Syllabi of Master of Pharmaceutical Sciences in

1. **Pharmaceutics**
2. **Pharmaceutical Chemistry**
3. **Pharmacology**
4. **Pharmacognosy**
5. **Quality Assurance Techniques**

SEMESTER-I

(M-I) Advanced Analytical Techniques
(Theory: 3hrs/week)

1. ***Spectroscopic methods:***
   Theory, Instrumentations, chemical applications and structural elucidation by UV, IR, ^{1}H NMR, ^{13}C NMR including DEPT, Mass Spectrometry, ESR and Emission spectroscopy.
2. ***Separation techniques:***
   Fundamental principles, theory, instrumentation and application of Gas-liquid chromatography, HPLC, Size Exclusion chromatography, GC-MS, LC-MS, UPLC, HPTLC, Ion Pair & Ion Exchange Chromatography and Supercritical Fluid Chromatography.
3. ***Thermal Analysis:***
   Theory, Instrumentations and applications of Thermogravimetric Analysis (TGA) and Differential Thermal Analysis (DTA).
4. ***Calorimetric Analysis:*** Theory, Instrumentations, chemical applications and structural Elucidation, Differential Scanning Calorimetry (DSC), Isothermal titration Calorimetry (ITC)
5. ***Powder X-ray Diffraction:*** Instrumentation and applications.

(M-I) Advanced Analytical Techniques
(Practical: 6 hrs. /week)

1. Combination Drug Analysis (Any Five)
   a. Vitamins
   b. Oral antidiabetics
   c. NSAIDs
   d. Antimicrobials
   e. Antihistamines
   f. Antihypertensive
2. Illustrations of theoretical principles using assay of drugs official in various pharmacopoeias (Any 10). This should cover titrimetric, spectro-photometric (including flamephotometric) methods, HPLC etc. The titrimetric methods should include argentometric, conductometric, and potentiometric end-point determination.

The students should be exposed to handling of as many instruments as possible by themselves or under the guidance of a teacher.

3. Interpretation of UV and IR spectra of some unknown intermediates and drugs. (Any two)

Reference Books for Theory & Practicals

1. M. Orchin and H.H. Jaffe – Theory and application of ultra- violet spectroscopy. (John Wiley and Sons. N.Y).
2. Silverstein, Basseler, Morril- Spectroscopic identification of organic compounds (John Wiley and Sons. N.Y).
3. Willard, Merritt, Dean – Instrumental methods of analysis (CBS Publishers and Distributors, Delhi).
4. J.R. Dyer – Application of absorption Spectroscopy of Organic Compounds (Prentice Hall, London).
5. C.N.R. Rao – Chemical Application of Infra-red spectroscopy. (Academic Press, N.Y.).
6. L.M. Jackmann and B.D. Sternhell – Application of NMR spectroscopy in organic chemistry (Pergamon Press, London.).
7. F.W. McLafferty- Interpretation of Mass Spectra.
8. R.J. Hamilton- Introduction to High Performance Liquid Chromatography.(Chapman and Hall, London).
9. J.W.Munson- Pharmaceutical Analysis- Modern methods –Part A and Part B (Marcel Dekker).
10. Introduction to Spectroscopy, 3rd edition, Pavia, Lampman, Kriz, Thomson Publisher.
11. Analytical chem.., 2nd edition by Kellner, Mermet, Otto, Valcarcel Wiley ECH.
12. Ewing's Analytical Instrumentation Handbook, 3rd edition, edited by Jack Cazes, Marcel Dekker.
13. P.D. Sethi – Quantitative Analysis of Drugs in Pharmaceutical formulations (VBS Publishers, Delhi).
14. Pharmacopoeia of India.
15. United State Pharmacopoeia
16. British Pharmacopoeia
17. A.H. Beckett, J.B. Stenlake – Practical Pharmaceutical Chemistry, Part I and Part II (CBS Publishers Delhi)
18. F. D. Snell and C. T. Snell- Colorimetric Methods of analysis (Van Nostrand Reinhold Company, N.Y.).
19. C.N.R. Rao – Chemical Application of Infra-red spectroscopy.(Academic Press, N.Y.).
20. J.R. Dyer – Application of Absorption Spectroscopy of Organic Compounds (Prentice Hall, London).

(M-2) Research Methodology

(Theory: 3hrs/week)

Sr. No.	Contents
1	Research-Meaning, purpose, Types, (Educational, Clinical, Experimental, historical descriptive, Basic applied and Patent oriented Research) objective of research
2	Literature survey-Use of Library, books & journals-Medlines-Internet, gating patients & reprints of articles as a source for Literature survey.
3	Selecting a problem & preparing Research proposals for different of Research mention above
4	Methods & tools use in research – 1 Qualities studies, quantitative studies 2 simple data organization descriptive data analysis, 3 Limitation & sources of Error 4 Inquiries in form of Questionnaire, Opinionnare or by Interview 5 Stastiscal analysis of data including variance, standard deviation, student " t" test, ANOVA, correlation data & its interpretation
5	Documentation- "How" of documentation Techniques of documentation Importance of documentation Uses of Computer packages in documentation.
6	The Research Report Paper writing/ thesis writing Different parts of the Research paper 1. Title –Title of project with authors name 2. Abstract- Statement of the problem, Background list in brief and purpose and scope. 3. Key Words. 4. Methology-subject, apparatus, instrumentation & procedure. 5. Results- tables, graphs, figures & statistical presentation 6. Discussion support or non support of hypothesis, practical & theoretical implications 7. Conclusion 8. Acknowledgements. 9. References 10. Errata 11. Importance of Spell check for entire project 12. Uses of footnotes
7	**Presentation** (Specially for oral) Importance, types different skills, contained, format of model, introduction & ending, Poster, Gestures, eye contact, facial, expressions, stage, fright, volume-pitch, speed, pause & language, Visual aids & seating, Questionnaire
8	**Protection of patents & trade marks designs & copyrights** The patents system in India, present status intellectual property rights. Advantages, The Science in law, Qurimetrics (Introduction)

	What may be patented, who may apply for patents, Preparation of patent proposal registration of patents in foreign countries & vice versa
9	Cost analysis of the project – cost incurred on raw materials, Procedure, instrumentations & clinical trials.
10	Sources for procurement research grants
11	Industrial-institution interaction- Industrial projects, their, feasibility reports.

Recommended Books: -

1. Research In Education- John V. Best, John V. Kahn 7th edition
2. Presentation skills - Michael Hallon- Indian Society for Institute education
2. Practical Introduction o copyright.- Gavin Mcfarlane
3. Thesis projects in Science & Engineering – Richard M. Davis.
4. Scientist in legal Systems- Ann labor science
5. Thesis & Assignment – Jonathan Anderson
6. Writing a technical paper- Donald Menzel
7. Effective Business Report Writing –Leland Brown
8. Protection of industrial Property rights- P. Das & Gokul Das
9. Spelling for the millions- Edna Furmess
10. Preparation for publication – King Edward Hospital Fund for London
11. Information Technology – The Hindu speaks
12. Documentation – Genesis & Development 3792.
13. Manual for evaluation of industrial projects-United Nations
14. Manual for the preparation of industrial feasibility studies

(M-I-1) Advanced Pharmaceutics

(Theory 3hrs/week)

Sr. No.	Name of the topic and Contents
1	PREFORMULATION:-Introduction and concept, Need, Advantages, Organization. Techniques:- Solubility & pKa, Spectroscopy, Chromatography, Thermal Analysis, X-ray diffraction:- Techniques to generate & characterize amorphous & crystalline forms. Stability. Brief account of preformulation of i) Conventional tablet - Compaction of powders with particular reference to distribution and measurement of forces within the powder mass undergoing compression including- physics of tablet compression; Effect of particle size, moisture content, lubrication, lubricant sensitivity ii) Oral liquids, Suspension, iii) Semisolid, iv) Aerosol products.
2	POLYMER SCIENCES:- Introduction and classification ,preparation methods of synthetic polymers, Molecular weight determination , Thermal characterization and rheology of polymers. Introduction to biodegradable & biodegradable polymers.
3	STABILITY:- Concept of stability of pharmaceuticals. Understanding of statistical aspects in expiry period. Degradation pathways, Physical instabilities & evaluation methods. Overages and ICH guidelines.
4	EXCIPIENTS: Overview of excipients used in formulations. Factors affecting the selection. Introductory aspects of drug-excipient and excipient, package interactions. Study of newer

	excipients like cyclodextrin, ion exchange resins, film coating materials, superdisintegrants, directly compressible vehicles, surfactants- micelle formation, liquid crystal phase, thickeners. Standardization of excipients.
5	QUALITY ASSUARANCE-: Concept of quality control, quality assurance & total quality controls. Sources of variation, Quality control of raw materials & pharmaceutical process & finished products. Documentation concepts of statistical quality control. Validation of pharmaceutical process (at least one case study of a process & analytical method.)
6	DIFFUSION & DISSOLUTION: Concept and importance of dissolution. Steady state diffusion. Determination of diffusion coefficient & its importance. Concept & importance of dissolution. Dissolution test, Historical development & USP dissolution test. Dissolution model like Hixson-Crowell, Higuchi's Model. Drug release modeling through polymer matrix & laminates. Concept of membrane controlled delivery & its importance in dosage form design.
7	MICRO ENCAPSULATION: Theory, methods, applications, kinetics of release of drugs from microcapsules, formulations and evaluation.
8	OPTIMIZATION:- Definition ,need ,advantages ,Meaning of general terms involved in optimization process .Classification of optimization methods. Brief description and importance of experimental design with special reference to designs adequate for large number of variables. Introduction of correlation & regression analysis & mathematical model, contour plots. Basic understanding with at least one example of following optimization techniques:-Simplex method, langarengian method, EVOP, Grid search method.

(M-I-1) Advanced Pharmaceutics

(Practicals 6hrs/week)

Sr. No.	Name of the topic and Contents
1	Preformulation study of tablets, Compressibility index, Heckle treatment, Kawakita plots.
2	Determination of the order of decomposition for drugs like Aspirin, Benzocaine, Acetanilide or any other three drugs.
3	To develop and validate the UV spectroscopic analytical method of any one drug
4	To develop and validate the analytical method of any one drug using high performance liquid chromatography
5	To determine the aqueous solubility of given drug sample at various temperature and report its thermodynamic parameters.
6	To study the effect of pH (2,4,6.2 and 8.0) on the apparent partition coefficient of a drug in n-octanol- water buffer system.
7	To determine the best compatible additive for aspirin tablets using at least five known tablet components.
8	To study the effect of copper ions on the ascorbic acid stability in solution
9	To characterize polymers rheologically and thermally.

10	To study the dissolution kinetics of IR and ER dosage form.
11	To study the dissolution kinetics of given drug.
12	To study the effects of pH on rheological characteristics of carbopol gels using Brookfield viscometer.

