**II Year II Semester**

**PHR16221 - PHARMACEUTICAL UNIT OPERATIONS – II (50Hrs)**

**UNIT-I 06**

**Heat Transfer:**

Source of heat, heat transfer, methods of heat transfer, heating of fluids, film coefficients, design of heating equipments, radiant heat transmission, steam and electricity as heating media, properties of steam.

*LO:* To understand principles and theory of Heat flow / Conductions, Convection, Radiation.

**UNIT-II 08**

**Evaporation:** Basic concept of phase equilibria, factors affecting the evaporation, evaporators, film evaporators, single effect and multiple effect evaporators.

*LO:* To understand evaporation, Phase equilibrium, Theory of evaporation- Evaporators.

**UNIT-III 08**

**Distillation:** Raoult's law, phase diagrams, volatility, simple steam and flash distillations, principles of rectification, Azeotropic and extractive distillation.

*LO:* Theory of distillation types of rectifiers, their application.

**UNIT-IV 10**

**Drying:** Moisture content and mechanism of drying, rate of drying and time of drying calculations, classification and types of dryers, dryers used in pharmaceutical industries tray dryer, Fluid bed dryer, spray dryer, vacuum oven and freeze-dryer.

*LO:* Drying, Moisture content, rate of evaporation, types of dryers construction working and

 Applications.

**UNIT-V 10**

**Size Reduction:** Definition, objectives of size reduction, factors affecting size reduction, laws governing energy and power requirements of a mill, types of mills including Ball mill, Hammer mill, Fluid energy mill etc.

*LO:* To understand theory of size reduction, factors involved in size reduction, equipments- Construction working and applications-selection of size reduction equipment.

**UNIT-VI 08**

**Mixing:** Theory of mixing, solid-solid, solid-liquid and liquid-liquid mixing equipment, Double cone, Twin-shell, Silverson mixer, Colloid mill, Sigma blade mixer, Planatery mixer, Propeller mixer and Turbine mixer.

*LO:* Theories of mixing solid-solid, solid-liquid & liquid-liquid mixing equipments.

**TEXT BOOKS**

1. S.J. Carter, Cooper and Gunn’s Tutorial Pharmacy, 6th ed., CBS publisher, Delhi.

2. CVS Subhramanyam, Pharmaceutical Engineering.

3. K. Samba Murthy, Pharmaceutical Engineering

4. Mc Cabe & Smidth.Unit Operations.

**REFERENCE BOOKS**

1. W.I. Macebe and J. C. Smith Macro, Unit Operations To Chemical Engineering, Hill Int. Book Co., London.

2. L. Lachman, H. Liebe rman & J**.** L Kaniz, The Theory And Practice Of Industrial Pharmacy, Lee & Febiger Philadelphia, USA

3. Badzer & Banchoro, Introduction to Chemical Engineering.

4. Perry’s Handbook of Chemical Engineering

5. M.E.Aulton, Pharmaceutics- The science of dosage form design, 2nd ed.

6. E.A. Rawlin’s, Bentley’s Text Book of Pharmaceutics, 8th ed ELBS

**II Year II Semester**

**PHR16222 - PHARMACEUTICAL ANALYSIS –I (50Hrs)**

**Unit-I 08**

A General introduction to Pharmaceutical analysis and general aspects of Standardization of Pharmaceutical chemicals and Formulated products mentioned in Indian pharmacopoeia. Importance of proper sampling and general books for pharmaceutical standards like pharmacopoeias, National formularies.

Computation of analytical results, Significant numbers, rejection of doubtful values with reference to Volumetric and Gravimetric analysis, sources of errors and Calibration of analytical equipment used in volumetric and Gravimetric analysis.

*LO:* To understand the concept of standardization by gravimetric and volumetric methods.

**Unit-II 10**

**Acid-Base titrations**: Theoretical basis of neutralization reactions including electrolytic dissociation, application of law of mass action, relative strength of acids and bases, hydrolysis of salts and buffer solutions, theory of neutralization indicators and factors involved in the selection of indicators for different types of acid-base titrations. Procedures involved in different types of titrations using strong acid, week base, strong base, week base and back titration with blank determination. Assay of Boric acid Sodium bicarbonate, Borax, calcium hydroxide, zinc oxide, calcium carbonate, Acetyl salicylic acid, Formaldehyde, NaOH in presence of sodium carbonate.

