

**SYLLABUS COPY FOR FINAL YEAR B. PHARM
SEMSETER VII**

PHARMACEUTICAL MEDICINAL CHEMISTRY – III

3 hrs/ week

S. No.	Topic	Hours
	Discussion of the following classes of drugs including classification, chemical nomenclature, structure including stereochemistry, generic names, chemistry, physicochemical properties, SAR, metabolism, molecular mechanism of action and synthesis, introduction to rational development if any of the class of drugs.	
1.	<p>Cholinergic Drugs:</p> <p>(i) cholinergic agonists (methocholine, carbochol*, bethanechol, pilocarpine)</p> <p>(ii) Ach esterase inhibitors (physostigmine, neostigmine*, tacrine*, ambenonium chloride, isofluorphate, pralidoxime)</p> <p>(iii) Cholinergic antagonists (atropine, scopolamine, homatropine hydrobromide, ipratropium bromide); synthetic cholinergic antagonists (cyclopentolate*, dicyclomine*, ben/otropine mesylate, procyclidine hydrochloride, isopropamide iodide, tropicamide)</p> <p>(iv) Ganglion blocking agents (trimethaphan, camsylate, mecamlamine)</p> <p>(v) Neuromuscular blocking agents (tubocurarine, gallamine, triethiodide, succinyl choline chloride)</p>	9
2.	<p>Adrenergic Drugs:</p> <p>(i) α-adrenergic agonists (phenylephrine, naphazoline, xylometazoline, oxymetazoline, methyldopa, clonidine*, guanabenz, guanfacine)</p> <p>(ii) β-adrenergic agonists (isoproterenol, terbutaline*, albuterol, salmeterol, isoxsuprine, ritodrine)</p> <p>(iii) α-adrenergic antagonists (tolazine, phentolamine, phenoxybenzamine, prazosin, doxazosin)</p> <p>(iv) β-adrenergic antagonists (propranolol*, atenolol, metoprolol, acebutalol, alprenolol, timolol, labetalol*)</p> <p>other adrenergic agents (amphetamine, pseudophedrine, ephedrine, guanethidine*, propylhexedrine, reserpine).</p>	9
3.	<p>CVS Drugs:</p> <p>(i) antianginal agents (amyl nitrite, isosorbide dinitrate, pentaerythritol tetranitrate, verapamil, bepridil, diltiazem, nifendipine*, amlodipine, nimodipine, dipyridamole)</p> <p>(ii) antiarrhythmic agents (quinidine, procainamide*, disopyramide, lidocaine, tocainide, mexilitine, encainide, amiodarone, pro[afenone, verapamil, diltiazem, propranolol, sotalol*).</p> <p>(iii) Antihypertensive agents (a) review of adrenergic agents (b) review of Ca channel blockers (c) ACE inhibitors (captopril*, enalapril, benazepril, ramipril) (d) angiotensin II receptor antagonists (losartan, valsartan*, candersartan)</p> <p>(iv) Vasodilators and K-channel agonists (diazoxide, minoxidil)</p> <p>(v) Antihyperlipidemic agents (clofibrate*, gemfibrozil, niacin, lovastatin,</p>	4 4 6 1

	atorvastatin)	3
	* Indicates synthesis to be discussed	

Reference Books:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 11th Ed. Eds. John H. Block and John M. Beale, Lippincott Williams & Wilkins, 2004
2. Foye's Principals of Medicinal Chemistry, Eds. T. L. Lemke and D. A. Williams. Williams & Wilkins, Baltimore, 2002.
3. Medicinal Chemistry, Ashutosh Kar, 4th Edition, New Age International Publishers, 2007.
4. The Art of Drug Synthesis, Eds. Douglas S. Johnson and Jie Jack Li, Wiley Interscience, 2007.
5. Pharmaceutical Chemistry, Vol. E Drug Synthesis Eds. H. J. Roth, A. Kleeman and T. Beissewenger, Ellis Horwood Ltd. 1988.
6. The Organic Chemistry of Drug Synthesis, Daniel Lednicer, Vols 1 to 7, Wiley.

PHARMACEUTICAL ANALYSIS IV

3 hrs/ week

S. No.	Topic	Hours
1.	Chromatography Principal's, terminology-stationery phase, mobile phase, classification of chromatography methods, migration rate of species (partition coefficient, retention time, adjusted retention time), Rate of solute migration (capacity factor, selectivity factor), Column efficiency and band broadening (shape of peak-Gaussssian, plate height, number of theoretical plates, van Deemeter equation), Optimisation of column performance (Column resolution, capacity factor, selective factor, tailing factor, peak width), Qualitative analysis, Quantitative analysis (Peak height, peak areas, calibration and internal standard, external standard, area normalization).	3
2.	Gas chromatography (GSC & GLC) Introduction, Principal, Instrumentation-carrier, columns, injection system, detectors (advantage, disadvantage, applications of Thermal conductivity, electron capture, thermionic, flame ionization, nitrogen phosphorus, photoionisation), head space analysis, applications.	5
3.	HPLC Introduction, Principal, Instrumentation-mobile phase reservoir, pumps (reciprocating, displacement, pneumatic, isocratic elution, gradient elution), solvent treatment system, Injection systems (Rheodyne injector in detail, direct sample introduction, sampling loops), columns and fittings (for reverse and normal phase, analytical and guard columns. Thermostats, column packing), detectors advantages, disadvantages, (UV-single wavelength, variable wavelength, phtodiode array), fluorescence, refractive index, electrochemical.	
4.	Ion exchange chromatography Principal, ion exchange resins, mobile phases, applications.	2