Recommended books:

1. Theory and Practice of Industrial Pharmacy By Lachmann and Libermann. Third edition, Varghese Publishing House.
2. Pharmaceutical dosage forms: Tablets Vol. 1-3 by Leon Lachmann. Second Ed.
3. Pharmaceutical Dosage forms: Disperse systems, Vol, 1,2,3; By Leon Lachmann. Second edition.
4. Modern Pharmaceutics; By Gillbert and S. Banker. Fourth Edition. Volume 121.
5. Remington's Pharmaceutical Sciences. Vol.I-II, 21 st Edition.
6. Advances in Pharmaceutical Sciences Vol. 1-5; By H.S. Bean & A.H. Beckett.
7. Physical Pharmacy; By Alfred martin. Fourth Edition, Published by B. I. Waverly Pvt. Ltd.
8. Bentley's Textbook of Pharmaceutics – Rawbins.
9. Good manufacturing practices for Pharmaceuticals: A plan for total quality control, By Sidney H. Willig, Second Ed.
10. Quality Assurance Guide; By Organization of Pharmaceutical producers of India.
11. Drug formulation manual; By D.P.S. Kohli and D.H. Shah. Eastern publishers, New Delhi.
12. How to practice GMPs; By P. P. Sharma. Vandhana Publications, Agra.
13. Pharmaceutical Process Validation; By Fra. R. Berry and Robert A. Nash. Vol-57, Second Edition. Revised and Expanded.
14. Pharmaceutical Preformulations; By J.J. Wells.
15. Applied production and operations management; By Evans, Anderson, Sweeney and Williams.

(M-II-1) Advanced Pharmaceutical Chemistry

(Theory 3 hrs/week)

1. **Stereochemistry & Chiral Techniques:**

i. Principles of stereochemistry including geometric isomerism, optical isomerism and conformational isomerism, Dynamic stereochemistry.

ii. Concept of chiral drugs, resolution of racemic mixtures, racemic switches, asymmetric synthesis of the following drugs: Vit C, Propranolol, Nifedipine, Atenolol, Ethambutol, Penicillamine, Omeprazole, Aspertame, Ampicillin, and Thalidomide.

iii. Role of stereochemistry in Pharmacokinetics and Pharmacodynamics

2. **Mechanisms, stereochemistry and applications of following individual reactions**:

    1. Hydrogenation
    2. Reduction with metallic hydrides

3. Clemensen Reduction
4. Wolf Kishner reduction
5. Birch Reduction
6. Meerwein-Pondorff reduction
7. Oppennauer oxidation
8. Free radical reaction
9. Allylic Bromination
10. Use of diazomethane and peracids in synthesis
11. Grignard Reaction
12. Pinacol and related rearrangements
13. Beckmann rearrangement and ozonolysis
14. Heck reaction
15. Sharpless oxidation
16. Suzuki coupling
17. Wittig Reaction

3. **Synthone approach:**
   Definition, terms and abbreviation, rules and guidelines used in synthesis of following drugs.
   Rosiglitazone, Trimethoprim, Terfenadine, Ibuprofen, Fentanyl, Midazolam, Ciprofloxacine, Captopril, Diclofenac, Losartan

4. **Solid phase Chemistry:** Reaction involved with mechanism, which include protection, de-protection, and coupling.

5. **Green Chemistry:**

Water as solvent, ionic liquids, supercritical liquids, Supported reagents and catalysts, Solvent free reactions, activation by Microwave, Ultrasound etc.

(M-II-1) Advanced Pharmaceutical Chemistry

(Practical 6 hrs/week)

1. Experimental techniques – Fractional distillation, Vacuum distillation, Preparative chromatography- Column and TLC.
2. Synthesis of any five different heterocyclic compounds using reactions discussed under point 2 of theory syllabus.
3. Practical illustrations of any five reactions described in the point(2) of theory syllabus.
4. Principles, mechanism and techniques of stereo controlled synthesis of Nifedipine, Chloroxazone and Paracetamol.
5. Isolation of phytochemical principles (e.g. alkaloids, steroids) from natural origin.

Recommended Books for Theory & Practical

1. Sykes- A Guidebook to Mechanism in Organic Chemistry.

2. March- Advanced Organic Chemistry –Reaction Mechanisms.
3. Eliel- Stereochemistry of Carbon Compounds.
4. Alexander- Principles of Ionic Organic Reaction.
5. Surrey- Reaction in Organic Chemistry.
6. Hendrickson – Organic Chemistry.
7. Jerry March- Advanced Organic Chemistry.
8. Asymmetric Synthesis, Vol. 1-7, Ed. J. A. Morrison
9. Chirotechnology - R.A Sheldon.
10. Practical Organic Synthesis: A Student's Guide - Reinhart Keese, Martin Brändle, Trevor Toube
11. Norman, Principles of Organic Chemistry, Carry and Sunberg, Organic Chemistry Part A & B.
12. Beuhler and Pearson – Organic Chemistry – Part A & B.
13. Mc Murry, Organic Chemistry.

M –III-1 Advance Pharmacology (Preclinical Evaluation of Drugs)

(Theory 3 hrs/week)

1. **Care**, **handling and breeding techniques of laboratory animals.** Regulations for laboratory animal care and ethical requirements. Knowledge of CPCSEA Performa for performing experiments on animals. Alternatives to animal studies.

2. **Organization of Preclinical screening** programme and safety assessment tests.

3. **Preclinical evaluation** of following category of drugs:

    a. Sedatives, hypnotics, anxiolytics, antidepressants, antipsychotic, nootropics, antiparkinsonian agents, analgesics, antipyretics
    b. Anti-inflammatory agents, anticonvulsants, local anesthetics, CNS stimulants
    c. Cardiac glycosides, anti-arrhythmic, antihypertensives, anti-atherosclerotic
    d. Anti ulcer agents, laxatives
    e. Bronchodilators, antitussives
    f. Diuretics
    g. Histamine antagonists
    h. Muscle relaxants, Anticholinesterases, anticholinergics, adrenolytics.
    i. Hypoglycemic, anti fertility agents, androgens
    j. Anti- thyroid agents

4. **In vitro testing of Drugs**: Animal cell lines and their uses, limitations of *in vitro* testing of drugs.

5. **Knowledge of Modern Methods of Pharmacological evaluations** including radioligand binding assay, patch clamp, ELISA, and other sophisticated methods

Recommended books:

1. Burn.J.H., Practical Pharmacology Blackwell Scientific, Oxford London
2. Ghosh M.N.: Fundamental of Experimental Pharmacology, Scientific book agency Calcutta.
3. Jaju B.P., Pharmacology: A Practice Exercise Book, Jaypee Brothers, New Delhi
4. Kulkarni S.K. Handbook of Experimental Pharmacology, Vallabh Prakashan, New Delhi
5. Lawrence, D.R.and Bacharch, A.L .Evaluation of Drug Activities, Pharmcometrics, Academic Press
6. Perry W.L.M. Pharmacological Experiments on Isolated Preparation, E&S Livingstone, London
7. Sheth U.K. Dadkar, N.K. and Kamat, U.G. Selected Topics in Experimental Pharmacology, (Kothari Book Depot Mumbai)
8. Thomson E.B. Drug Bioscreening, VCH, New York
9. Tuner, R.A.: Screening methods in Pharmacology (Academic Press London)
10. Vogel H.G. and Vogel, W.H. Drug Discovery and Evaluation: Pharmacological Assays, Springer, New York

M –III-1 Advance Pharmacology (Preclinical Evaluation of Drugs)

(Practical 6 hrs/week)

1. Introduction to Pharmacological evaluation methods and CPCSEA and OECD guidelines, GLP norms
2. Normal biochjemical reference values in various aminal species.
3. Standard techniques for injection of drugs, collection of blood samples and feeding of animals
4. Study of various techniques of anesthesia and euthanasia
5. Computer simulation of follwing animal experiments through soft wares such as X-pharma and X-cology
    a. Study of mydratic and miotic effects of the drugs
    b. Study of various drugs on dog Blood pressure
6. Screening of antiulcer agents
7. Evaluation of local anesthetics,
8. Evauation of anticonvulsant agents

Recommended books:

1. Burn J.H., Practical Pharmacology, Blackwell Scientific, Oxford, London
2. Ghosh. M. N.: Fundamental of Experimental Pharmacology, Scientific Book Agency, Calcutta
3. Jaju B.P., Pharmacology: A Practice Exercise Book. Jaypee Brothers, New Delhi
4. Lawrence, D.R. and Bacharch, A.L.; Evaluation of Drug Activities, Pharmacometrics, Academic Press
5. Kulkarni, S.K.; Handbook of Experimental Pharmacology, Vallabh Prakashan, New Delhi

6. Perry, W.L.M., Pharmacological Experiments on Isolated Preparations, E & S, Livingston, London
7. Sheth, U.K., Dadkar, N K. and Kamat, U.G., selected topics in experimental pharmacology, (Kothari Book Depot, Mumbai)
8. Thomson, E.B., Drug Bioscreening, VCH, New York
9. Turner, R.A., Screening Methods in Pharmacology, Academic Press, London
10. Vogel, H.G. and Vogel, W.H.: Drug Discovery and Evaluation: Pharmacological Assays, Springer, New York

M-IV-1 Advanced Pharmacognosy

(Theory 3 hrs/week)

1. ***Biogenesis of secondary metabolites:*** Application of tracer techniques in evaluation of biogenetic pathways of secondary metabolites.

2. Strategies to enhance secondary metabolite production through tissue culture techniques like-precursor feeding, elicitation, genetic manipulation, bioreactor techniques, biotransformaton, etc.

3. ***Chemotexonomy of medicinal plants:*** Introduction, principle of Chemotexonomy, Role of secondary metabolites in chemotaxonomy, applications of chemotaxonomy in medical botany.

4. Natural Product Drug Discovery

5. ***Natural products*** used as colour pigments, excipients, biopolymers, photosensitizimg agents, flavours, biofuels

6. ***Recent advances in Pharmacognosy:***

With special reference to anticancer, antidiabetic, hepatoprotective, anti-inflammatory, hypo lipidaemic, immunomodulatory drugs.

Reference Books

1. Trease and Evans, Pharmacognosy, Saunders Company, London.
2. Tyler, Brady, and Robbers, Pharmacognosy, Lea Febiger, USA.
3. Wallis T. E., Text Book of Pharmacognosy, CBS publishers & distribution, Delhi.
4. Kokate, Purohit, Gokhale, Pharmacognosy, Nirali Prakashan, Pune.
5. Rangari V.D., Pharmacognosy & Phytochemistry, Vol I, II, Career Publication, Nashik.
6. Agrawal O.P., Chemistry of Organic Natural Product, Goel Publication House, UP.
7. E. Ramstad, Modern Pharmacognosy, Mc-graw hill Book Company.
8. Pridham J B, Swain T, Biosynthetic pathway in higher plants, Academic Press, New York.

