SHREEMATI NATHIBAI DAMODAR THACKERSEY
WOMEN'S UNIVERSITY
Pariksha Bhavan, Juhu Road, Santacruz (W), Mumbai – 400 049

Ph.D. Entrance Test (PET)

IMPORTANT NOTE:

The written test will consist of two parts: (i) Research Methodology (50 marks) and
(ii) Subject Specific (50 marks).
Total - 100 marks
Total – 100 Questions

Duration & Timing of Entrance Exam – **MCQ Pattern**

All questions shall be with multiple choices, each correct answer carries 1 mark. No negative marking system.

Standard of passing –
General Category – 50% marks
Reserved Category – 45% marks

Candidate shall be admitted to Ph.D. Programme by two stage process through –

a) Entrance Examination, which shall be qualifying test. The Entrance Examination will be of 100 marks with multiple choice type questions.

b) Personal Interview of candidate s who qualifies in Entrance Test/ Candidates exempted from Entrance Examination to be conducted as per procedure prescribed in due course.

Syllabus for Ph. D. Entrance Examination (PET)

in the subject of

PHARMACY

(Effective from the year 2014)

Module 1	Pharmaceutics, NDDS and Related subjects
Contents	**Topics Covered**
	Pharmaceutics and Formulation development • **Designing & Evaluation of Liquid Dosages Forms:** Introduction, types of additives used in formulations, vehicles, stabilizers, preservatives, suspending agents, emulsifying agents, solubilizers, colors, flavors and others, manufacturing packaging, labeling, evaluation of clear liquids, suspensions and emulsions official in Pharmacopoeia • **Designing & Evaluation of Semisolid Dosage Forms:** Definitions, types, mechanisms of drug penetration, factors influencing penetration, semisolid bases and their selection. General formulation of semisolids, clear gels manufacturing procedure, evaluation and packaging • **Designing & Evaluation of Suppositories:** Ideal requirements, bases, displacement value, manufacturing procedure, packaging and evaluation; • **Extraction and Galenical Products:** Principle and method of extraction, preparation of infusion, tinctures, dry and soft liquid extracts; Blood Products and Plasma Substitutes: Collection, processing and storage of whole human blood, concentrated human RBCs, dried human plasma, human fibrinogen, human thrombin, human normal immunoglobulin, human fibrin, foam plasma substitutes, - ideal requirements, PVP, dextran etc. for control of blood pressure as per I.P. • **Designing & Evaluation of Pharmaceutical Aerosols:** Definition, propellants, general formulation, manufacturing' and packaging methods, pharmaceutical applications

	• **Designing & Evaluation of Ophthalmic Preparations:** Requirements, formulation, methods of preparation, labeling, containers, evaluation • **Designing & Evaluation of Capsules:** Advantages and disadvantages of capsule dosage form, material for production of hard gelatin capsules, size of capsules, formulation, method of capsule filling, soft gelatin, capsule shell and capsule content, importance of base absorption and minimum/gm factors in soft capsules, quality control, stability testing and storage of capsule dosage forms • **Micro-encapsulation:** Types of microcapsules, importance of microencapsulation in pharmacy, microencapsulation by phase separation, coacervation, multi-orifice, spray drying, spray congealing, polymerization complex emulsion, air suspension technique, coating pan and other techniques, evaluation of micro capsules • **Designing & Evaluation of Tablets:** Advantages and disadvantages of tablets, Formulation, evaluation and applications of different types of tablets, granulation, technology on large-scale by various techniques, different types of tablet compression machinery and the equipments employed. **Coating of Tablets**: Types of coating, film forming materials, formulation of coating solution, equipments for coating, coating process, evaluation of coated tablets. • **Stability kinetics and quality assurance** • **Designing & Evaluation of Parenteral Products:** Pre-formulation factors, routes of administration, water for injection, and sterile water for injection, pyrogenicity, non- aqueous vehicles, isotonicity and methods of its adjustment, Formulation details, Containers and closures and selection, labeling; Pre-filling treatment, washing of containers and closures, preparation

