M.Sc. Pharmaceutical Chemistry

Semester I

Paper I –PH1CO1: Physical CHEMISTRY-Core

Total Credit : 4 MM: 100 Hours: 52

UNIT I

1. Bioenergetics: coupled reactions, ATP and its role in bioenergetics, high energy bond, free energy and entropy change in ATP hydrolysis, thermodynamic aspects of metabolism and respiration, glycolysis, biological redox reactions.
2. Acid-base catalysis: specific and general catalysis, Skrabal diagram, Bronsted catalysis law, prototropic and protolytic mechanism with examples, acidity function.

UNIT II

3. Enzyme catalysis and its mechanism, Michaelis-Menten equation, effect of pH and temperature on enzyme catalysis.
4. Kinetics of enzyme inhibition, protein folding and pathological misfolding, Muscle contraction and molecular mo

UNIT III

5. Adsorption and various types of adsorption isotherms. The Langmuir theory, kinetic and statistical derivation, multilayer adsorption-BET theory, Use of Langmuir and BET isotherms for surface area determination. Adsorption of liquids by solids, positive and negative adsorption, Gibbs adsorption equation., flash desorption
6. Colloids: Zeta potential, Electrokinetic phenomena, Sedimentation potential and Streaming potential, Donnan membrane equilibrium.

UNIT IV

7. Theories of unimolecular reactions. Reactions in solution: factors determining reaction in solutions, effect of dielectric constant and ionic strength, cage effect, Bronsted-Bjerrum equation, primary and secondary kinetic salt effect, influence of solvent on reaction rates, significance of volume of activation,
8. Kinetics of Fast reactions: relaxation, flow and shock methods, flash photolysis, NMR and ESR methods of studying fast reactions.

Paper II –PH1CO2: Organometallic and nuclear CHEMISTRY-Core

Total Credit : 4 MM: 100 Hours: 52

Unit I

1. Reactions of Organometallic Compounds Substitution reactions-nucleophilic ligand substitution, nucleophilic and electrophilic attack on coordinated ligands. Addition and elimination reactions-1,2 additions to double bonds, carbonylation and decarbonylation, oxidative addition and reductive elimination, insertion (migration) and elimination reactions. Rearrangement reactions, redistribution reactions, fluxional isomerism.

Unit II

2. Catalysis by Organometallic Compounds. Homogeneous and heterogeneous organometallic catalysis-alkene hydrogenation using Wilkinson catalyst, Tolman catalytic loops. the Fischer-Tropsch reaction(synthesis of gasoline). Hydroformylation of olefins using cobalt or rhodium catalyst. Carbonylation reactions-Monsanto acetic acid process

Unit III

3. Bioinorganic Compounds Essential and trace elements in biological systems, structure and functions of biological membranes, mechanism of ion transport across membranes, sodium pump, ionophores, valinomycin and crown ether complexes of Na+and K+, ATP and ADP. S II. Role of calcium in muscle contraction, blood clotting mechanism and biological calcification. Oxygen carriers and oxygen transport proteins-haemoglobins, myoglobins and haemocyanin, haemerythrins and haemevanadins, cooperativity in haemoglobin. Iron storage and transport in biological systems-ferritin and transferrin. Redox metalloenzymes-cytochromes, peroxidases and superoxide dismutase and catalases. Nonredox metalloenzymes-CarboxypeptidaseA-structure and functions. Nitrogen Fixation-nitrogenase, vitamin B12 and the vitamin B12 coenzymes. Metal-Nuclei acid interaction
   Metals in medicine-therapeutic applications of cis-platin, radio-isotopes and MRI agents. Toxic effects of metals(Cd, Hg, Cr and Pb).

Unit IV

4. Analytical applications of radioisotopes-radiometric titrations, kinetics of exchange reactions, measurement of physical constants including diffusion constants, Radioanalysis, Neutron Activation Analysis, Prompt Gama Neutron Activation Analysis and Neutron Absorptiometry.
   Applications of radio isotopes in industry, medicine, radiopharmacology, radiation safety precaution, nuclear waste disposal.

Paper III –PH1CO3: Organic CHEMISTRY-Core

Total Credit : 4 MM: 100 Hours: 52

UNIT I

1. Physical Organic Chemistry. Energy profiles. Kinetic versus thermodynamic control of product formation, Hammond postulate, kinetic isotope effects with examples, Linear free energy relationship Hammet equation, Taft equation.
2. Modern Synthetic Methods:Baylis-Hillman reaction, Henry reaction, Nef reaction, Kulinkovich reaction, Ritter reaction, Sakurai reaction, Ugi reaction. Brook rearrangement. Tebbe olefination. Metal mediated C-C and C-X coupling reactions: Heck, Suzuki, Negishi and Sonogashira, Nozaki-Hiyama,