9. Street H E, Tissue culture and plant science, Academic press, London.
10. Rainerat and Bajaj, plant tissue culture.
11. Shah and Quadry Text Book of Pharmacognosy.
12. Chopra, Indigenous drug of India.
13. Wealth of India.
14. Nadkarni, Material Medica.
15. Ayurvedic Pharmacopoeia.
16. Indian Pharmacopoeia.
17. British Pharmacopoeia.
18. Martindale Extra Pharmacopoeia.
19. Wagner, Plant drug analysis.

M-IV-1 Advanced Pharmacognosy

(Practical: 6hrs/week)

Preparation of monograph (Min.10) of herbal drugs by considering the following parameters.

1. Pharmacognostic study of crude drugs: morphology, microscopy, quantitative microscopy, chemical tests etc.
2. Extraction, fractionation, proximate chemical analysis.
3. Physical parameters of evaluation: Moisture content, ash values, extractive values etc.

Reference Books

1. Kokate C.K, Practical Pharmacognosy, Vallabh Prakashan.
2. Khandelwal K.R, Practical Pharmacognosy, Nirali Prakashan, Pune.
3. Iyangar M.A, Pharmacognosy of powdered crude drug.
4. Iyangar M.A, Anatomy of crude drug.
5. Brain & Turner, The practical evaluation of phytopharmaceutics.
6. Harborne J.B, Phytochemical method.
7. Wagner, Plant drug analysis.
8. Stal Egon, Thin layer chromatography.
9. Wallis T.E, Textbook of Pharmacognosy.
10. Ayurvedic Pharmacopoeia of India.
11. Indian Pharmacopoeia.
12. British Pharmacopoeia.
13. Martindale, Extra Pharmacopoeia.

M-V-1 Advanced Quality Assurance Techniques (cGMP & Documentation) (Theory 3 hrs/week)

Study of following topic with reference to theoretical basis & related documentation

TOPIC 1: PERSONNEL

1.0 Introduction
1.1 Qualification Experience and Training
1.2 Responsibilities and Key Personnel
1.3 Personal hygiene and clothing
1.4 Legal Aspects
1.5 Consultants

TOPIC 2: SURROUNDING, BUILDING AND FACILITIES

2.0 Introduction
2.1 Principal Area
2.2 Plumbing and Drainage system
2.3 Lighting
2.4 Sewage, Refuge and Disposal of Water
2.5 Washing and Toilet Facilities
2.6 Sanitation
2.7 Maintenance

TOPIC 3: EQUIPMENT

3.0 Introduction
3.1 Design, size, location and Construction of Equipment
3.2 Equipment Identification
3.3 Equipment log
3.4 Cleaning and Maintenance of Equipment
3.5 Automatic, Mechanical and Electronic Equipment

TOPIC 4: MATERIALS MANAGEMENT

4.0 Introduction
4.1 Purchasing
4.2 Raw Materials
4.3 Packaging Materials
4.4 Intermediate and Bulk Products
4.5 Finished Products
4.6 Rejected and Recovered Materials
4.7 Recalled Products
4.8 Returned goods
4.9 Reagents and Culture Media
4.10 Waste Materials
4.11 Reference standards
4.12 Miscellaneous Materials

TOPIC 5: QUALITY MANAGEMENT

5.0 Introduction
5.1 Quality Assurance
5.2 Components of Q.A.
5.3 Good Manufacturing Practice

TOPIC 11: SAFETY AND ENVIROMENTAL PROTECTION

11.0 Introduction
11.1 Safety
11.2 Environmental Protection and Procedures

TOPIC 12: STERILE PHARMACEUTICAL PRODUCTS

12.0 Introduction
12.1 Personnel
12.2 Building and Premises
12.3 HVAC system
12.4 Water and Steam System
12.5 Equipment
12.6 Processes
12.7 Sterilization
12.8 Quality Control
12.9 Sanitation
12.10 Finishing of Sterile Products
12.11 Documentation
12.12 Documents and Formats

TOPIC 13: PHARMACEUTICAL QUALITY AUDITS

13.0 Plant Level documentation
13.1 Plant Level Department wise Quaternaries
13.3 Principle of Quality Audit

M-V-1 Advanced Quality Assurance Techniques (cGMP & Documentation). (Practicals 6 hrs/week)

1. Learning different programming languages, writing programmes for simple calculation, statistical analysis, data acquisition, processing and retrievals.
2. Physical and Chemical Examination of plastic containers.
3. Examination of labels, cartons and other printed materials.
4. Designing of following key documents
    a. Site master file
    b. SOP on SOP
    c. Mpcr / Bpcr (For sterile & non-sterile products)
    d. Change contract format
    e. Product complaint document
    f. Internal audit document
    g. Product recall document
    h. IPQC document
    i. Material receipt, sampling, dispensing & storage document
5. Experiment & documentation of dissolution test
6. IPQC tests for Tablets / Capsules / Injections / Liquid / Ointment

Recommended Books:

1. Pharmaceutical Quality Assurance, M.A. Potdar, Nirali Prakashan, Pune.
2. Current Good Manufacturing Practices, M.A. Potdar, Pharma-Med Press, Hyderabad.
3. GMP for Pharmaceuticals, 5th Edition, Sidney H. Willing, Marcel Decker Series
4. Regulatory guidelines related to GMP by
    a. Australian code of GMP for medicinal products, 16th Aug. 2002.
    b. 21 Code of Federal Regulation, parts 210, 211 & 58. (USFDA guidelines)
    c. MHRA, UK Guidelines on GMP
    d. GMP Guidelines by Medicines Control Council of South Africa
    e. Schedule M of D & C Act
5. Assurance of Quality, Pharmaceutical Total Quality Approach, M. S. P. Khan, Chitgaon, Bangladesh, Signet Press-1990

SEMESTER-II

M-3 Drug Regulatory Affairs

(Theory 3 hrs/week)

Sr. No.	Contents
1	Legislation to regulate the profession of pharmacy – The Pharmacy Act 1948.
2	Legislation to regulate, import, manufacture distribution and sales of drugs, cosmetics- The Drugs & Cosmetic Act 1940 & rules 1945 with amendments.
3	Legislation to control the advertisements, excise duties & prices of drug The Drugs and Magic Remedies Act & Rules (Objectionable advertisements) The Medicinal & Toiletry preparations (The Excise Duties Act- 1955 & Rules 1976) The Drug Price Control Order 1985
4	Legislation to control the operations relating to dangerous drugs & opium. Narcotic Drugs & Psychotropic Substance Act 1985
5	Aims, objects and salient features of following legislations governing Pharmaceutical Industry- Pollution Control Act Prevention of Food Adulteration Act 1954 Industrial Development & Regulation Act 1951 Consumer Protection Act
6	Standard institutes & certification agencies like ISI, BSS, ASTM, SO, WHO, US-FDA, UK-MCA, TGA
7	New Drug Application
8	Management of Intellectual Property in Drugs & Pharmaceuticals
9	Indian Patent Act 1970 and amendments there under, Copyright (Indian) Act
10	Pollution & Environment Control Act

11	Consumer & Environment Control Act
12	Drug Master File (Case Study-3 examples)
13	Material Safety Data Sheet (MSDS) preparation
14	Industrial Safety & Health
15	Guide lines for filing in countries like US & EU Good Clinical Practice Guideline Good Laboratory Practice Guidelines GMP Guidelines.
16	Drug Regulatory Agencies-Historical perspectives, organization structure activities & responsibilities: India, US, EU, Japan
17	Study of compendia – Evolution, Study of parts of compendia like: Policies, General notices, Monographs, Comparative picture of IP, USP, BP, EP&GP

Recommended Books: -

1. Forensic Pharmacy by B.S. Kuchekar, A. M. Khadatare and S. C. Jitkar, 6th Ed., Nirali Prakashan
2. Drugs and Cosmetics Laws by Krishnan Arora, Professional Book Publishers, New Delhi
3. Mittal B.M., A Textbook of Forensic Pharmacy, 9th Ed., Vallabh Prakashan
4. James Swarbrick, James C Boylon, Encyclopedia of Pharmaceutical Technology, 2nd Ed. Marcel Dekker Inc.
5. Deshpande S.W., Drugs and Cosmetic Act.1940
6. Bubuarm N.R, Whatever one should know about patent, 2nd Ed., Pharma Book Syndicate
7. Gnarino Richard A, New Drug Approval Process, 3rd Edition, Marcel Dekker Inc
8. Deshpande S.W, Drug and Magic Remedies Act 1954.
9. P. Warayan, Intellectual Property Laws, Eastern Law House.
10. Drug and Cosmetic Act 1940, Eastern Book company by Vijay Malic, 11th Ed. Patents for Medicine, by N. B. Zareri, Indian Drug Manufacturers Association (IDMA)
11. Pharmacy Law and Ethics by Dale and Appelbes, The Pharmaceutical Press, Joy Winfield.

M-I-3 Formulations & Development

(Theory 3 hrs/week)

Sr. No	Contents
1	PACKAGING OF PHARMACEUTICALS: Regulatory perspective of selection and evaluation of Pharmaceutical packaging materials for conventional dosage forms, sterile formulations and Novel drug delivery Systems.
2	SOLIDS: Basics of process automation of solid dosage form production. Study of newer excipients used in Gastro retentive Drug Delivery Systems, Mucoadhesive Systems, and Colon specific Drug Delivery Systems and sustained release Drug Delivery Systems, pulsatile drug delivery systems. Formulation development of mouth dissolving tablets, taste masking formulation, sublingual and buccal formulations.

3	LIQUIDS: Study of advances in liquid formulation including multiple emulsion, micro emulsion including Self Emulsified Drug Delivery Systems and Self Micro Emulsified Drug Delivery Systems.
4	SEMISOLIDS: Semisolid formulation with special reference to penetration enhancers. Emulgels, semisolids based on Liposomes, Niosomes.
5	INHALATION AEROSOLS: Inhalation products- Types and clinical role. Basic components of aerosol formulations. Therapeutic aerosols, Metered Dose Inhalers, Dry powder inhalers etc. Detailed discussion on propellants, package and filling technology. Quality assurance of components and formulations
6	VETERINARY DOSAGE FORMS: Need & problems of designing veterinary dosage forms. Specialized dose dispensers. Formulation strategy with special reference to dosage forms administered via feed or drinking water. Brief idea about quality control & regulatory aspects.
7	NANOPHARMACEUTICALS: Generation and significance of Nano-Pharmaceuticals like nanosuspensions, nanogels, nanocarrier systems

Recommended books:

1. Applied production and operations management; By Evans, Anderson, Sweeney and Williams.
2. Advances in Pharmaceutical Sciences Vol. 1-5; By H.S. Bean & A.H. Beckett.
3. Pharmaceutical Dosage forms: Disperse systems, Vol, 1-2; By Leon Lachmann.
4. Modern Pharmaceutics; By Gilbert and S. Banker and Christofer T. Rhodes, Fourth Edition, Marcel Decker Series.
5. Remington's Pharmaceutical Sciences. 21-st editions, Vol. I-II Lippincott Williams and Wilkins.
6. H.G.Brittain, Physical Characterization of Pharmaceutical solids, Marcel Dekker
7. Advanced Pharmaceutics: Physicochemical principles by Cherng-Ju uim, 2004. CRC Press.
8. J. C. Salomon's Polymeric materials encyclopedia.
9. Physical characterization of Pharmaceutical Solids edited by H. T. Brittain. Volume 70. Marcel-Decker Series.