	of solution and suspensions, filling and closing of ampoules, vials, infusion fluids, lyophilization & preparation of sterile powders, equipment for large scale manufacture and evaluation of parenteral products; Aseptic Techniques-source of contamination and methods of prevention, Design of aseptic area, Laminar flow bench services and maintenance. Sterility testing of pharmaceuticals • **Surgical products:** Definition, primary wound dressing, absorbents, surgical cotton, surgical gauzes etc., bandages,adhesive tape, protective cellulosic hemostastics, official dressings, absorbable and nonabsorbable sutures, ligatures and catguts • **Packaging of Pharmaceutical Products:** Packaging components, types, specifications and methods of evaluation, stability aspects of packaging. Packaging equipments, factors influence choice of containers, legal and official requirements for containers, package testing • **Designing of dosage forms:** Pre-formulation studies, Study of physical properties of drug like physical form, particle size, shape, density, wetting, dielectric constant. Solubility, dissolution and organoleptic properties and their effect on formulation, stability and bioavailability. Study of chemical properties of drugs like hydrolysis, oxidation, reduction, racemization, polymerization etc., and their influence on formulation and stability of products. Study of pro-drugs in solving problems related to stability, bioavailability and elegancy of formulations. Design, development and process validation methods for pharmaceutical operations involved in the production of tablets, suspensions. Stabilization and stability testing protocol for various pharmaceutical products.ICH Guidelines for stability testing of formulations

	• **Performance evaluation methods:** *In vitro* dissolution studies for solid dosage forms methods, interpretation of dissolution data. Bioavailability studies and bioavailability testing protocol and procedures. In vivo methods of evaluation and statistical treatment.GMP and quality assurance, Quality audit. Design, development, production and evaluation of controlled/sustained/extended release formulations • **New Drug Delivery Systems (NDDS):** Target oriented drug delivery systems, Mucosal systems. • **Cosmeticology and Cosmetic Preparations:** Fundamentals of cosmetic science, structure and functions of skin and hair. Formulation, preparation and packaging of cosmetics for skin, hair, dentifrice and manicure preparations like nail polish, nail polish remover, Lipsticks, eye lashes, baby care products Etc. **Biopharmaceutics and Pharmacokinetics** • **Introduction to biopharmaceutics:** Passage of drugs across biological barrier (passive diffusion, active transport, facilitated diffusion, ion-pair formation and pinocytosis); Factors influencing absorption- biological, physico-chemical, physiological and pharmaceutical; Drug distribution in the body, plasma protein binding. • **Pharmacokinetics:** Significance of plasma drug concentration measurement. Compartment model- Definition and Scope. Pharmacokinetics of drug absorption - Zero order and first order absorption rate constant using Wagner-Nelson and residual methods. Volume of distribution and distribution coefficient. **Compartment kinetics**- One compartment and two compartment models. Determination of pharmacokinetic parameters from plasma and urine data after drug administration by intravascular and oral route. Clearance concept, mechanism of renal clearance, clearance ratio, determination of renal clearance.

	Extraction ratio, hepatic clearance, biliary excretion, extrahepatic circulation. Non-linear pharmacokinetics with special reference to one compartment model after I.V. drug administration. • **Clinical Pharmacokinetics:** Definition and scope: Dosage adjustment in patients with and without renal and hepatic failure; Design of single dose bio-equivalence study and relevant statistics; Pharmacokinetic drug interactions and their significance in combination therapy. • **Bioavailability and bioequivalence:** Measures of bioavailability, Cmax, tmax, Keli and Area Under the Curve (AUC); Design of single dose bioequivalence study and relevant statistics; Review of regulatory requirements for conducting bioequivalent studies. Biopharmaceutical Classification System (BCS) of drugs. **Physical pharmacy** • **Matter, Properties of Matter:** State of matter, change in the state of matter, latent heats and vapor pressure,sublimationcritical point, Eutectic mixtures, gases, aerosols-inhalers, relative humidity, liquid. Complexes, liquid crystals, glassy state, solids-crystalline, amorphous and polymorphism. • **Micromeretics and Powder Rheology:** Particle size and distribution, average particle size, number and weight distribution, particle number, methods for determining particle volume, particle size - optical microscopy, sieving, sedimentation; measurements of particle shape, specific surface area; methods for determining surface area; permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness & flow properties. • **Surface and Interfacial Phenomenon:** Liquid interface, surface and interfacial tensions, surface free energy, measurement of surface and interfacial tensions, spreading coefficient, adsorption