**Non-aqueous titrations**: Principles, Advantages and pharmaceutical applications, solvents reagents and indicators used in Non aqueous titrimetry, other methods of detecting end points. Examples of titrations of alkali metal and alkaline earth metal salts of organic acids, primary, secondary and tertiary amines, halogen acid salts of bases, titration of acidic substances. Assay of thiamine hydrochloride.

*LO:* To understand the concept of standardization by aqueous and non-aqueous titrations.

**Unit-III 08**

**Oxidation-reduction titrations**: theoretical considerations including standard potentials, calculation of redox potentials, redox indicators, principle and procedure involved in different types of redox titrations using potassium permanganate, iodine. Titrations of released iodine and back titration of excess iodine, potassium iodate, ammonium ceric sulphate and titanous chloride. Assay of ferrous sulphate, Hydrogen peroxide, Sodium nitrate, Estimation of ascorbic acid with 2,6-dichlorophenol indophenols, Assay of mercuric chloride, Assay of sodium metabisulphite, Assay of copper sulphate

*LO:* To understand the concept of standardization by oxidation – reduction methods.

**Unit-IV 10**

**Precipitation titrations**: principles and procedures involved in Argentimetry, use of Silver nitrate and Ammonium thiocyanate. Indicators used in precipitation titrations including adsorption indicators, Mohr’s and Volhard’s methods with examples. Assay of Potassium chloride, Ammonium thiocyanate, Assay of Mercuric oxide.

**Complexometric titrations**: Basic principles of Complexometric analysis including theories of complex ions, chelating agents, properties of metal complexes with particular reference to EDTA. Basic principles of complexometric analysis including theories of complex formation. Werener’s coordination number and structure of complex ions, Chelating agents, properties of metal complexes with particular reference to EDTA, various examples of titrations of metal ions using Disodium acetate, indicators and end point detection using indicators and by physical methods, masking and demasking agents, pharmaceutical applications of complexometry with particular reference to I.P. Assay of Calcium gluconate injection/tablets, Calcium lactate and Assay of Aluminium sulphate

*LO:* To understand that standardization can be done for some compounds by Precipitation

titrations.

**Unit-V 08**

A detailed study of gravimetric analysis including principles involved, critical factors and typical methods involving precipitation, coagulation, digestion, filtration and incineration procedures with suitable examples. Advantages and disadvantages, sources of errors and their elimination in gravimetric analysis. Determination of sulphate as barium sulphate, Estimation of magnesium as magnesium pyrophosphate, Determination of thiamine as silico tungstate.

*LO:* To understand that standardization can be done for some compounds by gravimetric method.

**Unit-VI 06**

Principles and procedures involved and application of nitrite titrations, titrations using 2, 6-dichlorophenol-indophenol. Aquametry including use of Karl-fisher reagent and moisture balances.

**Gas analysis**: principles of gas analysis use of hempel’s gas burette and pipette, nitrometer, haldome’s and orset’s gas analysis apparatus and their operations. Examples of gas analytical methods of pharmaceutical significance.

*LO:* To understand that moisture in drugs can be determined by Karl-Fisher titration.

**TEXT BOOKS:**

1. Indian pharmacopoeia
2. Practical Pharmaceutical Chemistry by A.H. Becket and Stenlake
3. Quantitative Inorganic Analysis by A.I. Vogel.
4. L M. Atherden, Bentley and Driver’s Textbook of Pharmaceutical Chemistry, Oxford University Press, Delhi.
5. Pharmaceutical Analysis, Volume –I by PC Kamboj.