M-I-3 Formulations & Development

(Practicals 6 hrs/week)

Sr. No.	Contents
1	To perform quality control tests for a given sample of polyvinyl chloride.
2	To determine stability constant of β cyclodextrin complex of drug using phase solubility analysis.
3	Optimization of designing of dosage forms by 2^2 or 2^3 factorial design

4	To compare the dissolution efficiency of a drug in plain and as a solid dispersion prepared by any one suitable method.
5	To prepare mouth-dissolving tablet of nimesulide and compare its release with marketed product.
6	To prepare and evaluate transdermal drug delivery system.
7	To prepare liposome and determine particle distribution and drug entrapment efficiency.
8	To prepare magnetic microshere of a drug using egg albumin and gama ferric oxide.
9	To compare the release of drug through rat skin and egg membrane.

M-I-4 Novel Drug Delivery Systems

(Theory: 3Hrs/ week)

Sr. No.	Contents
1	**Fundamentals of Controlled Release Drug Delivery**: Influence of drug properties and routes of drug administration on the design of sustained and controlled release systems.
2	**Oral controlled drug delivery systems**: Formulation, fabrication and evaluation of various oral controlled drug delivery systems including gastro retentive, colon targeted and pulsatile drug delivery.
3	**Parenteral controlled release system**: Scope, terminology & techniques used, injectable controlled release, formulation. Long acting contraceptive formulations. Implantable drug delivery, micro spheres liposomes & quality control.
4	**Mucosal drug delivery models:** Buccal, rectal, nasal, mucosal & vaginal drug delivery. Mechanisms of transports of drugs through mucosal routes, penetration enhancers, formulation development, in-vitro, ex-vivo and in-vivo methods of evaluation (for each route).
5	**Transdermal drug delivery system**: Permeation through skin including mechanism, permeation enhances, In-vitro skin permeation, technologies for developing transdermal drug delivery system & evaluation parameters.
6	**Site specific drug delivery system:** Active & passive targeting, resealed erythrocyte, monoclonal antibodies drug targeting particulate carrier system, specific drug delivery to targeted organs like brain & colon, freeze drying of Parenteral, environmental controlled Parenteral manufacturing.
7	**Ocular Drug Delivery**: Ocular delivery mechanisms & development of Ocular controlled release systems.
8	**Protein & peptide drug delivery system:** Physical aspects, biochemistry of protein drug (structure, properties & stability- Mechanisms of destabilization. Techniques of stabilization of Proteins and Peptides.) General methods of analysis of protein & peptide drugs, barrier to transport & Pharmacokinetics, different route of delivery, practical considerations. Importance of pre-formulation & formulation considerations, toxicity immunogenicity, stability &

	regulatory perspective.
9	**Regulatory consideration in controlled release**: Modification requirements to demonstrate safety, efficiency & controlled release nature. Bioavailability, assurance, WHO & Indian condition.

Recommended Books:

1. Remington's pharmaceuticals sciences. 21 st Edition, Lippincott Wiilliams and Willkins- Vol. I & II
2. Novel drug delivery system – Marcel Dekker N.Y. Second Edition, Revised and Expanded by Yie W. Chien. Vol- 50.
3. Controlled drug delivery system – Vicent H.L., Marcel Dekker Second Edition, Revised and Expanded by J. R. Robinson and Vincent H. L. Lee. Vol- 29.
4. Bentley's textbooks of pharmaceuticals – E.A. Rawlin
5. Novel and controlled drug delivery systems – N.K. Jain
6. Advances in Novel and Controlled Drug Delivery- N.K. Jain
7. Chien, Y.W.: Novel Drug Delivery Systems, Marcel Dekker, New York and Basel
8. Robinson, J.R. & Lee, V.H.I.,: Controlled and Novel Drug Delivery Marcel Dekker, New York.

(M-II-3) Advanced Medicinal Chemistry

(Theory 3 hrs/week)

1. **Microorganism in drug development**: Microbial conversions of drugs like steroids, prostaglandins and antibiotics. These should include some biotechnology-oriented chapters like enzymes immobilization techniques.
2. **Molecular concept of drug receptor interactions.**
   Advances in following classes of receptors and their drug ligands, Opioid, Dopamine, Adrenergic, Cholinergic, Histamine, 5-HT_{IA}, GABA.
3. **Synthesis** of following drugs describing reaction conditions mechanism and strategies involved in the synthesis: Gefitinib, Cetrizine, Fexofenadine, Linezolide, Risperidone, Ziprasidone, Diazepam, Dapsone, Ethinyl estradiol, Vit. B, Diphenhydramine.
4. **Combinatorial chemistry**: solid phase synthesis, Different types of polymer supports, linkers, Strategies of library synthesis and characterization
   Solid phase strategies
   a. General strategies and concepts
   b. Specific implementation issues
      i . Solid support
      ii Anchoring chemistry
      iii. Coupling chemistry
      iv. Protection schemes
      v. Analytical methods
   c. Solution phase analysis

5. **Gene therapy**: A brief introduction, concept with suitable examples, scope, techniques and application.
6. Brief introduction to QSAR and CADD.

(M-II-3) Advanced Medicinal Chemistry
(Practical: 6 hrs/week)

1. Synthetic studies of any four drugs mentioned in the point (3) of the theory syllabus.
2. Determination of partition coefficient, refractive index & ionization constant of drugs using RPHPLC & RPTLC.
3. To perform a regression analysis of a series of bioactive compounds from a reputed scientific publication and develop a mathematical QSAR relationship with its complete interpretation. (This research paper should not have QSAR study).
4. Microwave assisted synthesis of any five compounds.

Books Recommended

1. Foye: Principles of Medicinal Chemistry, 6th ed. (Lippincott).
2. Ariens: Medicinal Chemistry Series.
3. Ellis and West: Progress in Medicinal Chemistry Series.
4. Butterworthser: Progress in Medicinal Chemistry Series.
5. Burgers Medicinal chemistry-The Basis of Medicinal chemistry by Manfred E. Wolff part-I (John Wiley & Sons).
6. Medicinal chemistry – The Role of organic chemistry in drug research by S.M.Roberts and B.J.Price.
7. Vogel's Textbook of practical organic chemistry by Arthur I Vogel (ELBS and Lognman)
8. Organic Chemistry of Drug Design and Drug Action – R. B. Silverman
9. The Organic Chemistry of Drug Synthesis (3 volumes) by Daniel Lednicer & Laster A. Mitscher (John Wiley & Sons).
10. An Introduction to Organic Laboratory Manual by Pavia, Lampman and Chris.
11. Principles of Organic and Medicinal Chemistry – Munson.
12. Comprehensive Medicinal Chemistry – Hansch and Leo.

M-II-4 Drug Design
(Theory 3 hrs/week)

1. A general study of co-relation of physicochemical properties and stereochemistry and drug action. Isosterism and bio-isosterism as guides to structural variations, metabolite, antagonism and theory of drug action.
2. An overall treatment of various approaches to drug design including the method of variation, e.g. – Fibonacci search, Topliss tree, Craigs plot, Simplex methods, and Cluster analysis.
3. Quantitative Structure-Activity Relationships (QSAR) with detail coverage of Hansch's Liner method, Free and Wilson methods, mixed approached principal component analysis and application of above.

4. Drug design based on antagonism and enzyme inhibition.
5. Computer Aided Drug Design
   Basic concept of computational chemistry like Quantum Mechanics, molecular mechanics, Force fields, Energy minimization, conformational reaction, Molecular Dynamics. Liqand based drug design based on active site of receptor/enzyme.
   Indirect Drug Design – Analog approach, Pharmacophore mapping, Template forcing, Excluded volume & shape analysis, artificial intelligence methods.
6. Drug metabolism based drug design – Prodrugs design.

Books recommended

1. Ariens-Drug Design, Vol. VII.
2. Smith-William-Introduction to the Principle of Drug Design.
3. Woodridge-Progress in Pharmaceutical Research.
4. Introduction to the Principles of Drug Design by John Smith & Hywel Williams (Wright PSG).
5. Guide to Chemical Basis of Drug Design by Alfred Burger (John Wiley & Sons)
6. Burgers Medicinal chemistry-The Basis of Medicinal chemistry by Manfred E. Wolff part-I (John Wiley & Sons).
7. Computer Assisted Drug Design By Edward. C. Olson (American Chemical Society, ACD symposium series 112).
8. Medicinal Chemistry – The Role of Organic Chemistry in Drug Research by S. M. Roberts and B. J. Price.
9. Principals of Medicinal Chemistry – Foye.
10. Comprehensive Medicinal Chemistry by Hansch & Leo, Vol. 4.

M-III-3 Clinical Pharmacology
(Theory 3 hrs/week)

Clinical research

1. New Drug discovery process and Role of Clinical evaluation of new drugs: Terminologies, Organization, types of clinical research, phases of clinical research, Ethics and Protocol for Clinical Trials.
2. Therapeutic drug monitoring principles

Pharmacotherapeutics of following Diseases: Management and Clinical Practice Guidelines

3. Hypertension, congestive heart failure, angina pectoris, acute myocardial infarction, cardiac arrhythmia, atherosclerosis, peripheral vascular disorders and coagulation disorders,
4. Pain
5. Gastrointestinal diseases: Peptic ulcer, nausea and vomiting, diarrhea and constipation.
6. Renal diseases: Acute and chronic renal failure, renal dialysis and transplantation, drug doses in renal impairment.