	at liquid interfaces, surface active agents, HLB classification, solubilization, detergency, adsorption at solid interfaces, solid-gas and solid-liquid interfaces, complex films, electrical properties of interface. • **Viscosity and Rheology:** Newtonian systems, Law of flow, kinematic viscosity, effect of temperature; non-Newtonian systems: pseudoplastic, dilatant, plastic; thixotropy, thixotropy in formulation, negative thixotropy, determination of viscosity, capillary, falling ball, rotational viscometers. • **Complexation:** Classification of complexes, methods of preparation, analysis, & applications. • **Introduction to dispensing and community pharmacy Prescription:** Handling of prescription, source of errors in prescription, care required in dispensing procedures including labeling of dispensed products. General dispensing procedures including labeling of dispensed products; Pharmaceutical calculations: Posology, calculation of doses for infants, adults and elderly patients; Enlarging and reducing recipes percentage solutions, alligation, alcohol dilution, proof spirit, isotonic solutions, displacement value etc. • **Principles involved and procedures adopted in dispensing of :** Typical prescriptions like mixtures, solutions, emulsions, creams, ointments, powders, capsules, pastes, jellies, suppositories, ophthalmic, pastilles, lozenges, pills, lotions, liniments, inhalations, paints, sprays, tablet triturates, etc. • **Incompatibilities:** Physical and chemical incompatibilities, inorganic incompatibilities including incompatibilities of metals and their salts, non-metals, acids, alkalis, organic incompatibilities. Purine bases, alkaloids, pyrazolone derivatives, amino acids, quaternary ammonium compounds, carbohydrates,

	glycosides, anesthetics, dyes, surface active agents, correction of incompatibilities. Therapeutic incompatibilities. • **Organization and Structure of hospital pharmacy:** Organization of a hospital and hospital pharmacy, Responsibilities of a hospital pharmacist, Pharmacy and therapeutic committee, Budget preparation and Implementation. • **Hospital Formulary:** Contents, preparation and revision of hospital formulary. • **Drug Store Management and Inventory Control:** Organization of drug store, Types of materials stocked, storage conditions; Purchase andInventory Control principles, purchase procedures, Purchase order, Procurement and stocking. • **Central Sterile Supply Unit and their Management:** Types of materials for sterilization, Packing of materials prior to sterilization, sterilization equipments, Supply of sterile materials. • **Manufacture of Sterile and Non-sterile Products:** Policy making of manufacturable items, demand and costing, personnel requirements, manufacturing practice, Master formula Card, production control, manufacturing records. • **Drug Information Services:** Sources' of Information on drugs, disease, treatment schedules, procurement of information,Computerized services (e.g., MEDLINE), Retrieval of information, Medication error- types of medication errors, correction and reporting. • **Pharmacoeconomics:** Introduction to pharmacoeconomics, different methods of pharmacoeconomics, application of pharmacoeconomics. • **Pharmacoepidemiology:** Definition and scope, method to conduct pharmacoepidemiological studies, advantages & disadvantages of pharmacoepidemiological studies.

	• **Nuclear Pharmacy:** Methods of handling radioisotopes, radioisotope committee. **<u>Unit operations in manufacturing</u>** • **Fluid Flow:** Types of flow, Reynold's number, Viscosity, Concept of boundary layer, basic equations of fluid flow, valves, flow meters, manometers and measurement of flow and pressure. • **Evaporation:** Basic concept of phase equilibria, factor affecting evaporation, evaporators, film evaporators,single effect and multiple effect evaporators, Mathematical problems on evaporation. • **Distillation:** Roult's law, phase diagrams, volatility; simple steam and flash distillations, principles of rectification, Mc-Cabe Thiele method for calculations of number of theoretical plates, Azeotropic and extractive distillation. • **Drying:** Moisture content and mechanism of drying, rate of drying and time of drying calculations;classification and types of dryers, dryers used in pharmaceutical industries and special drying methods. • **Size Reduction:** Definition, objectives of size reduction, mechanisms of size reduction, factors affecting size reduction, laws governing energy and power requirements of a mills including ball mill, hammer mill, fluid energy mill. Size separation: Different techniques of size separation, sieves, sieve shakers, sedimentation tank, cyclone separators, bag fillers etc. • **Mixing:** Theory of mixing, solid-solid, solid-liquid and liquid-liquid mixing equipments. • **Filtration and Centrifugation:** Theory of filtration, continuous and batch filters, filter aids, filter media, industrial filters including filter press, rotary filter, edge filter, Etc. Factors affecting filtration, filtration, optimum cleaning cycle in batch