**REFERENCES**

 1. A.H. Beckett & J.B Stanlake Vol.I&II., Practical Pharmaceutical Chemistry, Athlone Press

of the Univ of London

2. Y.Anjaneyulu, K.Chandrasekhar, Valli Manickam, A Textbook of Analytical Chemistry.

3. U N Dash, Pharmaceutical Analysis Biotech Pharma Publication

4. Fundamentals of Analytical Chemistry by Skoog, Donald M West.

5. A textbook of Pharmaceutical Analysis by Kenneth A Connors.

**II Year II Semester**

**PHR16223 - PHARMACOGNOSY – I (50Hrs)**

**UNIT- I**

Definition, History, Scope and development of Pharmacognosy. General introduction to alternative systems of medicine like Ayurveda, Siddha, Unani and Homeopathy. **02**

**Brief introduction to natural sources of drugs with examples**: Plant Source, Animal Source, Mineral Source, Marine Source and microorganisms. **04**

*LO:* To make the students understand that drugs are obtained from different sources and crude drugs are used in the indigenous systems of medicine.

**UNIT-II 06**

**Classification of Crude Drugs:** Alphabetical, Morphological, Pharmacological, Chemical, Taxonomical and Chemo taxonomical methods of classification with suitable examples.

*LO:* To make the students understand that crude drugs can be classified based on several criteria.

**UNIT-III 08**

**Cultivation, collection, processing, drying and storage of medicinal plants**:

• Factors influencing cultivation of medicinal plants.

• Plant hormones and their applications.

• Definitions and examples for polyploidy, mutation and hybridization with reference

 to medicinal plants.

**Good Agriculture Practices:** Strategies of obtaining improved cultivation of medicinal plants.

*LO:* To understand improve agricultural conditions provide high yield and the methods be standardized to get consistent yields.

**UNIT-IV 08**

**Adulteration & Evaluation of crude drugs:**

Adulteration of crude drugs: Different methods of adulteration of crude drugs and general methods for detection of adulterants like Organoleptic, Microscopic, Physical, Chemical and Biological methods of evaluation.

*LO:* To provide enough knowledge to identify adulterants from genuine products and to provide quality products.

**UNIT-V 08
Systematic Pharmacognostic study of the following carbohydrates and derived products:** Acacia, Tragacanth, Agar, Starch, Guargum, Pectin, Ispaghula and Honey.

*LO:* To provide quality products of the above as excipients.

**UNIT-VI 14
Systematic Pharmacognostic study of the following Lipids:** Castor oil, Cod liver oil, Shark liver oil, Linseed oil, Cocoa butter, Kokum butter, Bees wax, Wool fat, Hydnocarpus oil, Spermaceti, Lard and Olive oil.
**Study of Tannins & Tannin containing drugs**: Gambier, Black catechu, Myrobalan & Arjuna.

S**tudy of Resins & Resin containing drugs**: Benzoin, Asafoetida, Balsam of Tolu, Podophyllum.

***LO:*** To maintain quality in fixed oils & understand that Tannins and Resins and their combination products are produced by different plants.

**TEXT BOOKS**

1. Trease and Evans, Pharmacognosy.
2. Tyler, Brady & Robert, Pharmacognosy.
3. T.E.Wallis, Textbook of Pharmacognosy.
4. Kokate C.K, Purohit AP & Gokhale Pharmacognosy.
5. G.S.Kumar, K.N.Jayaveera, A Text Book of Pharmacognosy and Phytochemistry.

**REFERENCES**

1. Atal C.K & Kapur B.M, Cultivation & Utilization of Medicinal Plants.
2. Ayurvedic Pharmacopoeia of India, Pub by Govt. of India.
3. Heinrich, Fundamentals of Pharmacognosy and Phytotherapy.
4. R.N Chopra, S.L Nair and I.C Chopra, Glossary of Indian Medicinal Plants, CSIR, New Delhi
5. A A Farooqi and B S Sree Ramu, Cultivation of Medicinal and Aromatic Crops. University Press
6. Quadry, Pharmacognosy.

**II Year II Semester**

**PHR16224 - MEDICINAL CHEMISTRY-I (50Hrs)**

**UNIT-I 09**

**Heterocyclic compounds:**

1. Five and six membered ring systems with heteroatoms: Furan, Pyrrolo, Thiophene, Pyridine, Imidazole, Pyrazole, Oxazole, Isoxazole, Thiazole and Pyrimidine.
2. Fused ring systems with heteroatoms: Quinolines, Isoquinolines, Acridine, Benzimidazole and Phenothiazine.