7. Respiratory diseases: asthma, chronic obstructive pulmonary edema. Pulmonary embolism.
8. Hepatic disorders: cirrhosis, hepatitis
9. Immunopharmacology: Current concepts in theory and research of drugs for AIDS, vaccines and sera, drug allergy, tissue transplantation, immunostimulants, immunomodulators, immunosuppressant. Knowledge of various *in vitro* and *in vivo* tests carried out in immunological investigation.
10. Infectious diseases: General Guidelines for Rational Use of Antibiotics. Resistance to antibiotics
11. Neoplastic disorders: General principles of cancer chemotherapy

***Recommended books*:**

1. Roger and Walker; Clinical Pharmacy and Therapeutics, Churchill, Livingston, London
2. Dipiro, Joseph L.; Pharmacotherapy: A Pathophysiological Approach, Elsevier
3. Tussle, T.G.: Pathology and Therapeutics for Pharmacists: A Basis for Clinical Pharmacy Practice, Chapman and Hall, New York
4. Herfindal, E.T. and Hirschman, J L.; Clinical Pharmacy and Therapeutics
5. Koda and Kimble; Applied Therapeutics: The Clinical Uses of Drugs
6. Relevant Reviews Articles from Medical and Pharmaceutical Literature
7. Scott, L.T; Basic skills in interpreting laboratory data, American Society of Health System Pharmacist
8. Davidson's Principles of Internal Medicine, Vol-I And II, 14th Edition, Mc Graw-Hill
9. Harrison's Principle And Practice Of Medicine, 18th Edition, Churchill, Livingston, London
10. Chaudhari, Quintessence of Medical Pharmacology; Central Publishers, New Delhi
11. Kundu, A.K.; Bedside Clinics in Medicine, Academic Publishers, Part-I and II
12. Balakrishan, K.V., Komar's Manual of Medical Prescriptions, Paras Publications
13. Oxford Textbook of Medicine, Blackwell Science
14. Panda, U.N., Textbook of Medicine, CBS publisher, New Delhi
15. Ananth J; Treatment of Psychiatric Disorders, Jaypee Brothers, New Delhi
16. Misbahuddin, M, Chaudhari, M.A., Jalil, A; Community Pharmacology, Jaypee, New Delhi
17. Patten, J; Neurological Differential Diagnosis, 2nd Edition
18. Bickley, L.S., Bates's Guide to Physical Examination and History Taking, Lippincott
19. Walton, J.; Boain's Diseases of Nervous System, Tenth Edition

M-III-3 Clinical Pharmacology
(Practical, 6hr/week)

1. Bio assays of Ach, Histamine, Oxytocin, Adrenaline, Pancuroniuum
2. Monitoring of any one marketed drug in biological fluids

3. Determination of pA_2 values of any one antagonist.
4. Evaluation of antiparkinson agents
5. Evaluation of diuretics agents
6. Evaluation of antidepressant agents

Recommended books

12. Burn, J.H., Practical Pharmacology, Blackwell Scientific, Oxford London
13. Ghosh, M.N.: Fundamental of Experimental Pharmacology
14. Jaju B.P., Pharmacology: A practice exercise book. Jaypee Brothers, New Delhi
15. Lawrence, D.R. and Bacharch, A.L.; Evaluation of Drug Activities, Pharmacometrics, Academic Press
16. Kulkarni, S.K.; Handbook of Experimental Pharmacology, Vallabh Prakashan, New Delhi
17. Perry, W.L.M., Pharmacological Experiments on Isolated Preparations, E & S, Livingston, London
18. Sheth, U.K., Dadkar, N K. and Kamat, U.G., Selected Topics in Experimental Pharmacology, (Kothari Book Depot, Mumbai)
19. Thomson, E.B., Drug Bioscreening, VCH, New York
20. Turner, R.A., Screening Methods in Pharmacology, Academic Press, London
21. Vogel, H.G. and Vogel, W.H.: Drug Discovery and Evaluation: Pharmacological Assays, Springer, New York

M-III-4 Molecular Pharmacology

(Theory 3 hrs/week)

1. **Molecular mechanism of drug action:** Receptor occupancy and cellular signaling systems such as G-proteins, cyclic nucleotides, calcium and phosphatidyl inositol. Ionic channels and their modulators.
2. **Endogenous bioactive molecules** such as cytokines, neuropeptides and their modulators, neurosteroids, nitric oxide, phosphodiestrase enzyme and protein kinase C, arachidonic acid metabolites, COX-2 regulators and their role in inflammation, endothelium derived vascular substances (NO, endothelins) and their modulators. Pharmacology of atrial peptides, reactive oxygen intermediates, antioxidants and their therapeutic implications.
3. **Recent trends on different classes of receptors and drugs acting on them**
   a) Angiotensin receptors
   b) Excitatory amino acid receptors
   c) Kinin receptors
   d) Adrenoceptors
   e) Low molecular weight heparins, hirudins and GP II/IIIa receptor antagonists
   f) Imidazole receptors
   g) Cholinergic receptors
   h) Dopamine receptors
   i) Serotonin receptors
   j) Hormone receptors

k) GABA and Benzodiazepine receptors
l) Opiod receptors
m) Purinergic receptors
n) Glutamate receptors

4. Ion channel and their modulators: calcium, potassium, sodium and chloride channels
5. Apoptosis: pharmacological and clinical implications
6. Adhesion therapy and cardiac and vascular remodeling
7. Basic Concepts of Chronopharmacology and their implications to Drug Therapy.
8. Basic concepts of high throughput screening
9. Immunopharmacology: antibody dependent and cellular cytotoxicity.
10. Concept of gene therapy and recent development in the treatment of various hereditary diseases. Transgenic mouse and its applications. Human genome mapping and its potential in drug research.

Recommended Books:

1. Katzung, B.G; Basic and Clinical Pharmacology, Lange Medical Publisher, USA
2. Barar, F.S.K., Essentials of Pharmacotherapeutics; S. Chand and Company, New Delhi
3. Bowman, W.C. and Rand, M.J.; Textbook of Pharmacology, Blackwell, Oxford
4. Melmon, K.L., and Morelli; Clinical Pharmacology: Basic Principle of Therapeutics, Mc Millan, New York
5. Craig, C.R. and Stitzel, B.E.; Modern Pharmacology, Little Brown and Co, Boston
6. Drill, V.A.; Pharmacology in Medicine, McGraw Hill, New York
7. Grollman Pharmacology and Therapeutics, Lea and Tebiger, Philadelphia
8. Bacq Z.M., Cepek, Fundamentals of Biochemical Pharmacology
9. Avery, G.S., Drug Treatment, Adis Press, Sydney
10. Goodman and Gilman; Pharmacological Basis of Therapeutics, Mc Graw Hill
11. Rang, H.P., Dale, M.N., Pharmacology, Churchill Livingston, UK

M-IV-3 Phytochemistry & Phytopharmaceuticals
(Theory 3 hrs/week)

1. **Phytochemical screening of crude drugs:** Extraction, isolation, purification, characterization of following phytoconstituents.
   Alkaloids: Caffeine, Atropine, Ergometrine Morphine
   Glycosides: Digoxin, Sennosides
   Flavonoids: Rutin, Quercetin
   Terpenoids:Taxol, Pyrethrin
   Saponins: Glycyrrhizinic acid, Diosgenin

2. **Structrural illucidation** of above isolated phytoconstituents.

3. **Standardization of following phytopharmaceuticals by:** UV, IR, HPLC, and HPTLC, GCMS techniques**.** Vasicine, Andrographolides, Phylanthin, Solasodine, Gingerol, Bacoside, Curcumin, Lupeol,

4. **Brief introduction to Pharmacological Screening Methods with example of Following category of medicinal herbs.**
   a) Hepatoprotecives
   b) Antidaibetics
   c) Antiepileptics
   d) Hypolipidaemics
   e) Antioxidants
   f) Anti-inflammatory, analgesics.

5. **Study of Herbal Extracts:** Processing, equipment and analytical profiles. Sterility, stability and preservation of extracts

6. **WHO Guidelines for assessment of crude drugs**.
   Evaluation of identity, purity, and quality of crude drugs.
   Determination of pesticide residue.
   Determination of Arsenic and heavy metals.
   Determination of Micro-organisms.

Reference Books

1. Trease and Evans, Pharmacognosy, Saunders Company, London.
2. Tyler, Brady, and Robbers, Pharmacognosy, Lea Febiger, USA.
3. Wallis T. E., Text Book of Pharmacognosy, CBS publishers & distribution, Delhi.
4. Kokate, Purohit, Gokhale, Pharmacognosy, Nirali Prakashan, Pune.
5. Rangari V.D., Pharmacognosy & Phytochemistry, Vol I, II, Career Publication, Nashik.
6. Agrawal O.P., Chemistry of Organic Natural Product, Goel Publication House, UP.
7. E. Ramstad, Modern Pharmacognosy, Mc-graw hill Book Company.
8. Shah and Quadri Text Book of Pharmacognosy.
9. Chopra, Indigenous drug of India.
10. Wealth of India.
11. Nadkarni, Material Medica.
12. Chaudhari R D, Herbal Drug Industry, Eastern publication.
13. WHO, Quality Control methods for medicinal plant material.
14. Mukherjee Pulok, Quality Control of Herbal Drugs, Business Horizons.
15. Ayurvedic Pharmacopoeia.
16. Indian Pharmacopoeia.
17. British Pharmacopoeia.
18. Martindale Extra Pharmacopoeia.
19. Wagner, Plant Drug Analysis.
20. Stal Egon, Thin layer chromatography.

21. Screening Methods of Pharmacology, by Robert Turner.
22. Biological Standardisation by, J. N. Barn, D. J. Finley and L. G. Goodwin

M-IV-3 Phytochemistry & Phytopharmaceuticals
(Practical 6 hrs/week)

1. Extraction, isolation, purification and characterization of important phytoconstituents belonging to different classes.

    a. Eugenol from Clove
    b. Sennosides from Senna
    c. Curcumin from Turmeric
    d. Glycerrhizin from Liquorice
    e. Hesperidine from Orange Peels
    f. Caffeine from Tea
    g. Strychnine and Brucine from Nux Vomica
    h. Cineole from Eucalyptus

2. Study of UV, Visible, IR Spectral data of some phytoconstituents
3. Study of HPLC and HPLTC (if possible) Techniques for some important phytoconstituents.
4. Antimicrobial screening of plant extracts
5. Screening of drugs for microbial count
6. Experiments based on WHO guidelines of quality control of medicinal plant materials

Reference Books

1. WHO, Quality Control methods for medicinal plant material.
2. Mukherjee Pulok, Quality Control of herbal drugs, Business Horiz.
3. Ayurvedic Pharmacopoeia.
4. Indian Pharmacopoeia.
5. British Pharmacopoeia.
6. Martindale Extra Pharmacopoeia.
7. Wagner, Plant drug analysis.
8. Standardisation of Botanicals by V.Rajpal, Vol.1, Eastern Publishers, New Delhi, 2002.
9. Quality Standards of Indian Medicinal Plants, Vol 1,ICMR, New Delhi.
10. The Practical Evaluation of Phytopharmaceuticals.by Brain & Turner.
11. Biological Standardisation by, J. N. Barn, D. J. Finley and L. G. Goodwin

M-IV-4 Industrial Pharmacognosy
(Theory 3 hrs/week)

Role of Medicinal Plants in National Economy
Economic growth potential in natural health and cosmetic products. Future economic growth. Development of herbal medicine industry.

Worldwide trade in medicinal plants and derived products.
Demand for medicinal plants and herbal medicine. Trends in worldwide trade of Medicinal plants. International trade. Major importing-exporting regions and countries.

Indian trade in medicinal and aromatic plants.
Export potential of Indian medicinal herbs. Indian medicinal plants used in cosmetics and aromatherapy. Spices and their exports.