	filters. Principles of centrifugation, industrial centrifugal filters, and centrifugal sedimenters. • **Crystallization:** Characteristics of crystals like-purity, size, shape, geometry, habit, forms size and factors affecting them, Solubility curves and calculation of yields. Material and heat balances around Swenson Walker Crystallizer. Supersaturation, theory and its limitations, Nucleation mechanisms,crystal growth.Study of various types of Crystallizers, tanks, agitated batch, Swenson Walker,Single vacuum, circulating magma and Krystal Crystallizer, Caking of crystals and its prevention.Numerical problems on yields. • **Dehumidification and Humidity Control:** Basic concepts and definition, wet bulb and adiabatic saturation temperatures, Hygrometric chart and measurement of humidity, application of humidity measurement in pharmacy, equipments for dehumidification operations; • **Material of Construction:** General study of composition, corrosion, resistance, Properties and applications of the materials of construction with special reference to stainless steel and glass. • **Material Handling Systems:** Liquid handling - Different types of pumps, Gas handling-Various types of fans, blowers and compressors, Solid handling-Bins, Bunkers, Conveyers, Air transport. • **Plant location:** Layout, utilities and services. Industrial Hazards and Safety Precautions: Mechanical, Chemical, Electrical, fire and dust hazards. Industrial dermatitis, Accident records etc. • **Automated Process Control Systems:** Process variables, temperature, pressure, flow, level and vacuum and their measurements; elements of automatic process control and introduction to automatic process control systems; elements of

	computer aided manufacturing (CAM). Reactors and fundamentals of reactors design for chemical reactions.
Module 2	**Pharmaceutical/Medicinal Chemistry, Organic Chemistry Pharmaceutical Analysis, Biochemistry and Physical Chemistry**
Contents	**Topics Covered**
	<u>Pharmaceutical / Medicinal Chemistry</u> • **Basic Principles**: Physico-chemical and stereoisomeric (Optical, geometrical) aspects of drug molecules and biological action, Bioisosterism • **Drug-receptor interactions** including transduction mechanisms • Drug metabolism and Concept of Prodrugs • Synthetic Procedures, Mode of Action, Uses, Structure Activity Relationships including Physicochemical Properties of the following classes of drugs: **Drugs acting at synaptic and neuro-effector junction sites:** Cholinergics, anti-cholinergics and cholinesterase inhibitors, Adrenergic drugs, Antispasmodic and anti-ulcer drugs, Local Anesthetics, Neuromuscular blocking agents. Autacoids: Antihistaminics, Eicosanoids, Analgesic-antipyretics, Anti-inflammatory (non-steroidal) agents. **Steroidal Drugs:** Steroidal nomenclature (IUPAC) and stereochemistry, Androgens and anabolic agents, Estrogens and Progestational agents, Oral contraceptives, Adrenocorticoids **Drugs acting on the central nervous system:** General Anesthetics, Hypnotics and Sedatives, Anticonvulsants, Anti-Parkinsonian drugs, Psychopharmacological agents (Neuroleptics,