UNIT II

3. Oxidation: Metal based and non-metal based oxidations of (a) alcohols to carbonyls (chromium, manganese, aluminium, and silver based reagents) (b) phenols (Fremy's salt, silver carbonate) (c) alkenes to epoxides (peroxides/peracids based), Sharpless asymmetric epoxidation.(d) alkenes to diols (Manganese, Osmium based), Sharpless asymmetric dihydroxylation, Prevost reaction. (e) alkenes to carbonyls with bond cleavage (manganese, osmium, ruthenium and lead based, ozonolysis) (f) alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, Wacker oxidation) (g) ketones to ester/lactones (Baeyer-Villiger).
4. Reduction-(a) Catalytic hydrogenation (Heterogeneous: Pd /Pt /Rh /Ni etc; Homogeneous: Wilkinson). Noyori asymmetric hydrogenation. (b) Metal based reductions using Li/Na/Ca in liquid ammonia, Sodium, Magnesium and Zinc (Birch, Pinacol formation, McMurry, Acyloin formation, dehalogenation and deoxygenations) (c) Hydride transfer reagents (i) $NaBH_4$ triacetoxyborohydride; LiAlH4 and DIBAL-H, MeerweinPondorff-Verley reduction) (ii) Stereo/enantioselective reductions (Chiral Boranes, Corey-Bakshi-Shibata).

Unit III

5. Pericyclic Reactions: Main features of pericyclic reactions; Woodward-Hoffman rules, correlation diagram and FMO approaches; Electrocyclic reactions – conrotatory and disrotatory motions for 4n and 4n+2 systems;. Cycloadditions – antarafacial and suprafacial additions, [2+2] and [4+2] reactions ($h\nu$ and Δ), 1,3-dipolar cycloadditions and chelotropic reactions; Sigmatropic [i,j] shifts of C-H and C-C bonds; Sommelet-Hauser, Claisen, thio-Claisen, Cope and aza-Cope rearrangements.
6. Stereochemistry of Organic Compounds
   Center of chirality: molecules with C, N, S based chiral centers. Axial, planar and helical chirality with examples, stereochemistry and absolute configuration of allenes, biphenyls and binaphthyls, , spiranes, exo-cyclic . Topicity and prostereoisomerism, topicity of ligands and faces as well as their nomenclature.

Unit IV

7. Conformational Analysis of cyclohexane and its derivatives, decalins, adamantane, congressane, sucrose and lactose. Fused and bridged bicyclic systems. Conformation and reactivity of elimination (dehalogenation, dehydrohalogenation, semipinacolic deamination and pyrolytic elimination-Saytzeff and Hofmann eliminations), substitution and oxidation of 2^0 alcohols. Chemical consequence of conformational equilibrium - Curtin Hammett principle.
8. Chiral drug synthesis Introduction to Chiral drugs, importance of stereochemistry in drug action, concepts of eutomer, distomer and eudesmic ratio, stereospecific and stereoselective synthesis, Synthesis of Chiral drugs like Ibuprofen, Propranolol, ramipril, levofloxacin.

Semester II

Paper I –PH2CO4: Pharmacology and drug design-Core

Total Credit : 4 MM: 100 Hours: 52

Unit I

1. General principles of pharmacology: biological response to drugs, passage of drugs across membranes.Pharmacokinetic principles: absorption, distribution, metabolism and excretion of drugs. Dose of drugs and routes of administration. Pharmacodynamic principles: dose response relationships, mechanism of drug action, unusual and adverse responses of drugs, structurally specific and nonspecific drugs. Ferguson's principle.Drug interactions-synergism, antagonism, drug addiction and drug dependence, drug tolerance, drug hypersensitivity.

Unit II

2. General Principles of Drug Therapy. Relationship between chemical structure, lipid solubility and biological activity of drugs. Stereochemistry and biological activity.
   Drug action-receptor theories. Drug metabolism–different pathways.
   Drug design: various factors of drug design, rational drug design. Methods of lead discovery: optimisation of the lead, natural and synthetic sources of lead compounds. Bioisosterism. Prodrug and soft drug concept. Drug synthesis. Combinatorial synthesis (basic concepts). Retrosynthetic analysis of benzocaine, saccharin, salbutamol and benzodiazepines.

Unit III

Drugs acting on CNS

3. General anaesthetics. Inhalation anaesthetics - ether, enflurane, halothane, nitrous oxide, cyclopropane. Intravenous anaesthetics - thiopentone sodium, ketamine. Hypnotics, sedatives and anxiolytic agents. Anxiolytic agents-benzodiazepines, buspirone and meprobamate. Anticonvulsants: convulsions, types of epilepsy, barbiturates-hydantoins, oxazolidinediones, succinimides and benzodiazepines. Analeptics: xanthines, amphetamines, nikethamide and ethamivan.Centrally acting muscle relaxants: glyceryl ethers-mephenesin, alkane diol derivatives-meprobamate, benzodiazepines-librium, diazepam and baclofen. Antiparkinson's agents: dopamine agonists, dopamine releasing agents and synthetic anticholinergics. Drugs for Alzheimer's disease: cholinergic agonists and acetylcholine esterase inhibitors.
4. Synthesis of the following drugs - Enflurane, Ketamine,Etomidate, Phenobarbital, Diazepam, Chlordiazepoxide, Meprobamate, Buspirone, Ethinamide,Nikethamide, Ethamivan, Trimethadione,Ethosuximide, Denzimol, Topiramate, Mephenesin, Levodopa, Besiperidine and Tacrine.