Plant based industry and institutions involved in work on medicinal and aromatic plants in India.
Classification of medicinal plant based industry. Production and utilization of medicinal plants and their products in India. List of medicinal plants cultivated in India. Technology sources of some Indian medicinal plants.

Study of infrastructure for different types of industries involved in making standardized extracts and various dosage forms including traditional ayurvedic dosage forms and modern dosage forms.

Global regulatory status of herbal medicines.

Patents: Indian and international patent laws, Recent amendments as applicable to herbal/ natural products and processes Plant breeders right.

Reference Books

1. Textbook of Industrial Pharmacognosy, by A. N. Kalia, CBS Publishers and Distributors. New Delhi.
2. Trease and Evans, Pharmacognosy, Saunders Company, London.
3. Chaudhari R D, Herbal Drug Industry, Eastern publication.
4. PDR for Herbal Medicines, Second Ed., Medicinal Economic Company, New Jersey.

M-V-3 PHARMACEUTICAL VALIDATION
Theory (3 Hrs/week)

1. **Introduction to Pharmaceutical Validation:**
   Definition, Manufacturing Process Model, Government regulation, scope of Validation Advantage of Validation, Organisation for Validation, Validation Master plan, URS, D.Q., IQ, OQ & P.Q. of facilities.

2. **Calibration Master plan**

3. **Validation of Equipment**

Concept of URS, DQ, IQ, OQ & PQ, Validation of following equipment

- Dry Powder Mixers
- Fluid Bed and Tray dryers.
- Tablet Compression M/c.
- Dry Heat Sterilization/Tunnels
- Autoclaves
- Capsule filling machines.
- Validation of Integrated lines by media fill test.
- Validation of existing equipment.

4. **Vendor Certification**

5. **Utilities Validation**

Validation of Pharmaceutical Water System & pure steam, Validation of HAVC system
Validation of Compressed air

6. **Cleaning Validation**

Cleaning of Equipment, Cleaning of Facilities

7. **Analytical Method Validation**

General principles of analytical method validation, Validation of following analytical Instruments

- HPLC
- Dissolution test apparatus
- U.V./Visible spectrophotometers

8. **Process Validation**

Prospective, concurrent, retrospective & revalidation, Process validation of following formulations

- Coated tablets
- Capsules
- Ampoules & Vials
- Ointment/Creams
- Liquid Orals

9. **Computer System Validation**

M-V-3 PHARMACEUTICAL VALIDATION
Practicals (6 Hrs/week)

1. Validation of analytical method (minimum four exercises)
2. Validation of following equipment
    a. Autoclave
    b. Hot air oven

c. Powder Mixer (Dry)
d. Tablet Compression Machine

3. Validation of a processing area
4. Validation of at least two analytical instruments.
5. Cleaning validation of one equipment.

Recommended Books:

1. Pharmaceutical Process Validation, Second Edition, Ira R. Berry & Robert Nash, Marcel Dekker Inc.
2. Validation of Pharmaceutical Process (Sterile Products), Second Edition Revised & Expanded, F.J. Carleton and J.P. Agalloco, Marcel Decker Inc.
3. Pharmaceutical Quality Assurance, M.A. Potdar, Nirali Prakashan, Pune.
4. Current Good Manufacturing Practices, M.A. Potdar, Pharma-Med Press, Hyderabad.

M-V-4 QUALITY PLANNING AND ANALYSIS
(Theory) (3 Hrs /week)

1. Basic concepts of Quality
- Definition of Quality
- The quality function
- Managing for quality
- Perspective on Quality – Internal versus External

2. Quality Improvement and Cost Reduction
- Sporadic and chronic quality problems
- Need for quality improvement & cost reduction
- Causes of poor quality and high cost.
- Provide a remedy and prove its effectiveness for improving quality.
- Resistance to change
- Institute Controls to hold the Gains.

3. Control of Quality
- Definition of control
- Self control
- The control subject for quality
- Units of measure
- Setting a Goal for the Control subject
- The Sensor
- Measuring Actual performance
- Interpreting the difference between Actual performance and the goal.
- Taking action on the difference
- Continuous process regulation.

4. Developing: Quality Culture

- Technology and culture
- Theories of Motivation
- Create and Maintain Awareness of Quality
- Provide Evidence of management and empowerment
- Time to change the culture

5. Manufacturing

- Importance of manufacturing planning for quality
- Initial planning for quality
- Concept of controllability, self-control
- Defining quality responsibilities on the Factory floor
- Self Inspection
- Automated manufacturing
- Overall review of manufacturing planning
- Process quality audits
- Quality and production floor culture

6. Statistical Process control

- Definition and Importance of SPC
- Quality measurement in manufacturing
- Statistical control charts-general
- Advantages of statistical control
- Process capability
- Estimating Inherent or potential capability from a control chart analysis
- Measuring process control and quality improvement
- Pursuit of decreased process variability

7. **Inspection, test and Measurement**

- The terminology of Inspection
- Conformance to specification and fitness for use
- Disposition of Nonconforming product
- Inspection planning
- Seriousness classification
- Automated Inspection
- How much inspection is necessary?
- Inspection Accuracy
- Errors of Measurement

8. Inspection and test sampling plans

- The concept of acceptance sampling
- Economics of Inspections
- Sampling Risks: The operation characteristic curve
- Analysis of some rule of thumb sampling plans

- Evaluation of parameters affecting acceptance sampling plans
- Quality indices for acceptance sampling plans
- Types of sampling and Multiple sampling
- Characteristics of a good acceptance plan

9. **Quality Assurance General Concepts**
   - Definition of quality assurance
   - Concept of quality assurance
   - Quality audit- The concept
   - Subject matter of audits
   - Structuring the audit programme
   - Planning and performing audits of activities
   - Human relations in auditing.
   - Audit reporting
   - Essential ingredients of a quality audit programme
   - Quality surveys
   - Product audit
   - Sampling for product audit
   - Reporting the results of product audit.

Recommended Books:

1. Quality planning and Analysis, 5th Edition, J. M. Juran and F. M. Gryna, Publisher, Tata Mc-Graw Hill, India.
2. Improving Quality through planned experimentation By Moen: Tata McGraw Hill, India.
3. Statistical Quality Control by Grant – Publisher Tata McGraw Hill – India.
4. Juran's Quality Handbook, Fifth Edition, J. M. Juran , Publisher Tata McGraw Hill – India.

ELECTIVE SUBJECTS OF ALL SEMESTERS

I. Quality Control & Assurance of Pharmaceuticals.

(Theory) (3 **Hrs/Week)**

Note: Students of M. Pharm. in Quality Assurance Techniques cannot take this subject as elective.

Sr. No	Contents
1	**Quality control and Assurance technique:** Basis concepts of Quality:- Developing quality culture.

2	**Quality Assurance General Concepts:** Definition of quality assurance concept and components of Q. A., Good Manufacturing Practices, Quality control – The concept
3	**Personnel, Premises and Equipments:** Qualification, experience, training responsibilities and hygiene of personnel. Drainage system, Sewage, Sanitation, Lighting, maintenance of building and premises; Design, size, location, construction, cleaning and maintenance of equipments. Documents and formats related to personnel, premises and equipment.
4	**Material Management:** Purchasing, Raw material, packaging materials, Intermediate and Bulks products, Finished products, Rejected and recovered materials, recalled products, returned gods, Reagents and culture media, Waste materials, reference standards, Miscellaneous material. Documents and formats.
5	**Manufacturing operations and control:** Revised schedule M, sanitation of manufacturing premises, Mix –ups and cross contamination, processing of intermediates and Bulk product, Packaging operations, I.P.Q.C., Release of finished products process deviations, Drug product inspection, expiration dating, Document and formats.
6	**Documents and Records:** Specification, Master production and control record, Batch production and control record, Significance of SOPs and record, change control, Drug Master file, Documents and formats.
7	**Pharmaceutical Validation:** Definition & concept of validation, validation of building, equipments, instruments and facilities, process validation, cleaning – validation, validation master plan, Documents and formats.
8	**Quality control of Biological products:** International Biological standards, safety testing of pharmaceutical Quality control of antibiotics.
9	**Pharmaceutical Plant Audit:** Department wise documents and audit questionnaire.
10	**Sterile Pharmaceutical Products:** GMP aspects related to sterile products- General guidelines, personnel, building and premises, equipment, sanitation, processing, sterilization, Quality control and validation, Documentation

Recommended Books:

1. Pharmaceutical Quality Assurance, MA Potdar, Nirali Prakashan, Pune
2. Validation of Pharmaceutical process, F. J. Carleton and J. Agalloco, Marcel Dekker Inc.
3. Pharmaceutical Process Validation, Second Ed., Ira R. Ferry & Robert Nash., Marcel Dekker Inc.
4. Quality Planning & Analysis by J. M. Juran and F. M. Gryna, Tata Mcgraw Hill, India.
5. Improving Quality through Planned experimentation by Moen, Tata Mcgraw Hill.
6. Good Manufacturing Practices for Pharmaceutical; A Plan for total Quality Control, 4 th Ed, Sidney willing.
7. Quality Assurance Guide by Organization of Pharmaceutical producers of India.
8. Pharmaceutical Process Validation; By F. R., Berory and Robert A. Nash
9. Impurities Evaluation of Pharmaceutical; Satinder Ahiya Marcel Decker.

10. Quality Control of Packaging material in the Pharmaceutical Industry: Kenneth Harburn, Marcel Dekker.
11. Juran's Quality Control Handbook J.M. Jupron.4th Ed. Good design practices for GMP Pharmaceutical facilities. Andrew A Signature, Marcel Dekker.
12. cGMP for Pharmaceuticals. Pharma. Med. Press, I st edition by Manohar H. Potdar

II. **Pharmaceutical Plant Design and Operations**

(Theory 3 Hrs/Week)

Sr. No	Contents
1	Regulatory requirements of Pharma facilities with reference to cGMP, revised schedule M and Factory Act
2	Design, layout and operational facilities with services and utilities for Tablets, Capsules, Liquid orals, Ointments and Dry syrups.
3	Design, layout and operational facilities with services and utilities for sterile products powders ready for reconstitution
4	Design and operation of Q.C. Laboratory
5	Design of utility services - Water - stream- Compressed air and other gases
6	Design of effluent treatment plant
7	Designing of plant support services like security office, vehicle parking, fuel storage, canteen and cooking, garden and horticulture, scrap yards, Administrative block and training centre, sports and entertainment block, resident managers bungalow, residences for essential service staff, toilet facilities, medical services, crush

Recommended Books:

1. Project Management by Clifford F. Gray and Erik W. Larson Publisher: McGraw Hill company.
2. Pharmaceutical Production facilities: Design and applications by Graham Cole. Publisher: Taylor & Francis
3. Production/Operations Management by: El wood Bufa Publisher: Wiley Eastern Limited (New Delhi)
4. S. J. Turco; Sterile Dosage Forms: their Preparation and Clinical Applications; Lee and Febiger.
5. N. K. Jain; Controlled and novel drug delivery: CBS Publication.
6. J. R. Robinson and H. L. Lee; Controlled Drug Delivery: Fundamentals and Applications; Marcel Dekker.
7. F.J. Carleton and J.P.Agalloco; Validation of aseptic pharmaceutical processes: Marcel Dekker.
8. L. A. Trissel: Handbook on injectable drugs; American Society for Hospital Pharmacist Publication.