5.	Ion pair chromatography Principal, applications	1
6.	Size exclusion chromatography Principal for gel permeation and gel filtration method, support media, mobile phases, applications	1
7.	Paper chromatography Introduction, choice of filter papers, solvents, chromatographic chambers, development techniques (descending, ascending, radial multiple chromatography, two-dimensional chromatography), qualitative analysis-location of spots, Quantitative analysis (direct and elution method), factors affecting retention factor, applications.	3
8.	Thin layer chromatography Introduction, Principal, different absorbents different methods for preparation of plates, solvents, development techniques cascending, descending, horizontal, multiple development two dimensional development, preparative TLC, Qualitative evaluation visualization of spots, Quantitative evaluation (Area, weight, densitometry elution factors affecting RF, applications)	3
9.	High performance thin layer chromatography Introduction, Principal, preparation of plates, development techniques Qualitative evaluation, Quantitative evaluation Instrumentation (adsorbents, solvents, sample application, scanning and documentation), applications.	
10.	Validation of analytical methods as per U.S.P.	1
11.	Statistics & Statistical Quality control Normal distribution, t-test, F-test, linear regression correlation coefficient, confidence limits.	3
12.	Sampling procedures Objectives, different kinds of samples, sampling plan, sampling schemes, sampling equipments, methods of statistical analysts as applied to sampling and interpretation of results.	3
13.	Thermal methods of analysis Theory, introduction, instrumentation, factors affecting analysis, pharmaceutical applications of: Thermogravimetry (TG), Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC).	5

Reference Books:

1. Skoogh-Principals of Instrumental Analysis, 4th edition, Saunders College Publishing, 1992, USA.
2. Browning Chromatography, 1969, Mc Graw Hill, London.
3. Willard H. H., L. L. Merrit & John A. Dean-Instrumental Method of Analysis 6th edition, 1986, CBS Publishers & Distributors, New Delhi.
4. Beckett & Stenlake-Practical Pharmaceutical Chemistry, 4th edition, 1988, CBS Publishers & Distributors, India.
5. I.P., U.S.P., B.P. European Pharmacopeia.

6. James W. Munson-Pharmaceutical Analysis, Modern methods, Marcel Dekker Inc. 1981, USA.

PHARMACOGNOSY III

3 hrs/week

Drug mentioned in bold are or detailed study

S. No.	Topic	Hours
1.	Alkaloids: Chemistry, Classification and occurrence of alkaloid in general. Detailed study of the following plants containing alkaloids Ephedra , Colchicum, cocoa, & tea , coffee, lobelia, tobacco, belladonna, datura stramonium, hyoscyamus, cinchona , opium , ashwagandha, ipecac , rauwolfia , vinca, nux vomica , vasaka , aconite, kurchi , pilocarpus, cola, coca, pepper, curare, alkaloids, ergot. Biosynthesis of lysergic acid, opium alkaloids, tropane, alkaloids, colchicines, emethine, quinine.	12
2.	Occurrence structure and applications of following Glycosides a) Anthroquinone - Rubia, cochineal, aloes , hypericum, cascara, andira, senna , rhubarb . b) Isothiocyanate - Brassica c) Cyanogenetic - Almonds, wild cherry d) Napthoquinone - Plumbago, alkanna, henna , walnut Biosynthesis of aloe emodin, amygdaline, juglone.	6 2
3.	Brief introduction to Plant allergens Definition, classification (inhalant, injectant, infestants etc.) with example. Plants causing hay fever & dermatitis, mould causing allergy.	2
4.	Sources, preparation and uses of following enzymes: Papain, bromelain, malt extract, serratiopeptidase, urokinase, streptokinase, pepsin. Study of lectins and snake venom, Preparation of polyvalent antivenins	3
5.	Study of following herbs as health food (Neutraceuticals): Alfaalfa, arnica, apricot, pits, bran, chamomic, chicory, cucumber, fenugreek, onion, garlic, gentian, hydrocotyle, hibiscus, hops, honey, marigold, amla. Ginseng, ashwagandha, ginko biloba, spirulina, gymnema, momordica, tinospora.	3
6.	Occurrence, composition, preparation and uses of following drugs of mineral origin: Diatomic, chalk, bentonite, talc. Study of sulphur containing naturally occurring compounds (sulphide, thiophenes).	2

Reference Books:

1. Trease D. & Evans W.C; Textbook of Pharmacognosy; W. B. Saunders.
2. Tyler V. E. Brady L. R. & Robbers J. E.; Pharmcognosy; Lea Feibger, USA.

3. Wallis I. E. Textbook of Pharmacognosy; CBS Publishers, Delhi.
4. Kokate C. K. Purohit A. P. & Gokhale S. B. Pharmacognosy: Nirali Publications, Pune.
5. Harbone J. B. Phytochemical Methods: A guide to modern techniques of Plant Analysis Chapman & Hall, London.
6. Brunton J. Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
7. Vasudevan I. N. & Buddha K. S. A textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
8. The Indian Pharmacopeia. The Controller of Publication Delhi.
9. Brain K. R. & Fumer L. D. The Practical Evaluation of Phytopharmaceuticals Wright Sceintica, Bristol.
10. Lyenger M. A. & Nayak S. G. Anatomy of Crude Drugs: Manipal Power Press, Manipal.
11. Lyenger M. A. Pharmacognosy of Powdered Drugs: Manipal Power Press, Manipal.
12. Kokate C. K. Practical Pharmacognosy, Vallabh Prakashan.
13. Wagner, Bladi & zagainskit: Plant Drug Analysis: Springer Verlag.
14. Khandelwal K. R.: Practical Pharmacognosy Techniques and Experiments: Nirali Prakashan, Pune.
15. Vasudevan L. N. Laddha K. S.: Practical Pharmacognosy: New Vrinda Publishing House, Jalgaon.

PHARMACEUTICS VI

3 hrs/ week

S. No.	Topic	Hours
1.	Introduction to sterile dosage forms Parental products <ul style="list-style-type: none"> • Various routes of parental administration, pyogens, vehicle,- WFI preparation, purity, storage and distribution, vehicles other than WFI, additives in parental products, types of formulations, freeze drying , containers- glass and plastics- types and evaluation, concept of FFS, rubber closures and testing, personnel, facilities- layout, environmental control cleanliness classes, air handling (HVAC systems), HEPA filters, laminar flow, production procedures, QA & QC- sterility test, pyrogen/ endotoxin test, particulate evaluation, leaker test. 	12
2.	Ophthalmic products <ul style="list-style-type: none"> • Anatomy and physiology of eye – lachrymal system, tears, precorneal tear film, cornea, ocular bioavailability, types of ophthalmic products- solutions, suspension, ophthalmic ointments and gels, preservatives and efficacy test, additives, QA and QC sterility test, clarity, particle size for suspension, tests on ointments and collapsible tubes, packaging. • Contact lens solutions: types of lenses-cleaning solution, disinfection solution, lubricants, multipurpose solutions and packages. 	8
3.	Oral sustained and controlled release systems <ul style="list-style-type: none"> • Advantages of SR systems, biopharmaceutical consideration and 	8

	dose calculation of drug, properties of drug with reference to the design of oral SR systems, matrix and reservoir type of systems, dissolution controlled systems, diffusion controlled systems, ion exchange controlled systems.	
4.	Stability studies <ul style="list-style-type: none"> Kinetic principles, Arrhenius equation and derivation of shelf life based on Arrhenius equation, limitations and advantages equation, degradation pathways- hydrolysis, oxidation, photolytic degradation, methods to enhance stability studies, introduction to ICH guidelines. 	8