Unit IV

Analgesics

5. Narcotic analgesics - morphine and its analogues, phenyl(ethyl) piperidines, diphenyl heptanones and benzocaine derivatives. Antipyretics and NSAIDs: Basic idea of COX I &I I inhibitors, salicylatesaspirin, p-aminophenol derivatives-paracetamol, phenacetin, pyrazolidinedionesphenyl butazone, oxyphenbutazone, anthranilicacid derivatives-mefanamic acid,flufenamic acid,indoleacetic acid derivatives-indomethacin, arylacetic/propionic acid derivatives(ibuprofen, ketoprofen, flubiprofen and diclofenac), oxicams(piroxicam and tenoxicam).
6. Synthesis of the following drugs-levorphanol, pethidine, methadone, phenyl butazone, flufenamic acid, diclofenac, piroxicam, allopurinol and celicoxib.

Paper II –PH2CO5: Pharmacognosy -Core

Total Credit : 4 MM: 100 Hours: 52

Unit I

1. Pharmacognosy

Pharmacognosy of the official drugs frequently used in pharmacy: their sources and constituents. Eg:- senna, belladona, digitalis, stramonium,vasaka, cinnamon,cinchona, ergot, cannabis, ipecacuanha, rauwolfia, liquorice, ginger, cloves, pyrethrum, santonica, nutmeg, nuxvomica, cardamom, umbelliferous fruits like Cumin, Fennel, Caraway, Opium, Aloes, Asafoetida, Vinca rosea, Brammi (two varieties).

Fixed oils and essential oil used in pharmacy-their sources. Extraction,constituents, composition analysis of fixed oils. Elementary study of adulteration of fixed oils.

Fixed Oils: Castor oil, Olive oil, Shark liver oil.

Essential Oils: Eucalyptus oil, Turpentine oil.

A brief study of the substances used as pharmaceutical necessities – Starches, Gum Acacia, Gum Tragacanth, Agar Agar, Gelatin, Talc, Kaolin. Bentonite.

Unit II

2 Metallic compounds used in pharmaceutical chemistry:Calcium lactate, calcium gluconate, iron gluconate, iron fumerate, ferric ammonium citrate, ferrous sulphate, aluminium hydroxide gel, calamin, zinc oxide, zinc stearate, magnesium stearate, talc, yellow mercuric oxide, trivalent and pentavalent antomonials, selenium sulfide, lithium salts, gold, platinum and bismuth compounds.

3 Metal toxicity - cadmium, lead, copper and mercury.

UNIT III

4 Pharmaceutical Legislation in India. Legal aspects of trade in drugs. The drug Act and Drug rules. The Pharmacy Act. The dangerous Drug Act and Rules. The Drugs and Cosmetic Act and rules

Introduction to Pharmacopeia B.P, I.P. and general standard analysis,

Intellectual Property Rights (IPR), Patents, Trademarks, Copy rights, Patent Actsrelevant sections (basic ideas only)

Unit IV

Diagnostic Agents and Tests

5. Radiopaques - organo iodo compounds. Compounds used in function tests, dyes, radio isotopes, RIA, ELISA. Dyes used in pharmacy: fluorescein, mercurochrome, acridine dyes. Colouring agents: official colours, colour code. Liver and gastric function tests and kidney function tests

Paper III –PH2CO6: Chemistry of Natural Products and Biomolecule-Core

Total Credit : 4 MM: 100 Hours: 52

UNIT I

Steroids: classification and nomenclature of steroids. Reactions, structure elucidation, stereochemistry and biosynthesis of cholesterol. Structure and semi synthesis of steroid hormones-testosterone, estrogen and progesterone. Biosynthesis of steroids.

UNIT II

Alkaloids: General methods of structure elucidation of alkaloids. Structure elucidation and synthesis of papaverine, quinine and morphine. Stereoselctive synthesis of reserpine. Biosynthesis of alkaloids.

UNIT III

Vitamines: classification, structure and synthesis of vitamins A, C, B1 and B2.

β-lactam antibiotics: structure determination of pencillins and cephalosphorins, synthesis of pencillins and chloramphenicol. a brief study of macrolide antibiotics, aminoglycoside antibiotics, polyene antibiotics, fluoroquinolones.

UNIT IV

Natural colouring species: anthocyanins and carotenoids, structure and synthesis of cyanin, flavone, quercetine and β-carotene.