9. N.A. Halls; Achieving sterility in medical and pharmaceutical products; Marcel and Dekker.
10. Planning and control by: Samuel Eilon Publisher: Universal book corporation, Mumbai.

III. **Biopharmaceutics and Pharmacokinetics**

(Theory 3 **Hrs/Week)**

Sr. No	Contents
1	**Dissolution**:- Noyes- Whitney's dissolutions rate law, Study of various approaches to improve dissolution of poorly soluble drug, In – vitro dissolution testing models, In-vitro- In –vivo correlation.
2	**Bioavailability:-** Objectives and consideration in bio-availability studies, Concept of equivalents, Measurements of bio-availability, Determination of the rate of absorption, Bioequivalence and its importance, Regulatory aspects of bio-availability and bioequivalence studies for conventional dosage forms and controlled drug delivery systems.
3	Study of different *in-vitro* and *in-vivo* / biological models for determination of absorption, distribution, metabolism and excretion and permeability of drug
4	Study of physiological transporter systems like A B C. Dosage form design and physiological barriers like BBB, blood testis barrier and blood placental barrier
5	**Pharmacokinetics:-** Basic consideration, Pharmacokinetic models, Compartment modeling: One compartment model – IV bolus, IV infusion, Extra-vascular; Multi Compartment models; Two compartment model – Iv bolus, IV infusion, Extra-vascular, Three Compartment model in brie, Application of Pharmacokinetics in new drug development and designing of dosage forms and Novel drug delivery systems.
6	**Non-Linear Pharmacokinetics:-** Causes of non-linearity, Detection of non – linearity, Michaelis-Menten equation, Estimation of Km and Vmax .with respect to individualization of a drug
7	**Drug Distribution: -** significance and kinetics of protein binding and drug displacement interactions
8	Case studies based on pharmacokinetic principles
9	Determination of various pharmacokinetic parameters.

Recommended Books:

1. Biopharmaceutics and Pharmacokinetic, A Treatise, D. M. Brahmankar and Sunil B. Jaiswal, Vallabh Prakashan, Pitampura, Delhi
2. Current Concepts in Pharmaceutical Sciences: Biopharmaceutics, Swarbick. J, Lea and Febiger, Philadelphia.1970.
3. Clinical Pharmacokinetics Concepts and Applications 3rd edition by Malcolm Rowland and Thomas N. Tozer, Lea and Febiger, Philadelphia, 1987.

4. Dissolution, Bioavailability and Bioequivalence, Abdou. H. M. Mack Publishing Company, Pennsylvania, 1989.
5. Biopharmaceutics and Clinical Pharmacokinetics, an Introduction, 4th edition, revised and expanded by Robert, E. Notari, Marcel Dekker Inc, New York and Basel, 1987.
6. Biopharmaceutics and relevant Pharmacokinetics, by John. G. Wagner and M. Pernarowski, Ist edition, Drug Intelligence Publications, Hamilton, Illinois, 1971.
7. Encyclopedia of Pharmaceutical Technology, Vol 13, James Swarbrick, James. C. Boylan, Marcel Dekker Inc, New York, 1996.
8. Biopharmaceutics and Clinical Pharmacokinetics by Milo Gibaldi, 4th edition, Philadelphia, Lea and Febiger, 1991
9. Biopharmaceutics and Pharmacokinetics, A Treatise, D. M. Brahmankar and Sunil B. Jaiswal, Vallabh Prakashan, Pitampura, Delhi
10. Applied Biopharmaceutics and Pharmacokinetics by Shargel. L and Yu ABC, 2nd edition, Connecticut, Appleton Century Crofts, 1985.
11. Textbook of Biopharmaceutics and Pharmacokinetics, Dr. Shobha Rani R. Hiremath, Prism Books Pvt Ltd, Banglore, 2000.

IV. Sterile Products Formulation & Technology

(Theory 3 **Hrs/Week)**

Sr. No.	Contents
	A**) FORMULATIONS**
1	**Preformulation:** Physico-chemical properties of materials used in perenteral formulations. Selection of polymeric components. Selection of packaging components of packaging components.
2	**Formulation of SVP and LVP:** Requirement, components, materials, Pharmacopoeial requirements, special types of parenterals such as suspensions, emulsions, dried forms, Variables in formulation development.
3	**Ophthalmic Products:** Ocular anatomy and physiology relevant to ocular drug delivery, ocular Pharmacokinetics, conventional products, ocular inserts, particulate and liposome drug delivery, protein and peptide delivery.
4	**Sustained Release Parenterals:** Liposome's, and niosomes, nanoparticles, proteins and peptides, implants, loaded erythrocytes.
	B) TECHNOLOGY- Manufacturing of Parenterals
6	Layout of parenteral facilities, FFS and BFS technology for parenterals.
7	**Environmental control:** Temperature and humidity control, air handing systems and their validation.
8	**Industrial sterilization:** Large-scale sterilization processes, process selection, specifications, development and validation of process and equipment.
9	Parenteral devices such as syringes, cannula, catheters.
10	**Guidelines:** Overview of GMP and regulatory guidelines.
11	Hazards associated with parenteral therapy

Recommended Books:

1. K. E. Avis, H. A. Liebermann and Lachman; Pharmaceutical dosage forms: Parenteral Medications: Vol. 1,2,3, Marcel Dekker.
2. S. J. Turco Sterile Dosage Forms: their preparation and clinical application; Lee and Febiger.
3. N. K. Jain; Controlled and Novel drug delivery: CBS Publication.
4. J. R. Robinson and H. L. Lee; Controlled drugs delivery: Fundamentals and Applications; Marcel Dekker.
5. F. J. Carleton and J. P. Agalloco: Validation of aseptic pharmaceutical processes: Marcel Dekker.
6. L. A. Trissel: Handbook on injectable drugs; American Society for Hospital Pharmacist Publication.
7. N. A. Halls; Achieving sterility in medical and pharmaceutical products; Marcel and Dekker.

V. **Chemistry of Medicinal Natural Products.**

(Theory) (3 **Hrs/Week)**

1. Primary and Secondary metabolites in plants.
2. Various metabolic pathways in plants.
3. General isolation and purification techniques of phytochemicals covering alkaloids, glycosides, terpenoids, carbohydrates and flavanoids.
4. (a) Detailed chemistry and properties of Alkaloids (general)
   (b) Chemistry, structural elucidation by chemical and physical methods, methods of analysis for followings: Alkaloids, Morphine, Hyoscyamine, lobeline, atropine, caffeine, and ephedrine.
5. (a) Detailed chemistry and properties of plant steroids (general)
   (b) Chemistry, structural elucidation by physical and chemical methods, methods of analysis for following: (1) Solasodine. (2) Diosgenin.
6. (a) Detailed chemistry and properties of Flavanoids.
   (b) Detailed chemistry and properties of various plant pigments.
7. Detailed chemistry and properties of terpenoids.
8. Detailed Chemistry and properties of carbohydrates – mono & disaccharides.

Recommended Books:

1. Chemistry of organic natural products, Vol I and II by O. P. Agarwal.
2. Pharmacognosy by Trease and Evans, 13th Ed. (Baillier- Tindall)
3. Phytochemistry, Vol. I, II, III by Miller.
4. Organic Chemistry, Vol I by Finar.
5. Recent Advances in Phytochemistry V.C. Runeckles (Elenum Press).
6. Chemistry of Natural Products, P.S Kalsi
7. Natural Products Chemistry - K. Nakanishi Ed. , Vol I and II

VI. **Active Pharmaceutical Ingredients (APIs) Manufacturing Technology (Theory)** (3 **Hrs/Week)**

1. **Introduction to basic pharmaceutical and fine chemical chemistry:** Definitions of basic pharmaceuticals, intermediates, fine chemicals, heavy chemicals. Technology involved in manufacturing of pharmaceuticals. Unit processes in synthesis, biochemical processes in synthesis.
2. **Unit processes:** Study of the following chemical processes (with references to reagents, mechanisms, equipments and manufacture of drugs given below): Acylation, esterification, alkylation, amination, halogenation, hydrolysis, nitration, oxidation and reduction.
3. **Industrial processes & scale up techniques**
   Industrial manufacturing methods and flow charts of Sulphamethoxazole, Ciprofloxacin, Benzocaine, Adrenaline, Rifampicin, Aspirin and Pentothal sodium.
4. **Bioethics and Bio-Safety**
   Health hazards in manufacturing facility, The forms of Atmospheric contaminants, Chemical mixtures, Detection and sampling, Atmospheric contamination, industrial noise, criteria for hearing damage, Noise measuring instruments, effects of sound and ultrasound, the control of noise, vibration, Radiation Hazards, Radiation detection and measurement, personal protection, eye protection, Types of eye protection equipment. Finger & Arm protection, Foot & leg protection. Environmental protection laws related to industry.

Reference

1. M.G. Larians: Fundamentals of Chemical Engineering Operations.
2. W. L. Badger and Banchero: Introduction to Chemical Engineering.
3. L. Lachman-The Theory and Practice of Industrial Pharmacy.
4. Ganderton G.: Unit Processes in Pharmacy.
5. Groggin P. K.: Unit Processes in Organic Synthesis.
6. Marshall Sitting: Organic Chemical Processes.
7. Dryden C. L.: Outlines of Chemical Technology.

