

M. Pharm (Pharmaceutics)**I SEMESTER**

Th. hrs/week Pr. hrs/week

1. Bio Pharmaceutics & Pharmacokinetics	3	9
2. Pharmaceutical Formulation Technology	3	9
3. Physical Pharmaceutics	3	-
4. Quality Assurance (optional)	3	-
5. Seminars/Assignments	3	3

II SEMESTER

6. Novel Drug Delivery Systems-I	3	9
7. Novel Drug Delivery Systems-II	3	9
8. Pharmaceutical Equipment	3	-
9. Cosmetic Technology/ Regulatory affairs (optional)	3	-
10. Seminars/Assignments	3	3

* **Practicals for both papers****III SEMESTER**

Comprehensive Viva-voce
Seminar on Dissertation Topic (Project Work) (Introductory)

IV SEMESTER

Final Seminar on Dissertation (Results)
Dissertation

I - Bio Pharmaceutics & Pharmacokinetics:

3 hrs/week

1. Bio-availability, Bioequivalence and Therapeutic equivalence: Designing of bioavailability studies and interpretation of results. Tests of significance, Test, ANOVA.
2. Physico-Chemical properties affecting bioavailability, pH-partition theory, dissolution, surface area, adsorption, complexation, polymorphism etc., and techniques of enhancing dissolution rate.
3. Formulation factors affecting bioavailability of drug in dosage forms of tablets, capsules, Parenterals, liquid orals and topical dosage forms.
4. Basic concepts of Pharmacokinetics: Compartmental models: one, two and non compartmental approaches to pharmacokinetics. Recent trends, merits and limitation of these approaches. Application of these models to determine the various pharmacokinetic parameters pertaining to:
 - i. Absorption: (wherever applicable) Absorption rate constant. Absorption half life, lag time and extent of absorption, AUC.
 - ii. Distribution: Apparent volume of distribution and its determination.
 - iii. Metabolism: Metabolic rate constant and its determination.
 - iv. Elimination: Over all apparent elimination rate constant and half life.

Under the following conditions:

- a) Intra venous bolus injection
 - b) Intra venous infusion
 - c) Single dose oral administration
 - d) Multiple dose injections
 - e) Multiple dosage oral administration
 - v. Non invasive methods of estimating pharmacokinetic parameters with emphasis on salivary and urinary compartments.
 - vi. Concept of clearance: Organ clearance, total clearance, hepatic clearance, gut wall clearance, lung clearance and renal clearance.
5. Non-linear Pharmacokinetics: concepts of linear and non linear pharmacokinetics, Michaelis-Menten kinetic characteristics. Basic kinetic parameters, possible causes of non induction, non linear binding, non linearity of pharmacological response.
 6. Non compartmental Pharmacokinetics.

7. Time dependent Pharmacokinetics: Introduction, classification, physiologically induced time dependency: Chrono Pharmacokinetics.
8. Clinical Pharmacokinetics: Altered kinetics in pregnancy, child birth, infants and geriatrics, liver, and renal diseased states.

Practicals: Based on Theory.

II- PHARMACEUTICAL FORMULATION TECHNOLOGY

3hrs/week

1. **Performulation studies:**

- a) Goals of preformulation, preformulation parameters, Methodology, Solid state properties, Solubility and Partition coefficient, Drug excipient compatibility.
- b) Excipients used in pharmaceutical dosage forms.
- c) Properties and selection criteria for various excipients like surfactant, viscosity promoters, diluents, coating materials, plasticizers, preservatives, flavors and colours.

2. **Formulation Development:**

- a) **Solid dosage forms:** Improved production techniques for tablets: New materials process, equipments improvements, high shear mixers, compression machines, coating machines, coating techniques in tablet technology for product development , physics of tablet compression, computerization for in process quality control of tablets, types of tablets and their manufacture. Formulations, production and evaluation of hard and soft gelatin capsules.
- b) **Powder dosage forms:** Formulation development and manufacture of powder dosage form for internal and external use including inhalations dosage forms.
- c) **Liquid and Semi-solid dosage forms:** Recent advances in formulation aspects and manufacturing of monophasic dosage forms. Recent advances in formulation aspects and manufacturing of suspensions, dry syrups and semi-solid dosage forms.
- d) **Parenteral dosage forms:** Advances in materials and production techniques, filling machines, sterilizers and aseptic processing. Manufacturing of small and large volume parenterals and quality control.
- e) **Aerosols:** Advances in propellants, metered dose inhaler designs, dry powder inhalers, selection of containers and formulation aspects in aerosol formulation, Manufacture and quality control.