Reference Books:

1. Pharmaceutical dosage forms: Parental medications, Vol. I, II, III, ed. by Kenneth A. Avis, Leon Lachman and H. A. Liberman, Marcel Dekker Inc., 1986.
2. Pharmaceutics The Science of dosage form design ed. by M. E. Aulton, 2nd ed., Churchill Livingstone, 2002.
3. Modern Pharmaceutics, 4th ed. Revised and Expanded ed. by Gilbert S. Banker and Christopher T. Rhodes, Marcel Dekker INC., 2002.
4. The theory and practice of industrial pharmacy, ed. by Leon Lachman, H. A. Liberman, J. I. Kanig, 3rd ed., Verghese Publishing house, 1987.
5. Remington, The science and practice of Pharmacy, 21st ed., Vol. I and II, B. L. Publications Pvt. Ltd., 2005.
6. Ophthalmic drug delivery, ed. by Ashim K. Mitra, 1993, Marcel Dekker INC.
7. Turco and Kings, Sterile Dosage forms, 3rd Edn., Lea & Febiger, Philadelphia, 1985.
8. Michael J. Akers, Quality Control of Parenterals, Marcel Dekker
9. "Controlled drug delivery – Fundamentals and Applications", Robinson Joseph R., Lee Vincent H., Vol. 29, Marcel Dekker Inc.

BIOPHARMACEUTICS AND PHARMACOKINETICS

3 hrs/ week

Topic	Hours
Introduction to the subject of biopharmaceutics and Pharmacokinetics. Emphasis on the importance in drug discovery, development and clinical pharmacy.	1
Definitions, different mechanisms of drug transport, physiology of cell membrane and passage of drugs across cell membrane.	2
Modified pH partition theory and its limitations. Zero v/s first order transport.	2
Rate limiting steps in drug absorption, Theories of dissolution, Physicochemical factors affecting the bioavailability of drugs.	2
Physiology of GH and oral bioavailability Formulation, dosage form related factors and physiological factors affecting oral bioavailability	2
Different routes of drug administration as alternative to oral route Factors affecting bioavailability of drugs from parental routes e.g. insulin zinc suspension	2
Dissolution rate and methods of enhancing dissolution rate. Official and unofficial methods of dissolution. Application to different dosage forms	2

In vitro in view correction and its significance	1
Distribution Definition relationship of drug transport to distribution process, perfusion limitation permeability limitation. Plasma protein and tissue protein binding, introduction to the concept of volume of distribution and factors affecting distribution.	3
Elimination, Definition, introduction to elimination via metabolism and excretion Hepatic clearance drugs, first pass effect and dependence of hepatic extraction ratio. Introduction to renal clearance and factors affecting renal clearance.	3
Pharmacokinetics: Introduction to compartmental and physiological models. Introduction to the compartmental open model and its assumptions.	1
Mathematical treatment of Pharmacokinetics upon IV bolus dosing and extravascular dosing. Importance of volume of distribution. Clearance, elimination rate constant, half life, absorption rate constant, bioavailability. Introduction of the concept of area under the curve, the trapezoidal rule and the method residuals Introduction to the rate method and sigma minus method for urine analysis for IV.	9
Introduction to method for estimating bioavailability and bioequivalence.	2
Discussion of linear and nonlinear kinetics and description of factors resulting in non linear kinetics.	2
Application of PK principles through simple problems.	2

Reference Books:

1. Brahmankar, D. M. Jaiswal, Sunil B., "Biopharmaceutics and Pharmacokinetics: a treatise", 1st Edition, 1995, Vallabh Prakashan, Delhi.
2. Banakar, Umesh, "Pharmaceutical Dissolution Testing", Volume 49, Marcel Dekker Inc., New York, 1992.
3. Malcom Rowland, Thomas Tozer, "Clinical Pharmacokinetics: Concept and Application", 3rd Edition, 1996. A Lea-Febiger book, B. L. Baverly Books Pvt. Ltd. USA.
4. Robert E. Notari, "Biopharmaceutics and Pharmacokinetics An Introduction", 1971, 4th Edition, Marcel Dekker Inc., New York.
5. Leon Shargel, Susanna Wu-Pong, Andrew B. C. Yu. "Applied Biopharmaceutics & Pharmacokinetics" 5th Edition, 2005, Singapore.
6. Milo Gibaldi, "Biopharmaceutics Clinical Pharmacokinetics" 4th Edition, 1991, USA.

PHARMACOLOGY IV

3 hrs/ week

S. No.	Topic	Hours
1.	Drugs acting on central nervous system <ul style="list-style-type: none"> • Aliphatic alcohols • General anaesthetics • Local anaesthetics • Sedative-hypnotics & anxiolytic agents • Antidepressants • Antipsychotics 	18

	<ul style="list-style-type: none"> • Drugs used in Neurodegenerative disorders <ul style="list-style-type: none"> - Antiparkinsons - Drugs used in Alzheimer's disease • Analgesics, antipyretic and anti-inflammatory drugs • CNS stimulants & Psychotomimetic drugs (Convulsions and respiratory stimulants, Psychomotor stimulants and Psychotomimetic drugs) 	
2.	Autocoids <ul style="list-style-type: none"> - Histamine, Antihistaminics - 5 HT and Antagonists - Kinins, Ecosonides, Cytokines, PAF 	6
3.	Pharmacotherapy of Bronchial asthma	2
4.	Immunology – Regulation of Immune system physiological and pathological states, Signaling Pathways for activation and inhibition, Immunology of diseases like HIV and Cancer and their modulation & Immunomodulators.	6
5.	Principals of toxicology <ul style="list-style-type: none"> - Heavy metal poisoning and its treatment - Pesticide poisoning and its treatment - Opium alkaloid poisoning and its treatment 	4