*LO:* Nomenclature (numbering), one or two methods of preparation, important reactions, mechanisms and examples of drugs having the above ring systems.

**UNIT-II 06**

1. **Drug activity and physico-chemical properties:** solubility, partition coefficient, hydrogen bonding, chelation, surface activity, bioisosterism, optical and geometrical isomerism**,** prodrugs andsoft drugs.
2. **Mechanism of drug action:** receptor theories, enzyme stimulation and enzyme inhibition.
3. **Drug metabolism:** Phase I and Phase II reactions, factors affecting drug metabolism.

*LO:*Concepts involving receptors, drug-receptor interaction forces, mechanisms, equations, structures, advantages.

**UNIT-III 10**

**Drugs acting on CNS:**

1. Hypnotics and anxiolytics: Phenobarbital, Diazepam and Alprazolam.
2. Antipsychotics: Chlorpromazine and Haloperidol.
3. Antiepileptics: Phenytoin, Carbamazepine, Valproate sodium.
4. Antidepressants: Imipramine, Amitriptyline, Isocarboxazide, Iproniazide.
5. General anaesthetics: ketamine, Halothane and Thiopental sodium.

*LO:* Definition, scope, classification, mode of action, Structure-Activity Relationship (SAR) wherever applicable, therapeutic uses and synthesis of compounds as given above under each class.

**UNIT-IV 09**

1. **Adrenergic drugs:** Amphetamine, Salbutamol, Ephedrine, Phenylephrine and Dopamine.
2. **Adrenergic blockers:** Prazosine, Tolazoline, Propranolol, Atenolol
3. **Cholinergic drugs:** Carbachol, Bethanichol.
4. **Anticholinergics:** Propantheline, Dicyclomine.
5. **Neuromuscular blockers:** Succinyl choline.

*LO:* Definition, scope, classification, mode of action, Structure-Activity Relationship (SAR) wherever applicable, therapeutic uses and synthesis of compounds as given above under each class.

**UNIT-V 08**

1. **Analgesics and Non-steroidal anti-inflammatory agents (NSAIDs):** Paracetamol, Aspirin, Ibuprofen, Indomethacin, Diclofenac.
2. **Narcotic analgesics:** Meperidine, Methadone.
3. **Local anaesthetics:** Benzocaine, Procaine, Lignocaine and Dibucaine

**LO:** Definition, scope, classification, mode of action, Structure-Activity Relationship (SAR) wherever applicable, therapeutic uses and synthesis of compounds as given above under each class, an understanding of morphinans, its agonists and antagonists.

**UNIT-VI 08**

1. **Oral antihyperglycemic agents**:Tolbutamide, Gliclazide, Glipizide, Glibenclamide, Metformin and Pioglitazone.
2. **Thyroid drugs:** Methimazole, Propylthiouracil
3. **H1-receptor antagonists:** Diphenhydramine, Chlorpheniramine, Chlorcyclizine, Cetrizine.
4. **H2-receptor antagonists:**  Ranitidine
5. **Proton pump inhibitors:** Omeprazole, Rabeprazole, Lansaprazole.

**LO:** Definition, scope, classification, mode of action, Structure-Activity Relationship (SAR) wherever applicable, therapeutic uses and synthesis of compounds as given above under each class, an understanding of Morphinans , its agonists and antagonists.

### TEXT BOOKS

1. William O. Foye, Textbook of Medicinal Chemistry, Lea Febiger, Philadelphia.
2. JH Block & JM Beale (Eds), Wilson & Giswold’s Text book of organic Medicinal Chemistry and pharmaceutical chemistry, 11th Ed, Lipcott, Raven, Philadelphia, 2004.
3. S. N. Pandeya, Textbook of mediacinal chemistry, SG Publ. Varanasi, 2003.
4. M. Atherden, Bentley and Driver’s Textbook of Pharmaceutical Chemistry Ed: l. Oxford University Press, Delhi.