- f) **Aseptic processing operation:** Introduction, contamination control, microbial environmental monitoring, microbiological testing of water, Microbiological air testing, characterization of aseptic process, media and incubation condition, theoretical evaluation of aseptic operations.

III. Physical Pharmaceutics:

3hrs/week

1. **Theory of Solubilization and Solubilization Techniques:** Solubility and solubilization of non electrolytes, solubilization by the use of surfactants, cosolvents, complexation, drug derivatisation and solid state manipulation.
2. **Theories of Dispersion:** Solid-liquid dispersion: adsorption, wetting, crystal growth mechanisms and prevention of crystal growth.
3. **Emulsion:** Formation and stability of emulsion with special emphasis on electrical theory, HLB theory and dielectric properties. Preparation, evaluation and applications of multiple and microemulsions.
4. **Solid State Properties:** Crystal properties and polymorphism, Techniques for study of Crystal properties, solid state stability, flow properties of powders, segregation and its importance.
5. **Theories of Compaction and Compression:** Compression, consolidation strength of granules, compression and consolidation under high loads, effects of friction, distribution of forces in compaction, force volume relationships, Heckel plots, compaction profiles, energy involved in compaction, strength of tablet, crushing strength, friability, lamination, instrumentation of tablet machines.
6. **Polymer Science:** Polymer structure, classification and Properties of polymers, thermodynamics of polymer solution, phase separation, polymers in solid state. Applications of polymers in pharmaceutical formulations.
7. **Diffusion and Dissolution:** Diffusion, steady state diffusion procedures and apparatus. Diffusion principles in biological systems, Thermodynamics of diffusion. Dissolution: Basic theories of dissolution, models. Sink conditions in dissolution and its importance. In-vitro-in-vivo- correlations. Dissolution testing for Novel drug delivery systems.
8. **Kinetics and Drugs stability:** Stability calculations, rate equation, kinetics of decomposition, strategy of stability testing, methods of stabilization, methods of accelerated stability testing in dosage forms. Freeze-thaw methods, centrifugal methods, temperature and humidity control.

IV. Quality Assurance:

3hrs/week

1. **Plant Design:** Design of manufacturing facility as per current good manufacturing practices for the bulk production of different pharmaceutical dosage forms.
2. **Equipment Validation:** Installation, validation and maintenance of typical equipment used in bulk manufacture of pharmaceutical dosage forms with reference to GMP requirement.
3. **Process Validation:** Regulatory basis, validation of solid dosage forms, liquid dosage forms, and sterile products, Process validation of raw materials, validation of analytical methods.
4. **Quality Control:** Process controls involved in manufacturing process of pharmaceutical dosage forms, statistical quality control charts and its applications in process control. Testing programme and methods for testing quality of pharmaceutical dosage forms. Adulteration and misbranding.
5. **Stability studies:** ICH guidelines and stability protocols for different pharmaceutical dosage forms.
6. **Industrial Safety:** Industrial hazards due to fire accidents, mechanical and electrical equipment, chemicals and pharmaceuticals. Monitoring and prevention systems.
7. **Applications of optimization techniques:** Optimization parameters, statistical design and techniques in product development and evaluation. Production optimization and its importance.

V – Seminars & Assignments

II – Semester

IV-Novel Drug Delivery Systems - I

1. Review of Fundamentals of controlled drug delivery systems:

Fundamentals, rationale of sustained/controlled drug delivery, factors influencing the design and performance of sustained/controlled release products, Pharmacokinetic/ Pharmacodynamic basis of controlled drug delivery. Types and structure of polymers, Use of polymers and biocompatible polymers in controlled release of active agents.

2. Drug targeting principles and approaches: Active and passive targeting, Tumor targeting, Bone marrow targeting, cell surface biochemistry and molecular basis of targeting. Tumourbiology-Extra cellular matrix- knowledge of cell adhesion molecules- selectins and fibronectins -lectins for tumour targeting.

Monoclonal antibodies and engineered antibodies for drug delivery. Antibody-drug conjugates, Limitations of antibody targeting.