Reference Books:

1. Goodman & Gilman's Pharmacological Basis of Therapeutics – Joel G. Hardman, Lee E, Limbird, Alfred Goodman Gillman 11th Edition, The McGraw Hill Companies Inc., 2001.
2. Satoskar, R. S. Bhandarkar S. D. & Rege N. N. Pharmacology & Therapeutics 20th Edition, Popular Prakashan, 2007.
3. Rang & Dale Pharmacology – 5th Edition, Churchill Livingstone, 2003.
4. Lippincott's Illustrated Reviews: Pharmacology – Lippincott Raven 3rd Edition Howland & Nycets Publishers N Y, 2006.
5. Lewis Pharmacology – By Crossland – 5th Edition, Churchill Livingstone.
6. Laurence D. R. & Bennet Clinical Pharmacology – 9th Edition, Elsevier, N Y, 2006.
7. Kulkarni, S. K. Handbook of Experimental Pharmacology, 3rd Edition, Vallabh Prakashan, New Delhi, 2005.
8. B. G. Katzung - Basic and Clinical Pharmacology 9th Edition Appleton and Lange publication, 2004.
9. Gosh M. N. – Fundamentals of Experimental Pharmacology, 3rd Edition, Hilton & Company, Calcutta, 2005.

PHARMACOLOGY LABORATORY II

4 hrs/ week

S. No.	Topic
1.	Experiments Bioassay of - Acetylchoine

	- Histamine
2.	Demonstration - bioassay of oxytocin - bioassay of pancuronium (With Graph or Actual)
3.	Demonstration/ Simulated CD's - To study the CNS depressant activity of chlorpromazine on locomotor activity of mice using actophotometer - To study the effect of diazepam on the muscle grip strength of mice using rota-rod apparatus. - Analgesic effect of aspirin using analgesiometer - To study phenothiazine induced catatonia in rats and to study anticatatonic (antiparkinsons) effect of scopolamine - To study the anticonvulsant property of diazepam on pentylene tetrazole induced convulsions in mice or anticonvulsant effect of phenytoin against maximal electroshock induced convulsion in mice
4.	Toxicity studies (CPCSEA, OCED guideline) - brief introduction to acute, subacute and chronic toxicity studies.

Reference Books:

1. Kulkarni, S. K. Handbook of Experimental Pharmacology – 3rd Edition Vallabh Prakashan New Delhi, 2005.
2. Gosh M. N. Fundamentals of Experimental Pharmacology, 3rd Edition, Hilton & Company, Calcutta, 2005.
3. S. B. Kasture. A Handbook of Experiments in Pre-Clinical Pharmacology- 1st Edition, Career Publications, 2006.
4. W. L. M. Perry, Pharmacological Experiments On Isolated Preparations, 2nd Edition, E & S Livingstone, Edinburgh & London, 1970.
5. Websites: Indian Journal of Pharmaceutical education and research, Vol. 41 (1) Jan-Mar, 2007; 52-61. (www.ipper.org)

PHARMCEUTICAL CHEMISTRY LABORATORY – II

4 hrs/ week

1. Synthesis of heterocyclics: a) Benzimidazole from O-phenylenediamine, b) 4-methyl carbostyryl from Acetoacetanilide.
2. Perkin reaction: Cinnamic acid from benzaldehyde
3. Claisen/ Aldol Condensation acid from benzaldehyde.
4. Benzilic acid rearrangement: Benzilic acid from benzyl.
5. Hofmann rearrangement: Anthranilic acid from Phthalimide.
6. Reduction reaction: PABA from p nitrobenzoic acid.
7. Esterification: Benzocaine from PABA.
8. Condensation: Phenytoin.
9. Multistep reaction: Sulfanilamide from acetanilide.

PHARMACOGNOSY LABORATORY II**4 hrs/ week**

S. No.	Topic	Hours
1.	Morphology, microscope and chemical test for identification of cinchona, vasaka, ephedra, kurchi, datura, nux, vomica, senna, rauwolfia, ipeca.	8
2.	TLC analysis: 1) Alkaloids of nux vomica cinchona 2) Glycosides of senna/ aloe	2
3.	Morphological identification of drugs covered in theory (alkaloids and glycosides) any 20 samples	2
	Total	12

PHARMACEUTICS LABORATORY IV

1. Preparation and monographic testing WFI (IP)
2. Processing & testing of glass containers & rubber closures (as per IP)
3. Preparation and documentation of following:
 - A) Injections (official)
 - Sodium chloride and Dextrose injection
 - Calcium gluconate injection
 - Ascorbic acid injection
 - One injection with oily vehicle
 - One suspension injection
 - B) Ophthalmic preparations
 - Sulphacetamide eye drops
 - One Antibiotic eye ointment
 - Contact lens solution
4. Calculation of Pharmacokinetic parameters (plasma samples provided)

