, activation of  $K^+$  ion channels, inhibition of  $Ca^{2+}$  Channels, and activation of phospholipase  $C\beta_2$ . Glucagon and  $\beta$  - adrenergic - receptors - the catabolic cAMP- dependent protein kinase (PKA) pathway leading to glycogenolysis. Receptor desensitization: the Role GRKs and Arrestins.

12Hrs

**Unit III Heterotrimeric G protein-**Classification and structural relationship with Ras.  $G_{\alpha}$ -subunit: the Ras-like core, G-boxes and switch regions. GTP exchange, hydrolysis and switch movements.  $\beta/\gamma$ - and receptor binding surface of  $\alpha$ -subunits. Modulator of G protein activity-the 'RGS' protein family, RGS proteins and GTPase activation, RGS proteins: inhibition of nucleotide exchange; crosstalk with other pathways.  $G_{\alpha i/o/q}$  GEP proteins-unrelated to RGS. GRKs-RGS domain-containing S/T-kinases. Signal transduction by  $\beta/\gamma$  subunits.  $G_s$  and Cholera toxin. Monomeric G proteins, Classification, on and Off states of Ras-like proteins and their signaling

10Hrs

**Unit IV Adenylyl cyclase –** Structure and topology, Isoforms, Regulation by Heterotrimeric G Proteins, Signal termination, crosstalk and negative feedback. PDE isoforms.  $G_s$ -coupling catabolic receptors. B-Adrenergic/glucagon- receptor stimulation of glycogenolysis. B-Adrenergic/ glucagon- receptor inhibition of glycogen synthesis.  $\alpha_1$ -adrenergic receptor stimulation of glycogenolysis. Regulatory subunits of PKA, Anchoring Proteins and PKA



inhibitors. Adenylyl cyclase and Olfactory Signaling, Inhibitors of Adenylyl cyclase signaling- Forskolin and P-Site Inhibitors

**10 Hrs**

**Unit V Adenylyl cyclase** - PDE isoforms, Transmembrane isoforms, Signal termination, crosstalk and negative feedback. G proteins and the adenylyl cyclase effector isoforms. Gs-coupling catabolic receptors. B-Adrenergic/glucagon- receptor stimulation of glycogenolysis. B-Adrenergic/ glucagon- receptor inhibition of glycogen synthesis.  $\alpha$ 1-adrenergic receptor stimulation of glycogenolysis. Diffusible cascade or scaffolded pathway.

**PKA and PKC:** Active and inactive state of PKA, PKA anchoring Proteins, Activation of PKA by cAMP. Role of PKA on metabolic enzymes- Phosphorylase kinase, Glycogen phosphorylase and Glycogen synthase: Phosphorylase kinase- the catalytic  $\gamma$ -subunit, Regulatory subunits, substrates and autophosphorylation. Glycogen phosphorylase- isoforms, allosteric Sites, hormonal and metabolic control, functional differences between muscle and liver isoforms. Glycogen synthase, GSK-3- $\alpha$  multi-tasking enzyme, hormonal control. Protein kinase C, Lipid activation of PKC-DAG-binding isoforms and their activation by phorbol esters, Alternative DAG/phorbol ester receptors, PKC scaffolds

**16 Hrs.**

**Unit VI Regulation of gene expression by cAMP, cGMP and steroid Hormones:** Hormones that transduce signals through cAMP. Regulation of Transcription factors- CREB (cAMP Response Element-Binding Protein), CREM (cAMP Response Element Modulator) and ATF1 (Activating Transcription Factor-1) by cAMP, Regulation of gene expression by ANP- cGMP Regulation of gene expression by steroid hormones- Glucocorticoid and Mineralocorticoid

**04 Hrs**

**Unit VII Single pass growth factor receptors:** Receptors tyrosine kinases-ligands and signal transduction, RTK ligands and receptors. The PGDFR family -signal transduction, MAP kinases and MAPK kinases.

**The insulin signaling on metabolic enzymes** The insulin receptor- a pre-dimerised RTK with a unique substrate, Cluster of autophosphorylated tyrosine in the InsR intracellular region. InsR and IGF-IR: differentiation leads differential tissue effects. Features of metabolic control in key tissues. InsR downstream signalling pathways. MAPK/p90Rsk pathway mediated growth effects, PI-3-kinase -prime anabolic effector. IRS protein targeting, IRS-interacting proteins- Class 1A PI-3-kinases, IRS-1/2 phosphorylation and PI-3-kinase activation. Protein phosphatase-1 (PP-1), Glycogen granule targeting of PP-1, P70Rsk-inducer of GS dephosphorylation. Insulin reverses effects of adrenaline and/ or glucagon, Insulin's reversal of adrenaline-induced glycogenolysis in muscle, Insulin's reversal of adrenaline- and glucagon-induced glycogenolysis in liver, Insulin's reversal of adrenaline/glucagon- induced lipolysis in adipose tissue, PIP3 downstream effects- glycogen synthesis, PKB and GSK-3 inactivation, PKC-C- negative feedback control, PIP3 downstream effects- GLUT4 mobilization

**12 Hr.**



**References:**

1. Text Book of Biochemistry with Clinical Correlations – Thomas H. Devlin
2. Clinical Biochemistry-Controw and Trumper, W.B. Saunders Pub.
3. Harper's Review of Biochemistry with Clinical Correlations Ed. Martin et al, 25nd edn.,
4. Outlines of Biochemistry – White, Handler and Smith
5. Lehninger Principles of Biochemistry – 5th Edition. David L. Nelson and Michael M. Cox
6. Molecular Cell Biology – Eds. – Darnell, Lodish and Baltimore W.H. Freeman & Co..
7. Molecular Biology of the Cell – Bruce Alberts et al., Garland Science.
8. Aggarwal, B.. Human Cytokines. Blackwell Scientific, Oxford.
9. Estrov, Z.. Interferons, Basic Principles and Clinical Applications. R. G. Landes, Florence, KY.
10. Fitzgerald, K.). The Cytokine Facts Book. Academic Press, London.
11. Mantovani, A. Pharmacology of Cytokines. Oxford University Press, Oxford.
12. Mire-Sluis, A.. Cytokines. Academic Press, London.
13. Abbas, A.. Cellular and Molecular Immunology. W. B. Saunders, London.
14. Gary Walsh. Biopharmaceuticals Biochemistry and Biotechnology. 2nd Edition. John Wiley & Sons, Ltd, England
15. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3 Ed. Jhon Wiley and sons.
16. Fundamentals of Biochemistry; Voet, Voet, and Pratt. [Eds.], Jhon Wiley and sons.
17. Biochemistry; David Rawn, J. Neil Patterson Publishers.
18. Principles of Biochemistry; Smith et al., [Ed.], McGraw Hill.
19. The Biochemistry of Cell Signalling; Ernst Helmreich, OUP.
20. Basic Neurochemistry; George Siegel et al., Wippincott, Williams and Wilkins.
21. Cell biology; David E. Sadava; Jones and Bartlett Publishers
22. Biochemistry of Signal Transduction and Regulation; 3rd Edn. Gerhard Krauss, Wiley-VCH.
23. Introduction to Ecological Biochemistry, J. Harborne, Gulf Professional Publishing.