Brain targeting, Blood brain barrier, structure, role in drug transport, targets for targeting.

Receptor-structure, endocytosis, receptor mediated endocytosis and transcytosis.

Knowledge of drug targeting through chemical drug delivery approaches to different organs like brain, eye, lung and liver etc. Colon specific systems.

3. Transdermal drug delivery systems, Iontophoresis, Electroporation and Microneedles, Gastro Retentive Drug Delivery System, oro dispersible tablets, Dendrimers.

4. Design and fabrication of controlled release drug delivery system:

Principle involved and formulation of: Oral dosage forms – Diffusion system, Reservoir devices, Osmotic systems, Systems utilizing dissolution and ion exchange resins, prodrugs, Multiple Emulsions.

5. Parenteral dosage forms, intramuscular injections, implantable therapeutic systems, Transmucosal systems and mucoadhesive systems, Nasal delivery, intravaginal and intrauterine systems, Lung delivery systems. Ocular drug delivery, drug delivery to GIT.

6. Carrier Based Delivery Systems: Principle involved and formulation of Micro particulate drug carriers, Liposomes, Niosomes, Microspheres, Magnetic microspheres, Nanoparticles. Resealed erythrocytes.

Practicals: Based on theory

VII- NOVEL DRUG DELIVERY SYSTEMS - II

3 hrs/week

1. Cell membranes, epithelial barriers of Drug absorption and physiological factors affecting oral bioavailability.
 - a. Plasma membrane – Phospholipids bilayer, membrane modulation of fluidity modelsvproteins.
 - b. Epithelia – cell junctions – structure and role in drug absorption.
 - c. Transport across cell membranes – efflux transporter systems (multi drug resistance).
2.
 - a) Inter cellular routes of absorption, persorption.
 - b) M cells and peyer’s patches in GIT, mucus – structure and composition.
 - c) Permeation enhancers – classification and mode of action.
 - d. Lymphatic transport of drugs.
3. **Nucleic acid based therapeutic delivery systems:** Gene therapy, introduction, (ex vivo & in-vivo gene therapy) potential target diseases for gene therapy (inherited disorder and cancer), gene expression system (viral & non viral gene transfer), gene delivery systems (liposomal), biodistribution and pharmacokinetics. Clinical applications. Knowledge of therapeutic antisense molecules and aptamers as drugs of future.
4. **Genomics, Proteomics:** Definitions of genomics and proteomics and Bioinformatics. Brief Knowledge of Human genome project –Pharmacogenomics-genetic Polymorphisms influencing drug disposition and effect on drug response.
5. **Delivery of peptides and proteins/Biotechnology based drugs:-**Formulation aspects. Preformulation studies and problems: Protectants, delivery kinetics. Overview of delivery systems, site specific proteins, Stability problems, Evaluation of recombinant proteins. Knowledge of engineered proteins-techniques of getting engineered Proteins by DNA technology. Insulin derivatives like- Lispro, tissue plasminogen activator like reteplase. Antibodies, derivatives of antibodies Myelotarg, Herceptin, and Absciximab (Reopro).
6. **Vaccine Delivery:** Evidence and mechanism of uptake and transport of antigens. Delivery systems used to promote uptake. Absorption enhancers, Lipid carrier systems, oral immunization, peyer’s patches, common mucosal immune system, controlled release micro particles for vaccine development, single dose vaccine delivery systems using biodegradable polymers. Knowledge of peptide based and nucleic acid based vaccines. Antigen adjuvants in vaccine formulations.

VIII. Pharmaceutical Equipment:

3hrs/week

Installation, Validation, Maintenance and working of the following:

- 1) **Tablet Machines:** Rotary tablet, Multi punch
- 2) **Coating Equipment:** Pans, fluidized bed
- 3) **Dryers:** Freeze, spray, fluidized bed and tray dryer
- 4) **Granulators:** Rapid mixer, extruder-spheronizer
- 5) **Mixers/Milling:** Planetary, double cone, triple roller mill, colloidal mill
- 6) **Filters:** Plate and frame press, membrane filters, air filtration system (Laminar flow) and Aseptic Room
- 7) **Sterilization:** Autoclave
- 8) **Homogenizers** and High Pressure Homogenizer