Semester III

Paper I –PH3CO7: SPECTROSCOPIC METHODS IN PHARMACEUTICAL CHEMISTRY

-Core

Total Credit : 4 MM: 100 Hours: 52

Unit I

1. Ultraviolet-Visible and Chirooptical Spectroscopy :Energy levels and selection rules, Woodward-Fieser and Fieser-Kuhn rules. Influence of substituent, ring size and strain on spectral characteristics. Solvent effect, Stereochemical effect, non-conjugated interactions. Chirooptical properties-ORD, CD, octant rule, axial haloketone rule, Cotton effect. Poblems based on the above topics.

Unit II

2. Infrared Spectroscopy:Fundamental vibrations, characteristic regions of the spectrum (fingerprint and functional group regions), influence of substituent, ring size, hydrogen bonding, vibrational coupling and field effect on frequency, determination of stereochemistry by IR technique. IR spectra of different groups. Problems on spectral interpretation with examples.

Unit III

3 Nuclear Magnetic Resonance Spectroscopy: Magnetic nuclei with special reference to 1H and13C nuclei. Chemical shift and shielding/deshielding, factors affecting chemical shift, relaxation processes, chemical and magnetic non-equivalence, local diamagnetic shielding and magnetic anisotropy. Proton and 13C NMR scales. Spin-spin splitting: AX, AX2, AX3, A2X3, AB, ABC, AMX type coupling, first order and non-first order spectra, Pascal's triangle, coupling constant, mechanism of coupling, Karplus curve, quadrupole broadening and decoupling, diastereomeric protons, virtual coupling, long range coupling-epi, peri and bay effects. NOE. NOE and cross polarization. Simplification non-first order spectra to first order spectra: shift reagents, , spin decoupling and double resonance, off resonance decoupling. Chemical shifts and homonuclear/heteronuclear couplings. Basis of heteronuclear decoupling. 2D NMR and COSY, HOMOCOSY and HETEROCOSY Polarization transfer. Selective Population Inversion. DEPT, INEPT and RINEPT. Sensitivity enhancement and spectral editing, MRI. Problems on spectral interpretation with examples.

Unit IV

Mass Spectrometry

4 Molecular ion: ion production methods (EI). Soft ionization methods: SIMS, FAB, CA, MALDI, PD, Field Desorption Electrospray Ionization. Fragmentation patterns-nitrogen and ring rules. McLafferty rearrangement and its applications.HRMS, MS-MS, LC-MS, GC-MS. Problems on spectral interpretation with examples.

5 X-ray

Paper II –PH3CO8: MEDICINAL CHEMISTRY I **-Core**

Total Credit : 4 MM: 100 Hours: 52

Unit I

1. Drugs acting on ANS Adrenergic stimulants: Phenyl ethanolamine derivatives-adrenaline, isoprenaline, salbutamol, ephedrine, and phenylephrine. Imidazole derivatives-naphazoline, xylometazoline and oxymetazoline.
   Adrenergic blockers: α and β adrenoreceptor antagonists-ergot akaloids, phenoxybenzamine, phentolamine, tolazoline, DCI, propranolol, atenolol, labetolol. Neurone blockers–Bretilium and Xylocholine.
2. Cholinergic stimulants: nicotinic and muscarinic receptors, acetyl choline and analogues, pilocarpine, bethanechol and carbachol.
   Cholinergic blockers: tertiary and quaternary antimuscarinics, antispasmodic drugs-dicyclomine, glycopyrrolate, antiulcer drugs-pirenzepine, cycloplegic drugs-tropicamide, homatropine

UNIT II

3. Anticholinesterases: Competitive inhibitors-physostigmine and neostigmine. Non competitive inhibitors: organophosphorus compounds, Nerve gases, Cholinesterase regenerators-2 PAM.
   Ganglion blocking agents: mecamylamine and trimethophan
4. Synthesis of the following drugs: salbutamol, naphazoline, tolazoline, propranolol, bretilium, carbachol, mecamylamine and gallamine.

Unit III

Drugs acting on CVS

5. Cardiotonic drugs: cardiac glycosides-their chemistry and stereochemistry, Digoxin and digitoxin.
   Antiarrhythmic drugs: quinidine, disopyramide, lidocaine, phenytoin and procainamide, β-blockers-propranolol. Calcium channel blockers-verapamil and Neurone blockers-bretilium.
   Antihypertensive Drugs: peripheral antiadrenergics-prazosin and terazosin.
   Centrally acting drugs-reserpine, clonidine and methyl dopa. β-blockerspropranolol, atenolol and labetalol. Calcium channel blockers-nifedipine and amlodipine. ACE inhibitors-captopri. Angiotensin receptor blockers-losartan.
   Diuretics-thiazide diuretics.
   Antianginal drugs: vasodilators-nitrites and nitrates, β-blockers-propranolol. Calcium channel blockers-verapamil and nifedipine.
6. Anticoagulants: heparin, coumarin derivatives and indane dione derivatives.
   Antilipidemic agents: atherosclerosis(mention only), Statins-lovastatin,simvastatin, fluvastatin, Fibrates-clofibrate.