VII. Clinical Trials

(Theory) (3 **Hrs/Week)**

1. **Introduction to clinical Trial**
   History, terminologies, types of clinical research, phases of clinical research, role of clinical trial in new drug developments
2. **Regularly affairs in clinical trials**
   IND, NDA, ANDA- Parts and contents, Safety monitory boards, FDA in various countries including India
3. **Ethical issues in clinical trials**

Principal, responsible conduct, supervision of ethics, (Informed Consent, Institutional Review Board (Role responsibility, members and auditing), Protection of participants, The Nuremberg Code, The Declaration of Helsinki, The Belmont Report

4. **Clinical trial design**
   Designs used in clinical trials with their advantages and disadvantages, hypothesis, risks and benefits, subject selection, inclusion and exclusion criteria, randomization, blinding and controls
5. **Clinical trial protocol Development**
   Required Documentation including Investigator's Brochure, Case Report Forms, Serious Adverse Event (SAE) Reports, Laboratory Certification, data collection and quality control of data, closing out of clinical trial
6. **Good Clinical Practice**
   Concept, importance, and GCP guidelines including ICH guidelines
7. **Management of Clinical trials**
   Role and responsibilities of Stakeholders of clinical trials (FDA, CRO, Sponsor, Physicians, Nurses, Health professionals, Hospitals, Patient), monitoring of clinical trials, Publications of clinical trials
8. **Bioavailability, bioequivalence and Therapeutic Drug Monitoring**
   Concept, organization, advantages, special issues, applications, bioequivalence
9. **Data analysis issues in Clinical Trials**
   Monitoring of data, computer applications, statistical tests used, interpretation, survival analysis, sub-group analysis, Quality control of clinical trials

Recommended Books:

1. Dipiro, Joseph L.; Pharmacotherapy: A Pathophysiological Approach, Elsevier
2. Davidson's Principles of Internal Medicine, Vol-I And II, 14th Edition, Mc Graw-Hill
3. Harrison's Principle And Practice Of Medicine, 18th Edition, Churchill, Livingston, London
4. Roger and Walker; Clinical Pharmacy and Therapeutics, Churchill, Livingston, London
5. Herfindal, E.T. and Hirschman, J L.; Clinical Pharmacy and Therapeutics
6. Tussle, T.G.: Pathology and Therapeutics for Pharmacists: A Basis for Clinical Pharmacy Practice, Chapman and Hall, New York

VIII Safety Pharmacology

(Theory) (3 **Hrs/Week)**

1. **Definition and scope of safety pharmacology**
2. **Regulatory requirements for the new drug safety assessment:** ICH, OECD, USFDA, EMEA, Japan, MHW guidelines
3. **Principals and study design of safety evaluation**

a. Acute toxicity- rodent and non-rodent
b. Repeated dose studies (sub acute and chronic)
c. Analysis of safety pharmacological data

4. **Preclinical safety pharmacology**: In vitro and in vivo studies including genotoxicity, mutagenicity, carcinogenicity, reproductive and ocular toxicity, Safety testing for dermatological product
5. **Clinical Safety pharmacology:** definition, data collection, reporting methods and assessment and analysis of adverse event (AE) monitoring during clinical trials
6. **Pharmacovigilance:** Definition, collection of data, reporting, assessment of Post marketing surveillance, periodic safety update reports, Risk-benefit assessment

Recommended Books:

1. Sogliero-Gilbert, G., *Drug safety assessment in clinical trials*. Statistics, textbooks and monographs. 1993, New York: Dekker. x, 437 p.
2. Marx, U. and V. Sandig, *Drug testing in vitro : breakthroughs and trends in cell culture technology*. 2007, Weinheim: Wiley-VCH. xix, 298 p.
3. Gad, S.C., *Safety assessment for pharmaceuticals*. 1995, New York: Van Nostrand Reinhold. xv, 496 p.
4. Turner, J.R., *New drug development : design, methodology, and analysis*. 2007, Hoboken, N.J.: Wiley-Interscience. xxi, 270 p.
5. Dmitrienko, A., C. Chuang-Stein, and R.B. D'Agostino, *Pharmaceutical statistics using SAS : a practical guide*. 2007, Cary, N.C.: SAS Institute. ix, 444 p.
6. Smith, C.G. and J. O'Donnell, *The process of new drug discovery and development*. 2nd ed. 2006, New York: Informa Healthcare. 668 p.
7. Bénichou, C., *Adverse drug reactions : a practical guide to diagnosis and management*.1994, Chichester, West Sussex, England; New York: Wiley. xviii, 302p.
8. Mann, R.D. and E.B. Andrews, *Pharmacovigilance*. 2nd ed. 2007, Chichester, England ; Hoboken, NJ: John Wiley & Sons. xviii, 686 p.
9. World Health Organization., *WHO guidelines on safety monitoring of herbal medicines in pharmacovigilance systems*. 2004, Geneva: World Health Organization. vii, 18 p.
10. Cobert, B.L., *Manual of drug safety and pharmacovigilance*. 2007, Sudbury, Mass.: Jones and Bartlett Publishers. p.
11. Cobert, B.L. and P. Biron, *Pharmacovigilance from A to Z : adverse drug event surveillance*. 2002, Malden, MA: Blackwell Science. xiii, 235 p.

IX. Traditional Systems of Medicine & Ayurvedic Formulations

(Theory) (3 **Hrs/Week)**

1. Ethnopharmacognosy – General account.
2. A brief idea about Ayurveda. Chinese systems of medicine. Unani system of medicine. Homeopathy.
3. Comparative account of drugs used in above systems of medicine.
4. Ayurvedic dosage forms-Basic idea.
5. The formulation of Ayurvedic dosage forms : Churna, Bhasma, Kwatha Asava , Avaleha, Gutika, Watika Rasa, Rasayana, Taila Ghruta Guggulu Arka.

6. Ayurvedic Cosmetic formulations,
7. Standardization of Ayurvedic dosage forms using:
    a. Physical methods
    b. Chemical methods
    c. Biological methods.

Recommended Books:

1. Charaka Samhita
2. Sushrut Samhita
3. Sharangardhar Samhita
4. Ayurvedic formulary of India Govt of India.
5. Pharmacopocial standards for Ayurvedic drugs C.C.A.R.A., New delhi
6. Dravyagunavigyan
7. Homorpathic Materia medica.
8. World health W.H.O. 1977

X. Medicinal Plant Biotechnology

(Theory) (3 **Hrs/Week)**

1. Introduction to genetics & molecular biology.

a. Structural and molecular organization of Cell.
b. Genetic Material-DNA, RNA, Protein, Replication, Genetic Code, Regulation of Gene Expression, Structure & Complexity of Genome.
c. Cell Cycle, Cell signaling.
d. Mutation.
e. Recombinant DNA Technology –Principles, Tools, Process & Applications.

2. Methods of improving quality of crops & their application.

a. Plant Breeding.
b. Chemodemes.
c. Hybridization.
d. Mutation.
e. Polyploidy.

3. Tissue Culture

a. Types, Techniques & Application of Callus, Suspension, Haploid, Embryo, Organ and Immobilized Culture.
b. Organogenesis, Embryogenesis, Synthetic seed & Somaclonal variation.
c. Micropropagation.
d. Production of Secondary metabolites – Strategies involving use of Precursor, Growth regulators & Elicitors: Production of Shikonin.
e. Hairy Root Culture & Multiple Shoot Culture & their Applications.
f. Protoplast culture & Protoplast fusion.
g. Biotransformation.

4. Germplasm Conservation.

a. In- situ Conservation

b. In- vitro methods of Conservation.

5. Gene Transfer in Plants.

a. (i) Using vectors of Agarobacterium.

(ii) DNA Mediated gene transfer – Electroporation, Microprojectile, Macro & Microinjection, Liposomes, Ultrasonication & Chemical mediated gene transfer.

b. Localization of transferred gene in genetically modified plants:

i Nucleic acid Hybridization.

ii Use of Radioisotopes & Molecular Markers.

- Auto Radiography.
- Electrophoresis.

6. Applications of Transgenic Plants.

a. Resistance of herbicide.
b. Resistance to insect, fungus, & virus.
c. Resistance to Physiological stress.
d. Production of Phytopharmaceuticals.
e. Edible vaccine.

7. Gene Mapping & Molecular Maps of Plant Genomes.

a. Plant Chromosome Analysis.
b. Uses of PCR in gene mapping.
c. Molecular Maps-RFLP, RAPD.
d. Physical maps using in- situ hybridization.

8. Enzymes

a. Types & Properties of enzymes.
b. Isolation & Purification of enzymes.
c. Immobilization of enzymes & its applications.
d. Enzyme reactors.
e. Detailed study of Plant enzymes – Papain & Bromelain.

Recommended Books:

1. Pharmaceutical biotechnology S.P. Vyas and V.K. Dixit, CBS Publishers and Distributors, 2001
7. Advanced methods in plant breeding & biotechnology by David R. Murray. CAB International Panima book distributors.1991.
8. Plant tissue culture by Dixon IRL Press Oxford Washington DC, 1985.
9. Role of Biotechnology in Medicinal and Aromatic Plants Vol I & II By Irfan A Khan and Atiya Khanum Ukaoz Publications.1998
10. Plant Chromosome analysis, manipulation and engineering by Arun And Archana Sharma 1st Edition Harwood Academic Publishers 1999
11. Comprehensive Biotechnology by Murray Moo-Young Vol I- IV Pergamon Press LTD, 1985.
12. Transgenic Plants by R Ranjan Agrobotanica.1999

Recommended Journals:

1. Journal of plant biochemistry and biotechnology
2. Current Science

XI. Natural Products Management

(Theory) (3 **Hrs/Week)**

I) Farm Analysis & Farm Planning

- Management exercise before farm planning / analysis.
- Appraisal of farm resources, capital resources, management factor, land resources, Enterpreural aspects
- Management of resources: land, labour, machinery & equipment.
- Farm planning & budgeting.
- Application of research in farm management.

II) Marketing

- Demand & Supply: Meaning, factors affecting demand & supply.
- Market: Meaning process of a agricultural marketing.
- Processing practice & industries in India.
- Study of co-operative processing / efforts among collectors & growers to store, transport & market the natural products.
- Processing of cocoa and oil seeds.
- Mechanization / Modernization of natural products market.

III) Prioritized Medicinal Plant of India

- Protocols for cultivation & quality control.
- State wise natural habitat of prioritized species.
- Cultivation economics / project proposal for few prioritize species.
- Ex-situ / in-situ cultivation & conservation.
- National & International Trade of prioritized species.

IV) Concerned ministers / Departments / Organization / State / UT Government on policy matters

- Relating to scheme & programmers for development of medicinal plants in India.

V) Study of General Requirement to establish extraction unit based on herbs/ Herbal products.

VI) Patent Right & IPR in relation to medicinal herbs and herbal products.

VII) Import – export of natural Products –

Legal requirement & processing / techniques for marketing of raw material & value-added products (Medicine, food supplements, herbal cosmetics)

VIII) Review of Trade of herbs, phytoconstituents, Nutraceuticals & other. National medicinal products in national & international market.

Recommended Books:

1. Text Book of Agricultural Business Management, Kalyani Publisher, New Delhi, Brodway A C.
2. Acharya S.S. and Agrawal N.N. Agriculture Marketing in India, Oxford IDH Publication, New Delhi.
3. Memoria C.B. and Joshi Principal and Marketing in India, Kitab Mahal Agency, New Delhi.
4. Das Dilipkumar, Introductory Soil Science Kalyani Publisher, New Delhi.
5. Chaudhary – Herbal Industries
6. Kapoor & Attal – Cultivation and Utilization of Medicinal Plants.
7. Kapoor & Attal – Cultivation and Utilization of Aromatic Plants.
8. Chopra – Indigenous Drugs.
9. Wealth of India NISCAIR Publication, New Delhi.
10. www.nmpb.nic.in.
11. Official Journals, Periodicals, Magazines, Bulletin, Newspapers & Website be referred..