IX. COSMETIC TECHNOLOGY/REGULATORY AFFAIRS (Optinal)

3 hrs/week

1. **Preformulations studies:** Preformulation studies and stability testing of Cosmetic products – Shelf–life determination of Cosmetic products, Effects of environmental factors like light, temperatures etc., on product stability.
2. **Raw materials used for Cosmetic preparation:** Detailed knowledge of various raw materials used in cosmetic industry, like surfactants, humectants, perfumes and colours.
3. **Good Manufacturing Practices and Regulatory Requirements:** Knowledge of the Regulatory Standards governing Cosmetic products in India as well as International Markets.
4. **Hair Care Products:** Introduction, Hair structure, Antidandruff shampoos, setting lotion, Hair dyes.
5. **Skin Care Products:** Introduction, anatomy and physiology of skin, formulation of skin cleaners, moisturizers, sunscreen products, anti acne products, anti-ageing creams.

- 6. Colour cosmetics:** Introduction lip sticks, nail polish, face make-up and eye make-up.
- 7. Herbal Cosmetics:** Introduction, use of plants and plant materials in formulation of cosmetics with emphasis on dentifrices, skin care products and personal hygiene products.
- 8. Personal Hygiene Products:** Shaving creams and after shave products, Antiperspirants and deodorants.
- 9. Safety testing of Cosmetic Products:** Microbiology in Cosmetics.
Knowledge of the various microbial contaminants in cosmetic products.
Knowledge of various preservative systems for cosmetic products.
Selection criteria for preservatives.
Efficacy and safety testing of preservatives in cosmetic products.
- 10. Packaging in Cosmetics:**
Knowledge of various packaging materials used in cosmetic products.
Knowledge of various machines used for packing of cosmetic products.
Contemporary trends in cosmetic packaging.
Compatibility and stability testing of packaging materials in cosmetic products.

I – Semester

Biopharmaceutics and Pharmacokinetics (Practicals) (9hrs/week)

- 1) Calculation of Pharmacokinetic Parameters using one compartment open model in blood when given by
 - a) I.V. bolus
 - b) Oral administration (Method of Residuals)
 - c) I.V. infusion

- 2) Calculation of Pharmacokinetic parameters using one compartment open model by urinary excretion data:
 - a) Rate Excretion method
 - b) Sigma Minus method.

- 3) Calculation of absorption rate constant by Wagner-Nelson method.

- 4) Calculation of Pharmacokinetic parameters using Two-Compartment open model in blood when given by:
 - a) Oral route
 - b) I.V. route

- 5) Effect of formulation factors on Bioavailability of the drug from various dosage forms.

- 6) Comparison of Invitro-dissolution profiles of marketed preparations.

- 7) Effect of Polymorphism on drug dissolution

- 8) Determination of a protein binding of a drug.

- 9) Effect of Complexation on the solubility and dissolution rate of drug from dosage forms.

- 10) To conduct a bioequivalence study using plasma/urine/saliva samples.

I - Semester**Pharmaceutical Formulation Technology & Physical Pharmaceutics**

9 hrs/week

- 1) Preparation and evaluation of Oral suspensions.
- 2) Preparation and evaluation of Effervescent tablets.
- 3) Preparation and evaluation of Gel based formulations.
- 4) Design and evaluation of a Aerosol based formulations.
- 5) Effect of compression force on tablet hardness and disintegration.
- 6) Effect of pH of dissolution medium on release rate profile of a drug.
- 7) Effect of various disintegrating agents and superdisintegrants on hardness, disintegration and dissolution of drug from dosage form.
- 8) Comparison of drug release from tablets prepared by Dry granulation, wet granulation, and slugging.
- 9) Comparison of Intrinsic dissolution rate with dissolution rate profile of dosage form.