7. Synthesis of the following drugs: procainamide, disopyramide, amlodipine,verapamil, captopril and fluvastatin.

Unit IV

Chemotherapy

8. Sulphonamides: sulphanilamide, N-substituted sulphanilamide derivatives, mechanism of action, sulphones-dapsone, dihydrofolate reductase inhibitorstrimethoprim and cotrimoxazole.

   Antitubercular agents: first line drugs-isoniazid, rifampicin, pyrazinamide, ethambutol, and streptomycin. Second line drugs-ethionamide, paraaminosalicylic acid and fluoroquinolones.

   Antifungal agents: Antibiotics-amphotericinB, griseofulvin and nystatin. Azole derivatives-ketoconozole,terconozole,fluconozole and clotrimazole. Pyrimidine derivatives- 5 Flucytosine.
9. Antiviral drugs: amantidine, interferon and ribavirin. Anti HIV agentszidovudine, and abacavir. Anti herpes simplex agents-brivudine, vidarabin and acyclovir. Anti-influeza agents-oseltamivir(tamiflu).

   Antiprotozoal agents: Amoebicides-metranidazole and tinidazole. Antimalarialschloroquine, primaquine, mefloquine, quinacrine and proguanil. Anthelminticspiperazines and benzimidazoles. .
10. Synthesis of the following drugs: ampicillin, cephalexin, chloramphenicol, sulphamethoxazole, dapsone, trimethoprim, ethambutol, griseofulvin, clotrimazole, acyclovir, metranidazole, primaquine, mebendazole.

Paper III –PH3CO9: MEDICINAL CHEMISTRY II **-Core**

Total Credit : 4 MM: 100 Hours: 52

Unit I

1. Antineoplastic Drugs:Neoplasm-cause therapeutic approaches. Alkylating agents-nitrogen mustards,nitrosourea, aziridines and aryl sulphonates. Antimetabolites-folic acid.Antagonists-purine and pyrimidine antagonists. Antibiotics-anthracyclines,actinomycinD, bleomycin. Plant products-vinca alkaloids, taxol derivatives.
2. Hormones and their antagonists-tamoxifen.
   Synthesis of the following drugs: chlorambucil, carmustin, thiotepa, methotrexate, 5-fluoro uracil, procarbazine.

Unit II

Psychopharmocological Agents

3. Tranquilisers: rauwolfia alkaloids, meprobamate, oxazepim, benzodiazepines, chlordiazepoxide, phenothiazene derivatives.
   Antidepressants: MAO inhibitors-Isocarboxazide, tranylcypromine and phenelzine. Tricyclic compounds-imipramine, trimipramine, amitriptynine, doxepine, amoxapine.
   Antipsychotics: phenothiazine and thiothixene derivatives, butyrophenoneshaloperidol, droperidon, rauwolfia alkaloids. Hallucinogens: triptaminederivatives-DMT, psilocybin, phenylalkylaminesmescaline, lysergic acid derivatives-LSD.
4. Synthesis of the following drugs: chlordiazepoxide, meprobamate, imipramine chlorpromazine, tranylcypromine and haloperidol.

Unit III

5. Diuretics: common diuretics and their mechanism of action-mercurial and nonmercurial diuretics, carbonic anhydrase inhibitors- acetazolamide and methazolamide, thiazide derivatives-hydrochlorothiazide, Loop diureticsfurosemide and ethacrynic acid, potassium sparing diuretics-amiloride, spironolactone.
6. Antihistaminic drugs: histamine and its biological role, H1 antagonistsaminoalkyl ethers, diphenhydramine and doxylamine, ethylenediamine derivatives-pyrilamine, phenothiazines-promethazine, trimeprazine, piperazine derivatives-cyclizines, miscellaneous compounds-cetrizine and cyproheptadine.
7. Hypogycemic agents: type 1 and type 2 diabetes, insulin, suphonyl ureastolbutamide, acetohexamide and glibenclamide, biguanides-metformin, thiazolidinediones-rosiglitazone.

UNIT IV

8. Local anaesthetics: clinical application of local anaesthesia, coca and cocaine, hexylcaine, paraaminobenzoic acid derivative-benzocaine, procaine, tetracaine,chloroprocaine, anilides, lidocaine, etiodacaine and prilocaine.

9. Antitussives: centrally acting antitussives-opium alkaloids and synthetic substitutes-codaine, noscapine, pholcodine, ethylmorphine, dextromethorphan, Non narcotic antitussives-diphenhydramine, expectorants-terpin hydrate, guaicol and bromhexine.
10. Synthesis of the following drugs: acetazolamide, chlorthiazide furosemide, ethacrynic acid, amiloride, diphenhydramine, pyrilamine, promethazine, omeprazole, tolbutamide, phenformin, benzocaine, procaine lidocaine, dextromethorphan.