**SYLLABUS COPY FOR FINAL YEAR B. PHARM.
SEMESTER VIII**

Pharmaceutical Medicinal Chemistry – IV

3 hrs/ week

S. No.	Topic	Hours
	Discussion of the following classes of drugs including, classification, chemical nomenclature, structure including stereochemistry, generic names, chemistry, physicochemical properties, SAR. Metabolism, molecular mechanism of action, and synthesis, introduction to rational development if any of the class of drugs:	
1.	<p>CNS Drugs</p> <p>1. Sedatives and hypnotics (mephobarbital, Phenobarbital pentobarbital, secobarbital, diazepam, nitrazepam*. Oxazepam. Alprazolam. Midazolam, chlorodiazepoxide, choral hydrate, gluthethimide*, zolpidem, zopiclone)</p> <p>2. Anticonsulvants (Phenobarbital, chlordizepoxide, diazepam, clonazepam*, phenytoin, trimethadione, paramethadione, ethosuximide*, phenosuximide, primidone, sodium valproate, carbamazepine*, progabide, lamotrigine, vigbatrin)</p> <p>3. Antipsychotics (chlorpromazine*, triflupromazine, thioridazine, fluphenazine, chlorprothixene, loxapine, clozapine, haloperidol*, droperidol, risperidone*, pimozide, molindone)</p> <p>4. Antianxiety agents (meprobamate, tybamate, hydroxyzine, buspirone)</p> <p>5. Antidepressants (imipramine, chlorimipramine, amitriptyline, nortriptyline, doxepine*, fluoxetine*, paroxetine, trazodone, iproniazid, pargline, isocarboxazide, tranlycypromine)</p> <p>6. Antiparkinsons (carbidopa*, levodopa, selegiline, amantadine, bromocriptine, benzotropine*, procyclidine, trihexyphenidyl, orphenadrine)</p> <p>7. Analgesics (opioids) (morphine, codeine, levophanol, dextromethorphan, phenazocine, pentazocine, meperidine*, α- and β-prodine, pheniridine, anileridine, fentanyl, methadone*, phenadoxone, racemoramide, dextropropoxyphene*, nalorphine, naloxone, naltrexone)</p>	5 5 5 1 5 2 7
2.	NSAID's (aspirin, paracetamol, phenylbutazone*, oxyphenbutazone, indomethacine, sulindac, mefenamic acid, ibuprofen, naproxen*, ketoprofen, nabumetone, diclofenac*, nimesulide, celecoxib, rofecoxib, piroxicam*, colchicines, sulfinpyrazone, allopurinol).	6
	* indicates synthesis to be discussed	

Reference Books:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 11th Ed., Eds., John H Block and John M Beale, Lippincott Williams & Wilkins, 2004.
2. Foye's Principles of Medicinal Chemistry, Eds., T. L. Lemke and D. A. Williams, Williams & Wilkins, Baltimore, 2002.
3. Medicinal Chemistry, Ashutosh Kar, 4th Edition, New Age International Publishers, 2007.
4. The Art of Drug Synthesis, Eds., Douglas S Johnson and Jie Jack Li, Wiley Interscience, 2007.
5. Pharmaceutical Chemistry, Vol. 1: Drug Synthesis, Eds., H. J. Roth, A. Kleeman, and T. Beissewenger, Ellis Horwood Ltd., 1988.
6. The Organic Chemistry of Drug Synthesis, Daniel Lednicer, Vols. 1 to 7, Wiley.

PHARMACEUTICAL ANALYSIS V**3 hrs/ week**

S. No.	Topic	Hours
1.	Atomic absorption and Emission spectroscopy Principle, difference between atomic absorption spectroscopy and flame emission spectroscopy, Instrumentation- Radiation sources, Flame atomization (types of flames, flame structure, flame atomizers), single and double beam spectrophotometers, advantages and disadvantages, Pharmaceutical applications.	3
2.	Nuclear Magnetic Resonance Spectroscopy Introduction, Phenomenon (Spinning nucleus, effect of an external magnetic field, precessional motion, precessional frequency, energy transitions), theory, Chemical shift and its measurement (factors influencing chemical shift-shielding, deshielding, Vander Waals deshielding, anisotropic effect. e.g. alkanes, alkenes, carbonyl, aromatic and cyclohexane), solvents used in NMR (Choice of solvents, solvent shifts-concentration, temperature, hydrogen bonding effects), Spin-spin coupling constants and splitting (splitting of NMR signals, theory, coupling, constants, multiplicities, of signal, chemical and magnetic equivalence), spin-spin decoupling, Instrumentation (Magnets, magnetic field sweep, radiofrequency oscillator, receiver, recorder and integrators, applications.	6
3.	Mass spectrometry Introduction, Basic principles, Instrumentation (single focusing and double focusing mass spectrometer, quadrupole mass spectrometer GC-MS, HPLC-MS), Electron impact, chemical ionisation, Field ionisation mass spectrometry, fast atom bombardment spectrometry), base peak, Molecular ion, metastable ions, Fragmentation processes, Applications.	6
4.	Radiochemistry and Radiopharmaceuticals- Fundamentals of radioactivity (radionuclide, Isotope, radioactive, decay,	5

	half-life of radionuclide, specific activity, Bccquerel, Curie), Properties of radiation, Radiation protection, measurement of radioactivity (Geiger-Muller counter, liquid scintillating counting, gamma scintillation detector), Radiopharmaceuticals (Properties of radionuclide, pharmaceutical properties, chemical properties), 99m Tc generator, Quality control of radiopharmaceuticals (Physical, chemical and sterility control, radionuclide purity and radiochemical purity), Isotope dilution analysis.	
5.	Near IR spectroscopy- Introduction, Principles, Advantages, Qualitative measurements- NIR overtone bands of organic functional groups, Quantitative absorption-Absorbance measurements, diffuse reflectance measurements, Instrumentation- Radiation source, Wavelength selection, Detectors, Sample interface, Sample preparation, pharmaceutical applications of NIR.	3
6.	X-Ray methods- Introduction, Instrumentation, identification of crystalline compound, X-ray powder diffraction, Bragg reflections, diffraction methods, Pharmaceutical analytical applications.	3
7.	Structural elucidation problems based on UV, IR, NMR, Mass spectroscopy (simple problems with molecular formula given).	8
8.	Hyphenated Techniques-GC-MS, LC-MS (Interfaces and Applications only).	2

Reference Books:

1. Skoogh-Principles of Instrumental Analysis, 4th edition, Saunders College Publishing, 1992, USA.
2. Browning- Chromatography, 1969, McGraw Hill, London.
3. Willard H. H., L. L. Merritt & John Dean-Instrumental Method of Analysis, 6th edition, 1986, CBS Publishers & Distributors, India.
4. Beckett & Stenlake-Practical Pharmaceutical Chemistry, 4th edition, 1988, CBS Publishers & Distributors, India.
5. I.P., U. S. P., B. P., European Pharmacopoeia.
6. William Kemp-Organic Spectroscopy, 3rd edition, Reprinted 2005, Palgrave Publishers Ltd., New York.
7. Clive Whiston-Analytical Chemistry by open learning, 1987, John Wiley & Sons New York, Toronto.