Physical Pharmaceutics

- 1) Diffusion study of drug through various Polymeric membranes.
- 2) Determination of shelf life of a drug using Accelerated stability studies. (Temperature, pH and Humidity).
- 3) Formulation and evaluation of Multiple and Micro emulsions.
- 4) Enhancement of Solubilization of Non-electrolytes by
 - a) Surfactants
 - b) Co-solvents
 - c) Complexation
 - d) Solid dispersion
- 5) Effect of Compression force on tablet strength, Friability and lamination.
- 6) Effect of various blends of glidants on flow properties of powders, granules.
- 7) Measurement of rheological properties of some polymers and study the influence of plasticizers.
- 8) Measurement of surface tension/interfacial tension to determine the CMC of surfactants.
- 9) Preparation of polymer solutions & studying the rheological behaviour
- 10) Drug-excipient interaction study using Differential scanning calorimeter.
- 11) Determination of log P value

II - Semester

Novel Drug Delivery Systems – I (Practicals)

9 hrs/week

- 1) Preparation and evaluation of Microcapsules.
- 2) Preparation and evaluation of Transdermal patches of a drug.
- 3) Preparation and evaluation of Liposomal drug delivery systems.
- 4) Preparation and evaluation of Bioadhesive oral dosage form.
- 5) Preparation and evaluation of Microspheres.
- 6) Preparation and evaluation of Buccal drug delivery systems.
- 7) Design of Protein and peptide drug delivery systems.
- 8) Development of matrix type sustained release drug delivery.
- 9) Development of controlled release dosage form for oral use.(Elementary osmotic pump).
- 10) Preparation and Evaluation of ODT.
- 11) Preparation and Evaluation of GRDDS.
- 12) Preparation and evaluation of a Drug immunoconjugate
- 13) Preparation and evaluation of solid lipid nano particles

Novel Drug Delivery Systems – II & Pharmaceutical Equipment

9 hrs/week

- 1) Studying the drug transport across Porcine buccal mucosa/skin (hydrophilic lipophilic drugs)
- 2) Preparation of liposomal gene delivery systems
- 3) Preparation of vaccine delivery systems
- 4) Preparation & Evaluation of stability of protein formulation by gel electrophoresis
- 5) Studying the role of permeation enhancers in drug transport across biological membranes
- 6) Preparation of a DNA vaccine
- 7) Validation of
- 8) Validation of a dryer
- 9) Validation of a filtration assembly (membrane filter)
- 10) Validation of Rotary tablet machine
- 11) Validation of Aseptic room
- 12) Validation of a coating pan

Kakatiya University**List of Equipment Required for M. Pharm. Pharmaceutics**

1) Digital Disintegration Time apparatus	1.No
2) Dissolution apparatus (U.S.P.) with 8 flasks with paddles and baskets	1.No
3) Mini Rotary Tablet Machine 6/8 station	1.No
4) Hardness Testers Pfizer, Monsanto, advanced digital	1 each
5) Advanced screw guage digital	1.No
6) Top loading Electronic balance 0.1mg sensitivity	1.No
7) U.V spectrophotometer	1.No
8) Moisture determination apparatus digital	1.No
9) Stability Chambers	2.Nos
10) Deep freezer	1.No
11) Centrifuge digital with 3000-4000 rpm	1.No
12) Digital Micropipettes variable volume 20-200 µl	1.No
13) Digital Micropipettes variable volume 100-1000 µl	1.No
14) High Performance liquid Chromatograph with UV detector and soft ware	1.No
15) Sonicator water bath	1.No
16) Probe Sonicator	1.No
17) Research Microscope with photographic arrangement	1.No
18) Rheometer with software preferably Brooke field	1.No
19) Oven Thermostatic	1.No
20) Refrigerator	1.No
21) Electronic Top loading balance 1 mg sensitivity	1.No
22) PH meter digital	1.No
23) Vacuum Oven	1.No
24) Freeze dryer	optional
25) Spray dryer	optional
26) I.R Press	optional
27) All glass distilled water still	1.No
28) Tensile strength apparatus	1.No (optional)
29) Cooling Centrifuge	optional
30) Rotary flash evaporator Buchi/Hidolf	1.No
31) Homogenizer high pressure	1.No
32) Magnetic stirrer cum hot plate with digital display	3.Nos
33) Vortex mixer	1.No
34) Mixer	1.No
35) Aseptic cabinet	optional 1.No
36) Gel electrophoresis	optional 1.No
37) Gel documentation system	optional 1.No
38) Injection pump	optional 1.No
39) Coating pan with speed regulator, hot & cold air& spraying device	1.No
40) Diffusion Cells (Franz/Chin type)	6.No
41) Peristaltic pump	1.No
42) Zeta sizer if both branches are available	1.No
43) Sicve shaker digital with sel of sieves	1.No
44) Tray dryer	1.No