Semester IV

Paper I –PH4CO10: Biochemistry and Bacteriology **-Core**

Total Credit : 4 **MM: 100** **Hours: 52**

Unit I

1. Amino acids, Proteins and Nucleic Acids. Cells-classification and cell division. Ramachandran plot and secondary structure of proteins. Tertiary structure and structural motifs-protein folding and domain structure of proteins. Quaternary structure of proteins. Purification and characterization of proteins. Functions of proteins. Chemical synthesis of proteins-protecting groups, solid phase peptide synthesis. DNA and RNA. Double helical structure of DNA. Replication of DNA. RNA classification of RNA. Genetic code. Nucleic acids as carriers of genetic information. Protein biosynthesis. DNA fingerprinting technique. Elementary principles of Recombinant DNA technology, gene therapy, cloning and bioinformatics.

Unit II

2. Enzymes and Hormones: Nomenclature and classification of enzymes. Mechanism of enzyme action.Substrate specificity of enzymes. Enzyme inhibition. Isoenzymes. Allosteric enzymes. Enzyme synthesis. Enzymes and digestion of food. Clinical uses of enzymes. Immobilization of enzymes. Clinical tests for sugar and cholesterol.ELIZA.
   Functions and modes of actions of hormones. Pituitary, thyroid, parathyroid, pancreatic, adrenal and adrenocortical hormones. Male and female sex hormones.Antihormones.

Unit III

3. Biological Oxidation and Metabolism:ATP and ADP. Oxidative phosphorylation. Cytochromes. Food as a source of energy. Calorific value of food. Basal metabolism.Respiratory quotient. Carbohydrate metabolism: Glycogenesis and Glycolysis. Blood sugar level. Cori cycle. The role of insulin. The citric acid cycle. Genetic and metabolic disorders. Diabetes mellitus (type 1 and type 2). Lipaemia.
   Lipid metabolism. Oxidation of fatty acids. Ketogenesis and ketosis. Biosynthesis of fatty acids. Essential fatty acids. Prostaglandins-nomenclature, structure and biosynthesis.
   Metabolism of amino acids and proteins. Oxidative deamination and trans amination reactions. Urea formation-ornithine cycle. Inborn errors of metabolism.

Unit IV

4. Blood Composition and Acid Base Balance: Blood groups-Rh factor. Blood transfusion. Composition of blood cells.Chemistry of haemoglobin. Anaemias. Plasma proteins. Blood clotting- factors and mechanism. Coagulants.
   Regulation of acid base balance. Acidosis and alkalosis. Renal function formation and composition of urine.

Paper II –PH4CO11: Analytical Chemistry **-Core**

Total Credit : 4 MM: 100 Hours: 52

UNIT I

1. Titrimetric and Gravimetric Methods of Analysis: General principles: Solvents in analytical chemistry, acidbase equilibria, concentration systems, stoichiometic calculation, acid-base titration, titration curves, acid base indicators, applications of acid-base titration,complexometric titration, metal-ion indicators, precipitation titration, Mohr's titration, Volhard's titration, adsorption indicators, Fajan's titration, titration curves in oxidation-reduction titration, redox indicators, applications of redox titrations.
   Quantitative analysis via functional group, spot tests
   Bio-Assay: Quantitative assay of drugs by biological methods.
2. Optical rotation, refractive index, atomic absorption, kinematic,Viscosity, pharmacokinetics.

Unit-II

3 . Separation Techniques –I: (A) Solvent Extraction: Fundamental treatment, theoretical principle, classification, and factors favouring extraction,extraction equillibria, applications. Liquid – liquid extraction, use of oxine. Ultra centrifugation, dithiazone - in extraction.
(B) Solid phase extraction and solid phase micro extraction, applications.
(C) Ion- Exchange: Theories, use of synthetic ion exchange in separation, chelating ion exchange resins, liquid ion exchangers, experimental technique.

Unit-III

4 Separation Techniques –II:An introduction to chromatographic methods, paper, thin layer and column chromatography, theory of chromatography, classification of chromatographic techniques, retention time, relationship between retention time and partition coefficient, the rate of solute migration, differential migration rates, band broadening & column efficiency, kinetic variables affecting band broadening (No mathematical derivation), Electrophoresis and capillary electrophoresis.

Unit-IV

5. GC, LC and HPLC:Instrumentation of GC, LC and HPLC, applications in qualitative and quantitative analysis, comparison of GC and HPLC,Ion chromatography, pyrolytic gas chromatography, size exclusion chromatography, super critical fluid chromatography, affinity chromatography. Column matrices. Detectors. Affinity and chiral columns.