PHARMACOGNOSY IV

3 hrs/ week

S. No.	Topic	Hours
1.	Glycosides Saponin glycosides (liquorice , quillaia, asparagus , ginseng, dioscorea, agave, fenugreek, bacopa, hydrocotyle, alpine, smilax <i>Acacia concinna</i> , <i>sapiandus</i>)	6

	Cardiac (digitalis , strophanthus, squill, nerium, thevetia) Biosynthesis of steroidal glycoside molecule.	
2.	Volatile oils: with respect to sources, composition & preparation of volatile oils and uses. Umbelliferous fruits (anise, caraway, dill , ajowan, fennel , coriander), clove , cardamom , cinnamon , <i>Saussurea lappa</i> , eucalyptus , sandalwood, star anise, patchouli oil, lemongrass, winter green, palmrosa, rose, abolmescus, rasana, nutmeg, lemon peel oil, orange peel oil, spearmint oil and peppermint oil, jatamansi, valerian, artmesia, vetiver.	9
3.	Resins turpentine , cannabis hops, (Colophony , niyrrh, shellac, benzoin, balsams (tolu, peru) , turmeric , guggulu , ginger , colocynth, guaiacum, asafetida , capsicum.	4
4.	Flavonoids Quercetin, Rutin, hesperidin & Flavonoids from orange peel powder.	2
5.	Phenylpropanoids & Lignans Podophyllum, psoralea, Ammi majus, phyllanthus	2
6.	Polyketides – male fern, podophyllum	1
7.	Terpenoids & iridoids (Structure, occurrence and uses) Quassia, picrorrhiza, tinospora, Artemisia, taxus, carrot, gentian, chirata, andrographs	4
8.	Biosynthesis of terpenoids (mono, sesqui, di and triterpenoids) (skeleton only)	2
9.	Phytotoxins <i>Abrus precatorius</i> , <i>aconite</i> , <i>belighia sapida</i> , curare, datura, lily of the valley, ergot, poison hemlock, poison ivy, yew, mushrooms, psoralea.	2
10.	Introduction to marine Drugs Cytotoxins with any two examples.	2
11.	Special aspects of preparation of Ayurvedic formulations and herbal formulations. Preparation and Evaluation of plant extracts and formulations with respect to phytoconstituents.	2

Reference Books:

1. Trease D. & Evans W. C.: Textbook of Pharmacognosy; W. B., Saunders.
2. Tyler V. E. Brady L. R. & Robbers J. E.: Pharmacognosy; Lea Feibger, USA.
3. Wallis T. E.: Textbook of Pharmacognosy; CBS Publishers, Delhi.
4. Kokate C. K. Purohit A. P. & Gokhale S. B.: Pharmacognosy; Nirali Publications, Pune.
5. Harbone J. B.: Phytochemical Methods: A guide to modern techniques of Plant Analysis; Chapman & Hall, London.
6. Bruneton J.: Pharmacognosy, Phytochemistry, Medicinal Plants; Intercept Limited.
7. Vasudevan T. N. & Laddha K. S.: A Textbook of Pharmacognosy, Vrinda Publication House, Jalgaon

8. The Indian Pharmacopoeia: The Controller of Publication; Delhi.
9. Brain K. R. & Turner T. D.: The Practical Evaluation of Phytopharmaceuticals: Wright, Scientica, Bristol.
10. Iyenger M. A. & Nayak S. G.: Anatomy of Crude Drugs: Manipal Power Press, Manipal.
11. Iyenger M. A.: Pharmacognosy of Powdered drugs: Manipal Power Press, Manipal.
12. Kokate C. K.: Practical Pharmacognosy: Vallabh Prakashan.
13. Wagner, Bladi & Zgainski: Plant Drug Analysis; Springer Verlag.
14. Khandelwal K. R.: Practical Pharmacognosy Techniques and Experiments; Nirali Prakashan, Pune.
15. Vasudevan T. N., Laddha K. S.; Practical Pharmacognosy; New Vrinda Publishing House, Jalgaon.

PHARMACEUTICS VII

3 hrs/ week

Note: References to latest amendments of schedule M and Schedule U of Drugs and Cosmetics Act 1940 to be made wherever it is appropriate.

S. No.	Topic	Hours
1.	Quality assurance (discuss specimen documents) Raw material control, actives and inactive, in process control, sanitization, environmental and microbiological control, packaging and labeling control, finished product control, standard operating procedures, cGMP. Q. C. standards of identity, purity, quality and potency, Q. C. Charts, sampling & sampling plans.	8
2.	Documentation – need/ importance, batch manufacturing records, SOPs, Maintenance & Retrieval of Documents.	3
3.	Pilot plant scale up techniques – group's responsibilities, facilities, example of scaling up of manufacturing of tablets, liquids and semisolids.	5
4.	Validation – Definition, Types, Qualification Process Validation – steps & documentation (Brief), Examples – Raw Materials, mixing and granulation, mixer, granulator, Validation of sterilization process and equipment – microbial death kinetic terms, F Value applications, steps for validating steam sterilization method	5
5.	Production management Pharma industry – current scenario Site selection and development – factors to be considered in designing a facility, layout of manufacturing facilities, environmental aspects, materials of construction, equipment selection, handling of components and containers, vendor audit, warehousing, maintenance and service aspects, Personnel – qualifications, selection, responsibilities & training. Materials management, sales forecasting, inventory control, production planning, elements of cost & cost controls.	8
6.	Factory Layout- considerations/ steps, Examples of Typical layout schemes for Tablets, capsule, liquids, sterile formulations manufacturing areas.	4

Reference Books:

1. The theory and practice of industrial pharmacy, ed., by Leon Lachman, H. A. Liberman, J. L. Kanig, 3rd ed., Verghese Publishing house, 1987.
2. The science and practice of Pharmacy, 21st ed., Remington, Vol. I and II, B. L. Publications Pvt. Ltd., 2005.
3. Cole, Graham, "Pharmaceutical Production Facilities: Design and Application", 1990.
4. Pharmaceutical Process Validation, 2nd Edition, Nash Robert A. Berry Ira R. Volume 57, 1992, Marcel Dekker Inc., New York.
5. Pharmaceutical dosage forms; parenteral medications, Vol. I, II, III, ed., by Kenneth A. Avis, Leon Lachman and H. A. Liberman, Marcel Dekker INC., 1986.