**REFERENCES**

1. D. Abraham (Ed), Burger Medicinal chemistry ad Drug discovery, Vol. 1 & 2. John Wiley & Sons, New York 2003, 6th Ed.
2. Lippincott Williams and Wilkins, Remington Pharmaceutical Sciences; 20th Edition.
3. B.N. Lads, MG.Mandel and F.I. way, Fundamentals of drug metabolism & disposition, William & welking co, Baltimore USA.
4. C. Hansch, Comprehensive medicinal chemistry, Vol 1 – 6 Elsevier pergmon press, Oxford

**II Year II Semester**

**PHR16225 - PHARMACOLOGY – I (50Hrs)**

**UNIT – I 06**

**General Pharmacology:** Introduction to pharmacology, sources of drugs, dosage forms and routes of administration, mechanism of action, Structural activity and relationship (SAR), factors modifying drug action, tolerance and dependence; Pharmacogenetics; Enzyme Induction & Inhibition; Absorption, distribution metabolism and excretion of drugs; Principles of drug discovery and development of new drugs.

**L.O:**  Knowledge imparting basic concepts of Pharmacology, mechanism of action of drugs, SAR, Pharmacokinetics and drug discovery.

**UNIT – II 10**

**Pharmacology of Autonomic Nervous System:**

Neurohumoral transmission in peripheral nervous system (autonomic and Somatic)

Parasympathomimetics & parasympatholytics, sympathomimetics & sympatholytics

Ganglionic-stimulants and blocking agents, skeletal muscle relaxants.

**L.O:** To understand the basics of physiology and neurotransmitters and their roles. To gain knowledge on the drugs acting on ANS and muscle relaxants.

**UNIT – III 08**

**Drugs acting on Central Nervous System:**

Neurohumoral transmission in the C.N.S, General anesthetics, Alcohols and Disulfiram, Sedatives, hypnotics, & anti-anxiety agents.

**L.O:**  To understand the role of neurotransmitters in the CNS and pharmacology of various classes of drugs acting on CNS.

**UNIT – IV 08**

Analgesics, Antipyretics, Anti-inflammatory and Anti-gout drugs, Narcotic analgesics & antagonists, Pharmacology of Local Anaesthetics

**L.O:** To have knowledge on the pathophysiology on Analgesia, pyretics, inflammation, gout and drugs used in their treatment.

**UNIT – V 06**

Antipsychotics & Lithium, Antidepressants, Pharmacology of Anti-epileptic drugs,

Pharmacological management of Parkinsonism & other movement disorders, C.N.S. stimulants, Drug Addiction & Drug Abuse.

**L.O:** To impart knowledge on pathophysiology of various disease conditions of the above topics and pharmacology of drugs.

**UNIT – VI 06**

**Drugs Acting on the Gastrointestinal Tract**

Antacids, Antisecretory & Anti-ulcer Drugs, Laxatives & antidiarrhoeal drugs, Appetite Stimulants & Suppressants, Emetics & anti-emetics, Carminatives, Demulcents, Protectives,

Adsorbents, Astringents, digestants, enzymes & mucolytics.

**L.O:** To impart knowledge on pathophysiology and conditions relating to peptic ulcers and emesis and to understand the pharmacology of drugs used in GIT disorders.

**TEXT BOOKS**

1. Sathoskar, Pharmacology and Pharmacotherapeutics Vol. 1 & 2, Publ by Popular Prakashan, Mumbai.
2. Tripathi, Text book of Pharmacology.
3. H.P Rang, M. M. dale & J.M. Ritter, Pharmacology, Churchill living stone.
4. F.S.K. Barar, Text book of Pharmacology, S.Chand.

**REFERENCE BOOKS**

1. J.G. Hardman and Lee E. Limbard, Good Mann & Gilmann, The Pharmacological basis of therapeutics, Mc Graw hill, Health Professions Dvn.
2. Bertram. G. Katzung, Basic and Clinical Pharmacology, 9th Edn.
3. J. Crossland, Lewis‘s Pharmacology, Church living stone.
4. Ruth Woodrow, Essentials of Pharmacology for Health Occupations.