Paper III –PH4CO12: Pharmaceutical Training **-Core**
Total Credit : 4 **MM: 100**

3-4 Months training in any Pharaceutical or Scientific laboratory. After the completition of training project report will be submitted, followed by its presentation & viva-voce

M.Sc. Pharmaceutical Chemistry
Semester I
PH1PO1 and PH1PO2- Laboratory courses

Total Credit: 8 **MM: =200** **Hrs: 104**

Practical (laboratory work) : 150 Marks **Hrs: 80** **Credit : 6**

Inorganic Chemistry
Part I

1. Redox titrations
   (a) Dichromatometry
   (b) Iodometry
2. Gravimetric method
   (a) Ag as AgCl
   (b) Cu as CuSCN
3. Complexometric titrations of
   (a) Magnesium using EDTA
   (b) Zinc using EDTA
4. Neutralization reactions

Part II
Organic Chemistry

Systematic separation, purification and Identification of three Components of an Organic Mixture.

Part III
Seminar **:50 Marks** **Hrs: 24** **Credit: 2**

Submission of Seminar report on a given topic followed by its presentation & viva-voce examination.

M.Sc. Pharmaceutical Chemistry
Semester II
PH2PO3 and PH2PO4-Laboratory courses

Total Credit: 8 MM: 200 Hrs: 104

Practical (laboratory work) : 150 Marks Hrs: 80 Credit : 6

Part I

1. Synthesis of
   (a) $Ni(DMG)_2$
   (b) $Hg[Co(CSN)_4]$
   (c) Cis- and trans-$[Cu(gly)_2]$
   (d) $[Ni(PPh_3)_2Cl_2]$
   (e) $[Ni(PPh_3)(SCN)_2]$
   (f) $[Al(acac)_3]$

Part II

General methods of separation and purification of organic compounds such as:
1. Solvent extraction
2. Fractional crystallization
3. TLC and Paper Chromatography
4. Column Chromatography

PART III
Drawing the structures of organic molecules and reaction schemes by ChemDraw and Chemsketch. Draw the structures and generate the NMR spectra of the substrates and products in the following reactions:
1. Cycloaddition of diene and dienophile (Diels-Alder reaction)
2. Oxidation of primary alcohol to aldehyde and then to acid
3. Benzoin condensation
4. Esterification of simple carboxylic acids
5. Aldol condensation

PART IV
Seminar :50 Marks Hrs: 24 Credit: 2

Submission of Seminar report on a given topic followed by its presentation & viva-voce examination.

M.Sc. Pharmaceutical Chemistry
Semester III
PH3PO5 and PH3PO6 Laboratory courses

Total Credit: 8 **MM: 200** **Hrs: 104**

Practical (laboratory work) : 150 Marks **Hrs: 80** **Credit : 6**

Part I

1. Preparation of some specified crude plant extracts and qualitative analysis (chemical or TLC) of crude plant extracts/ products to detect the presence of phytochemicals-alkaloids, carbohydrates, glycosides, tannins, flavanols and saponins.
2. Analysis of drugs as per Pharmacopoeia of India (I.P.) and British Pharmacopoeia (B.P.),

Part II

1. Isolation of phytochemicals from their natural sources.
   - Caffeine from Tea
   - Piperine from black pepper
   - Cucumin from turmeric
   - Citric acid from lemon
   - Lycopene from tomato
   - B-Carotene from carrot
   - Trimyristin from nutmeg
   - Eugenol from cloves
2. Dispensing

Part III

Seminar **:50 Marks** **Hrs: 24** **Credit: 2**

Submission of Seminar report on a given topic followed by its presentation & viva-voce examination.

M.Sc. Pharmaceutical Chemistry
Semester IV
PH4PO7 and PH4PO8 Laboratory courses

Total Credit: 8 **MM: 200** **Hrs: 104**

Practical (laboratory work) : 150 Marks **Hrs: 80** **Credit : 6**

Part I
Two-three step synthesis of drugs and drug intermediates

Part II
Identification of organic compounds by analysis of their spectral data (UV, IR, 1H & 13 CNMR and Mass Spectroscopy)

Part III

Seminar **:50 Marks** **Hrs: 24** **Credit: 2**

Submission of Seminar report on a given topic followed by its presentation & viva-voce examination.

Elective Paper I
M. Sc. Pharmaceutical Chemistry Semester-I
Total Credits: 3 Max. Marks: (70+30) Hours: 40

UNIT I

Symmetry: Molecular symmetry, representation of symmetry operations as matrices, set of symmetry operations of molecules satisfying the conditions of point groups, multiplication tables.

UNIT II

Transition Metal Chemistry: magnetic moments, magnetic properties of transition metal complexes. Interior magnetic coupling. Spin state crossovers. Comparison of firsttransition series with 2^{nd} and 3rd transition series.

UNIT III

Valence Bond Theory: Concepts of VB theory. Hybridization (sp, sp2, dsp2, sp3, sp3d, dsp3, sp3d2,d2sp3). Application of V.B theory to simple inorganic molecules and transition metal complexes. Inner and outer orbital complexes

UNIT IV

Chemical statistical thermodynamic :Brief review of laws of thermodynamics, Concepts of free energy, entropy, fugacity and activity. Partial molar properties and their determination. Thermodynamics ofideal and non ideal mixtures, dilute solutions, excess functions. Activity coefficients of electrolytes, mean ionic activity coefficient, Debye Huckle treatment of dilute electrolyte solutions.