NOVEL DRUG DELIVERY SYSTEMS

3 hrs/ week

S. No.	Topic	Hours
1.	<u>Oral Controlled Drug Delivery Systems-</u> a) Multiparticulate drug delivery systems (Pellets)- need and significance of pelletization, techniques- pan coating, extrusion and spheronization, equipments, evaluation b) Osmotic Systems- Basic principles, classification, oral osmotic pumps, applications & evaluation c) Gastroretentive drug delivery systems (GRDDS)- Regional variability in intestinal absorption and concept of absorption window, Design of GRDDS technologies- low density (Floating systems), Swelling and expanding systems, Mucoadhesive systems, high density systems, Evaluation of GRDDS.	2 1 2
2.	<u>Mucoadhesive drug delivery systems-</u> Mucoadhesion and theories, factors influencing mucoadhesion, <i>in vitro</i> - <i>in vivo</i> methods to study mucoadhesion, bioadhesive polymers and systems.	4
3.	<u>Ocular drug delivery systems</u> Limitations of conventional systems, ophthalmic inserts-nonerosible and erodible inserts, pilocarpine ocular insert, Lacrisert, SCDI, Minidisc, NODS, polymers, particulates, enhancers, intraocular solutions, ocular iontophoresis, evaluation.	6
4.	<u>Transdermal drug delivery systems (TDDS)</u> Skin and skin permeation, modes of percutaneous penetration, components of TDDS, different types of TDDS and release control mechanisms, production, evaluation of PSA and TDDS – <i>in vitro</i> , <i>in vivo</i> .	6
5.	Introduction to targeting, Passive and active targeting	1
	a) Targeting to lymphatic systems Anatomy of lymphatic system, lymphatics in intestine, factors enhancing intestinal drug uptake, approaches, prodrug and delivery systems examples, parental drug administration for lymphatic transport	2

b) Liposomes Structural components and classification, methods of preparation, size reduction, characterization, stability, applications.	2
c) Drug targeting to brain The blood brain barrier, transport through blood brain barrier, factors affecting drug permeation through BBB, strategies for brain drug delivery	1
d) Nanoparticles Preparation techniques, characterization, biodistribution, evaluation and applications.	2
e) Colonic targeting- Physiology of colon, difficulties in colonic targeting, approaches- prodrug, pH sensitive polymers, polysaccharides, time release systems, osmotic systems, azo polymers, evaluation.	3

Reference Books:

1. Advances in controlled and novel drug delivery, ed. by N. K. Jain, CBS publishers and distributors, 2001.
2. Modern Pharmaceutics, 4th ed. Revised and Expanded ed. by Gilbert S. Banker and Christopher T. Rhodes, Marcel Dekker INC., 2002.
3. Targetted and controlled drug delivery, Novel carrier systems, S. P. Vyas and R. K. Khar, CBS publishers and distributors, 2002.
4. Controlled and Novel drug delivery, ed. by N. K. Jain, CBS publishers and distributors, 1997.
5. Controlled drug delivery, concepts and advances, S. P. Vitas and R. K. Khar, Vallabh Publishers, 2002.
6. The theory and practice of industrial pharmacy, ed. by Leon Lachman, H. A. Liberman, J. L. Kanig, 3rd ed., Verghese Publishing house, 1987.
7. The science and practice of pharmacy, 21st ed., Remington, Vol. I and II, B.L. Publications Pvt. Ltd., 2005.
8. Bioadhesive Drug Delivery Systems- Fundamentals, Novel Approaches, and Development, Mathiowitz Edith, Chickening III, Donald E., Lehr Claus-Michael, Volume 98, Marcel Dekker INC, New York, 1995.
9. Nanoarticulate Drug Delivery Systems, Thassu Deepak, Dellers Michael, Pathak Yashwant, Volume 166, Marcel Dekker Inc., New York, 2007.
10. "Microencapsulation Methods and Industrial Applications", Benita Simon, 2nd Edition, Marcel Dekker Inc., New York, 2006.
11. Controlled and Novel Drug Delivery, Jain N. K. 1st Edition, CBS Publishers and Distributors, New Delhi, 2004.
12. "Targeted and Controlled Drug Delivery- Novel Carrier Systems", Vyas S. P. Khar R. K., 1st Edition, CBS Publishers and Distributors, New Delhi, 2002.
13. Ophthalmic Drug Delivery Systems, Mitra, Ashim K., Volume 58, Marcel Dekker Inc., New York, 1993.
14. "Encyclopedia of Pharmaceutical Technology, Swabrick, Boylan, Volumes 1,6,8,9,10,12,13,14,15,16,17,18,19,20." Marcel Dekker Inc., New York.
15. Oral Mucosal Drug Delivery, Rathbone Michael J., Volume 74, 1996, Marcel Dekker Inc., New York, 1996.

FORENSIC PHARMACY AND JURISPRUDENCE**3 hrs/ week**

S. No.	Topic	Hours
1.	Historical perspective including details of Chopra Committee and Hathi Committee	1
2.	An objective study of the following Acts incorporating the latest amendments Pharmacy Act 1948 <ul style="list-style-type: none">• Definition• PCI and State Councils, Composition and Function• Preparation of Registers and qualifications for entry into registers• Educational Regulation and Approval of Courses and Institutions• Offences and Penalties	5
3.	Drugs and Cosmetic Act 1945 <ul style="list-style-type: none">• Definitions• Advisor bodies DLAB and DCC Composition and function• Drug Control Laboratories and Government Analysts• Drug inspectors, Licensing Authorities, Controlling Authorities and Customs Collectors• Provisions Governing Import, Manufacture and Sale of Drugs.• Labeling and Packaging of Drugs• Provisions applicable to manufacture and Sale of Ayurvedic Drugs• Provisions Governing Import, Manufacture and Sale of Homeopathic Drugs.• Various offences and corresponding Penalties• Broad content of various Schedules of the Drugs and Cosmetic Act and Rules.	14
4.	Drugs and Magic Remedies (Objectionable Advertisements) Act 1954. <ul style="list-style-type: none">• Definitions, Prohibited Advertisement, Savings.	2
5.	Narcotic Drugs and Psychotropic Substances Act <ul style="list-style-type: none">• Definitions• Narcotics Commissioner and other officers• Illicit Traffic and measures to prevent illicit traffic of opium.• Offences and corresponding penalties.	2
6.	Drug Price Control Order 1995 and new Drug Policy	2
7.	Medicinal and Toilet Preparations (Excise Duties) Act. <ul style="list-style-type: none">• Definitions, restricted and unrestricted preparations• Manufacturing in bond and outside bond	2
8.	Prevention of Food Adulteration Act 1954 <ul style="list-style-type: none">• Definitions• Central board of food standards, central food laboratory, compositions and functions• Public analysis and food inspectors	2
9.	Indian Patents Act 1975	2