**II Year II Semester**

## PHR16226 - PHARMACEUTICAL UNIT OPERATIONS – LAB

1. Measurement of flow of fluids and their pressure, determination of Reynolds’s number and calculation of frictional losses.
2. Evaluation of filter media, determination of rate of filtration and study of factors affecting filtration including filter aids.
3. Experiments to demonstrate applications of centrifugation.
4. Determination of Humidity‑use of Dry Bulb and Wet Bulb thermometers and Psychometric charts.
5. Determination of radiation constant of painted and unpainted glass, metal cylinder (Iron, Brass).
6. Determination of overall Heat Transfer Coefficient.
7. Determination of rate of evaporation.
8. Experiments based on steam. Extractive and Azeotropic distillations.
9. Determination of rate of drying, free moisture content and bound moisture content.
10. Experiments to illustrate the influence of various parameters on the time of drying.
11. Experiments to illustrate principles of size reduction, Laws governing energy and power requirements of a size reduction.
12. Experiments to illustrate solid‑solid mixing, determination of mixing efficiency using different types of mixers.

**II Year II Semester**

**PHR16227 - PHARMACEUTICAL ANALYSIS –I LAB**

**Acid-base titrations**

1. Standardization of HCl, H2SO4 & NaOH
2. Assay of following (any 6)
	1. Assay of Boric acid
	2. Assay of Sodium bicarbonate
	3. Assay of Borax
	4. Assay of Calcium hydroxide
	5. Assay of Zinc oxide
	6. Assay of Calcium carbonate
	7. Assay of Acetyl salicylic acid
	8. Assay of Formaldehyde
	9. Assay of NaOH in presence of Sodium carbonate.

**Redox titrations:**

1. Standardization of Iodine & KMnO4
2. Assay of following (any 5)
	1. Assay of Ferrous sulphate
	2. Assay of Hydrogen peroxide
	3. Assay of Sodium nitrate
	4. Estimation of Ascorbic acid with 2,6-dichlorophenol indophenols
	5. Assay of Mercuric chloride
	6. Assay of Sodium metabisulphite
	7. Assay of Copper sulphate

**Precipitation titrations**

1. Standardization of Silver nitrate
2. Assay of Potassium chloride or Ammonium thiocyanate or Mercuric oxide.

**Complexation titrations**

1. Standardization of EDTA
2. Assay of Calcium Gluconate injection/tablets
3. Assay of Aluminium sulphate

**Non-aqueous titrations**

1. Assay of Thiamine hydrochloride
2. Any other assay involving Perchloric acid

**Gravimetry**

1. Determination of Sulphate as Barium sulphate or Magnesium as Magnesium pyrophosphate.

**Limit tests**

1. Limit test for Chlorides
2. Limit test for Sulphates
3. Limit test for Iron
4. Limit test for Arsenic.

**II Year II Semester**

**PHR16228 -** **PHARMACOGNOSY LAB – I**

1. Collection of natural herbs and preparation of herbarium / laminated photos for five drugs.
2. Quantitative microscopy:
	1. Ratio values: Stomatal number and Stomatal Index.
	2. Determination of dimensions of starch grains and fiber lengths using eye piece micrometer and Camera lucida methods.
3. Determination of proximate values:
	* 1. Moisture content
		2. Ash value
		3. Extractive values.
		4. Swelling Factor.
4. Macrosopy, Microscopy and Chemical tests of any five carbohydrate drugs mentioned in theory.
5. Macrosopy and Chemical tests of any five lipid drugs mentioned in theory.
6. Macrosopy and Chemical tests of any two Tannin drugs mentioned in theory.
7. Macrosopy and Chemical tests of any two Resin drugs mentioned in theory.
8. Cultivation of medicinal plants: Maintenance of one plant in medicinal garden.

**TEXTBOOKS:**

1. C.K. Kokate et.al, Practical Pharmacognosy.
2. Kandhelwal, Practical Pharmacognosy.
3. G. Krishna Mohan, K. N. Jayaveera, G. S. Kumar, Practical Pharmacognosy, A laboratory Handbook.

**REFERENCES**

1. T.E. Wallis, Practial Pharmocognosy 4th Edition.
2. Harborne, Phytochemical methods: A guide to modern technology of plant analysis.