Elective Paper II
M. Sc. Pharmaceutical Chemistry Semester-II
Total Credits: 3 Max. Marks: : (70+30) Hours: 40

UNIT I

1. Review of basic concepts in organic chemistry: bonding, hybridisation, MO picture, inductive effect, electromeric effect, resonance effect, hyperconjugation, steric effect. Bonding weaker than covalent bonds.
   The formalism of curved arrow mechanisms. Practicing of line diagram drawing.
   Concept of aromaticity: delocalization of electrons - Hückel's rule, criteria for aromaticity, examples of neutral and charged aromatic systems - annulenes. NMR as a tool for aromaticity. Anti-and homo-aromatic systems - Fullerenes, Carbon nanotubes and Graphene.

UNIT II

2. Mechanism of electrophilic and nucleophilic aromatic substitution reactions with examples. Arenium ion intermediates. SN1, SNAr, SRN1 SN2, SNi, SE1, SE2, and Benzyne mechanisms

UNIT III

3. additionelimination and elimination-addition sequences), elimination (E1 and E2) and addition reactions (regioselectivity: Markovnikov's addition-carbocation mechanism, anti-Markovnikov's addition-radical mechanism). Elimination vs substitution.
   1.2 A comprehensive study on the effect of substrate, reagent, leaving group, solvent and neighbouring group on nucleophilic substitution(SN2 and SN1) and elimination (E1 and E2) reactions.

UNIT IV

4. Stereochemistry: Conformational analysis of cycloalkanes (5 –6 membered rings), Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, method of resolution, optical purity.

Elective Paper III

M. Sc. Pharmaceutical Chemistry Semester-III

Total Credits: 3 Max. Marks: : (70+30) Hours: 40

Unit I:

Chemistry of Carbanions:Formation, structure and stability of carbanions. Reactions of carbanions: C-X bond (X = C, O, N) formations through the intermediary of carbanions. Chemistryof enolates and enamines. Nucleophilic additions to carbonyls groups. Named reactions under carbanion chemistry-mechanism of Claisen, Dieckmann, Knoevenagel, Stobbe, Darzen

Unit II:

Chemistry of Carbocations : Formation, structure and stability of carbocations. Classical and non-classical carbocations. C-X bond (X = C, O, N) formations through the intermediary of carbocations. Molecular rearrangements including Wagner-Meerwein, Pinacol-pinacolone, semi-pinacol, Dienone-phenol and Benzilic acid rearrangements.

Unit III

Radical Reactions : Generation of radical intermediates and its (a) addition to alkenes, alkynes (inter & intramolecular) for C-C bond formation - Baldwin's rules (b) fragmentation and rearrangements-Hydroperoxide: formation, rearrangement and reactions. Autooxidation.Named reactions involving radical intermediates: Barton deoxygenation and decarboxylation, McMurry coupling.

Unit IV:

Chemistry of Carbonyl Compounds: Reactions of carbonyl compounds: oxidation, reduction (Clemmensen and WolfKishner), addition (addition of cyanide, ammonia, alcohol) reactions, Cannizzaro reaction, addition of Grignard reagent. Structure and reactions of α, β- unsaturated carbonyl compounds involving electrophilic and nucleophilic addition-Michael addition, Mannich reaction, Robinson annulation.

Elective Paper IV
M. Sc. Pharmaceutical Chemistry Semester-IV
Total Credits: 3 Max. Marks: : (70+30) Hours: 40

UNIT I

1. Principles of green chemistry, basic concepts, atom economy, twelve laws of green chemistry, principles of green organic synthesis.
   Green alternatives of organic synthesis: coenzyme catalysed reactions, green alternatives of molecular rearrangements, electrophilic aromatic substitution reactions, oxidation-reduction reactions, clay catalysed synthesis, condensation reactions. Green photochemical reactions. Microwave assisted organic synthesis.
   Green chemistry in the pharmaceutical industry: Ibuprofen manufacture, biocatalysis.

UNIT II

2. Photoreactions of carbonyl compounds: enes, dienes, dienones and arenes.Norrish reactions of acyclic ketones. Patterno-Buchi reaction. Barton, Di-π-methane and photo Fries rearrangements. Photochemistry of nitro and azo groups.

UNIT III

Classification: electrocyclic, sigmatropic, cycloaddition, chelotropic and enereactions. Woodward Hoffmann rules - frontier orbital and orbital symmetry correlation approaches - PMO method.Highlighting pericyclic reactions in organic synthesis such as Claisen, Cope,Wittig, Mislow-Evans and Sommelet-Hauser rearrangements

UNIT IV

Unimolecular pyrolytic elimnination reactions: cheletropic elimination,decomposition of cyclic azo compounds, β -eliminations involving cyclic transition states such as N-oxides, acetates and xanthates.