10.	Bombay Shops and Establishments Act <ul style="list-style-type: none"> • Definitions and Provisions 	1
11.	Factories Act 1954 <ul style="list-style-type: none"> • Definitions and Provisions 	1
12.	Indian Penal Code and Code of Criminal Procedures <ul style="list-style-type: none"> • Provisions pertaining to different Courts, jurisdiction and power • Provisions governing entry, search, arrest, bailable and non-bailable offences, Cognizable and non-cognizable offences 	1
13.	Insecticides Act <ul style="list-style-type: none"> • Definitions • Procedure for licensing and registration of Insecticides • Savings 	1

Reference Books:

1. "Forensic Pharmacy", Kuchekar and Kadtare and Itkar, Nirali Prakashan, 5th edition, 2005.
2. "Textbook of Forensic Pharmacy" N. K. Jain, Vallabhprakashan, 4th edition, 1999.
3. D & C Acts, 1940 and Rules, 1945, S. W. Deshpande and Nilesh Gandhi, Sumit Publishers 2006, Mumbai.
4. Govt. of India Publication of above Acts and Rules.

CLINICAL PHARMACY AND DRUG INTERACTION

3 hrs/ week

S. No.	Topic	Hours
1.	Concept of clinical pharmacy, community pharmacy and hospital pharmacy (definition, scope and objectives)	6
2.	Concept of therapeutic drug monitoring and patient compliance	6
3.	Role of Pharmacist as a patient councilor	3
4.	Rational use of drugs <ul style="list-style-type: none"> - Drug- drug interactions – possible mechanisms and examples - Drug interaction with food, alcohol, tobacco - Adverse drug reactions – Types and examples - Detection and Prevention of ADR - Drugs used in geriatrics, pediatrics and pregnancy - Irrational drug combination - Dose adjustment in renal and hepatic dysfunction 	16
5.	General Introduction to drug discovery and development Pre-Clinical Stages Clinical development – phases of clinical trials Commercial Aspects	5

Reference Books:

1. Clinical Pharmacy Dr. Tipnis, Dr. Bajaj, 1st Edition, Career Publications, 2003.

- Clinical Pharmacology- P. N. Benett, M. J. brown, 9th Edition, Churchill Livingstone, 2006.
- Text Book of Clinical Pharmacy Practice- G. Parthisarathi, Karin Nyfort Hansen, Milap C. Nahata, Orientlongman, 2004.
- Clinical Pharmacy and Therapeutics- Roger Walker, Clive Edwards, 3rd Edition, Churchill Livingstone, 2003.

PHARMACEUTICS LABORATORY V

4 hrs/ week

- S. R. oral tablets- use of hydrophobic and hydrophilic matrix materials (monolithic and reservoir) - preparation and *in vitro* release evaluation.
- Dissolution testing – Marketed formulations of conventional tablets – soluble drug & poorly soluble drug (selection of medium)
- Ophthalmic DDS- Mucoadhesive gel and evaluation.
- Accelerated stability testing of any suitable drug/ formulation
- Demonstration of sugar and film coating of tablets.
- Microencapsulation by coacervation phase separation technique of a liquid (volatile oil) & a solid (Charcoal/ Paracetamol), evaluation of the products.
- SR suppositories- PEG base and Hydrogel base- evaluation of *in vitro* release.

PHARMACOGNOSY LABORATORY III

4 hrs/ week

S. No.	Topic	Hours
1.	Macroscopy- microscopy of liquorice, clove, fennel, dill, cardamom, cinnamon, coriander, quassia, kalmegh, picrorrhiza, asparagus.	8
2.	Extraction and detection of phytoconstituents of following classes (Any two examples of each class) Flavonoids, glycosides (liquorice), volatile oils (clove, fennel, anise, dill)	2
3.	Qualitative analysis of unorganized drugs as covered drugs as covered in theory (asafetida, myrrh, benzoin, guggul, and aloes).	2
4.	Microscopic evaluation of Ayurvedic churna formulation & analysis of total tannins from Triphala churna.	1
5.	Morphological identification of drugs covered in theory (volatile oils and glycosides) any 20 samples	1
	Total	14

PHARMACEUTICAL ANALYSIS LABORATORY III

4 hrs/ week

1. Determination of pka 1 and pka 2 of phosphoric acid.
2. Determination of HCl and phosphoric acid in a given mixture potentiometrically.
3. Assay of paracetamol tablets, propranolol tablets, albendazole tablets, Rifampicin capsules as per I. P.
4. Assay of quinine sulphate by fluorimetry.
5. Study of quenching effects of iodide ions on fluorescence of quinine sulphate.
6. Assay of phenylephrine hydrochloride ophthalmic solution by difference spectroscopy.
7. Assay of caffeine and sodium benzoate injection by simultaneous equation method and absorbance ratio method.
8. Assay of trimethoprim in cotrimoxazole tablets as per I. P.
9. Assay of nifedipine and atenolol tablets by UV.
10. Determination of streptomycin base colorimetrically from Injection.
11. Identification of sample by TLC.

Demonstration experiments:

1. Assay of sample by HPLC/ HPTLC/ GC.
2. Qualitative analysis by I. R.
3. Determination of K⁺ from KCl by flame photometry.
4. Selection of mobile phase for TLC.
5. Identification of amino acids by paper chromatography.