	Anti-depressants, Anxiolytics), Opioid analgesics, Anti-tussives, CNS stimulants. Diuretics **Cardiovascular drugs:** Anti-hypertensives, Anti-arrythmic agents, anti-anginal agents, Cardiotonics, Anti-hyperlipedemic agents, Anticoagulants and Anti-platelet drugs Thyroid and Anti-thyroid drugs; Insulin and oral hypoglycemic agents, Chemotherapeutic Agents used in bacterial, fungal, viral, protozoal, parasitic and other infections, Antibiotics: ß-Lactam, macrolides, tetracyclines, aminoglycosides, polypeptide antibiotics, fluoroquinolones, Anti-metabolites (including sulfonamides); Anti-neoplastic agents; Anti-viral agents (including anti–HIV); Immunosuppressives and immunostimulants; Diagnostic agents; Pharmaceutical Aids.
	Organic Chemistry • Importance of fundamentals of Organic Chemistry in pharmaceutical sciences; Structure and Properties: Atomic structure, Atomic orbitals, Molecular orbital theory, wave equation, Molecular orbitals, Bonding and Anti-bonding orbitals, Covalent bond, Hybrid orbitals, Intramolecular forces, Bond dissociation energy, Polarity of bonds, Polarity of molecules, Structure and physical properties, Intermolecular forces, Acids and bases • **Stereochemistry:** Nomenclature, isomerism, stereoisomerism, conformational and configurational isomerism, optical activity, specification of configuration, Reactions involving stereoisomers, chirality, conformations; Stereoselective and stereospecific reactions, Enantiomers and Diastereomers • **Structure, Nomenclature, Preparation and Reactions of:** Alkanes, Alkenes, Alkynes, Cyclic analogs, Dienes, Benzene, Polynuclear aromatic compounds, Arenes, Alkyl halides, Alcohols, Ethers, Epoxides, Amines, Phenols, Aldehydes and

	Ketones, Carboxylic acids, Functional derivatives of' carboxylic acids, α,ß-Unsaturated carbonyl compounds, Reactive intermediates- carbocations, carbanions, carbenes and nitrenes • **Electrophilic and Nucleophilic Aromatic Substitution Reactions:** Reactivity and orientation; Common reactions under this class • **Electrophilic and Nucleophilic Addition Reactions**: Reactivity and orientation; Common reactions under this class Markovnikov's rule, Anti-Markovnikov's Rule • **Rearrangements:** Beckman, Hoffman, Benzilic acid, pinacole-pinacolone and Bayer-Villager • **Elimination reactions: E2 and E1 reactions** • **Name Reactions** • **Heterocyclic Compounds:** Nomenclature, preparation, properties and reactions of 3, 4, 5, 6 & 7-membered heterocycles with one or two hetero-atoms like O, N, S in the ring.
	Pharmaceutical Analysis • Methods of expressing concentration, primary and secondary standards, standardization of various titrants • **Acid Base Titrations**: Direct, back and blank titrations, Relative strengths of acids and bases, Common ion effect, pH, Hydrolysis of salts, Henderson-Hasselbach equation, Buffer solutions, Titration curves, Acid-base indicators, Theory of indicators, Choice of indicators, Assays based on acidimetry-alkalimetry, Equivalent weights of acids and bases • **Non-aqueous Titrations**: Conjugate acids and conjugate bases, Solvents, Titrants and Indicators used, Pharmacopeial assays based on non-aqueous titrations • **Oxidation Reduction Titrations**: Concept of oxidation and reduction, Redox reactions, Half reactions, Strengths and

	equivalent weights of oxidizing and reducing agents, Theory of redox titrations, Redox indicators, Oxidation-reduction curves, Assays involving titrations based on Permanganate, Ceric, Potassium iodate, Potassium bromate, Iodimetry and Iodometry • **Precipitation Titrations**: Precipitation reactions, Solubility product, Effect of pH, temperature and solvents upon the solubility of a precipitate, Argentometric titrations and titrations involving ammonium or potassium thiocyanate, mercuric nitrate, Indicators used, Mohr's method, Volhard's method, Fajan's method • **Complexometric Titrations**: Types of Ligands, Complexing and chelating agents, Common titrants used, pM Indicators, Masking and demasking agents. Buffers used, importance of pH, Stability of complexes, structures of complexes, Assays based on complexometry • **Miscellaneous Methods of Analysis**: Diazotization titrations, Kjeldahl method of nitrogen estimation, Karl-Fischer aquametry • **Electrochemistry**: Types of electrodes, Cell representations, Measurement of electrode potential, Concept of half cells, EMF series • **Potentiometry**: Principle, Standard redox potential, Nernst equation, Half-cell potential, Standard and indicator electrodes, potentiometric titrations, Applications and advantages • **Conductometry**: Principle, Specific and equivalent conductance, conductometric titrations, Applications and advantages • **Coulometry**: Principle, Coulometric titrations, Applications and advantages • **Polarography**: Principle, Dropping mercury electrode, Saturated Calomel electrode, Decomposition potential, Half-wave potential, Diffusion/convection/migration currents, Ilkovic

	equation, Cathodic/anodic polarography, C-V curve, Applications, Organic polarography • **Amperometry**: Principle, Amperometric titrations, Applications and advantages • **Chromatography**: Theories of chromatography - Plate theory, Rate theory, Factors affecting resolution, Column efficiency, selectivity factor and capacity factor, Van Deemter equation, The following chromatographic techniques (including principle, stationary phase, mobile phase, instrumentation and applications) with relevant examples of Pharmacopoeial products: HPLC, TLC, HPTLC, GLC, Paper Chromatography, Gel chromatography, Ion-exchange chromatography, Affinity chromatography, Chiral chromatography, Methods of quantitation, Internal and External standards • **Spectrometry**: Theoretical Aspects, Basic Instrumentation, Interpretation of Spectra, and Quantitative and Qualitative Applications of the Following Spectroscopic Techniques: Ultraviolet and visible spectrophotometry, Infrared spectrophotometry, ^{1}H and ^{13}C Nuclear Magnetic Resonance spectroscopy, Mass Spectrometry, Fluorimetry, Flame Photometry, Atomic Absorption Spectroscopy, X-ray Diffraction Analysis • **Radioimmunoassays** • **Quality assurance**: GLP, ISO 9000, TQM, QbD, Quality Review and Quality documentation, Regulatory control, regulatory drug analysis, interpretation of analytical data, Validation, quality audit: quality of equipment, validation of equipment, validation of analytical procedures • **Drug Design and Discovery**: Hits, Targets, and Leads, Principles of QSAR, Physico-chemical parameters, Hansch Analysis, Linear Regression Method, Softwares used

	• **Combinatorial Synthesis**: Chemical Libraries, Types of supports and linkers used, Mix and split method, deconvolution, Houghton's Tea bag Method, High throughput screening, instrumentation thereof.
	Biochemistry • The concept of **free energy**, Determination of change in free energy - from equilibrium constant and reduction potential, bioenergetics, production of ATP and its biological significance • **Enzymes**: Nomenclature, enzyme kinetics and their mechanism of action, mechanism of inhibition, enzymes and iso-enzymes in clinical diagnosis. **Co-enzymes:** Vitamins as co-enzymes and their significance. Metals as cofactors and their significance • **Carbohydrate Metabolism**: Chemistry of Carbohydrates, Conversion of polysaccharides to glucose-1-phosphate, Glycolysis, fermentation and their regulation, Gluconeogenesis and glycogenolysis, Role of sugar nucleotides in biosynthesis, and Pentose phosphate pathway; The Citric Acid Cycle: Significance, reactions and energetics of the cycle, Amphibolic role of the cycle, and Glyoxalic acid cycle • **Lipids Metabolism**: Chemistry of lipids, ß-oxidation of fatty acids and energetics, biosynthesis of ketone bodies and their utilization, biosynthesis of saturated and unsaturated fatty acids, Control of lipid metabolism, Essential fatty acids & eicosanoids (prostaglandins, thromboxanes and leukotrienes), phospholipids, and sphingolipids, Biosynthesis of eicosanoids, cholesterol, androgens, progesterone, estrogens corticosteroids and bile acids. • **Biological Oxidation**: Redox-potential, enzymes and co-enzymes involved in oxidation reduction and its control, The respiratory chain, its role in energy capture and its control, energetics of oxidative phosphorylation, Inhibitors of respiratory

	chain and oxidative phosphorylation, Mechanism of oxidative phosphorylation • **Metabolism of ammonia and nitrogen containing monomers**: Nitrogen balance, Biosynthesis of amino acids, Catabolism of amino acids, Conversion of amino acids to specialized products, Assimilation of ammonia, Urea cycle, metabolic disorders of urea cycle, Metabolism of sulphur containing amino acids • **Purine and Pyrimidine biosynthesis**: Biosynthesis of Nucleic Acids: Brief introduction of genetic organization of the mammalian genome, alteration and rearrangements of genetic material, Biosynthesis of DNA and its replications • **Mutation**: Physical & chemical mutagenesis/carcinogenesis, DNA repair mechanism, Biosynthesis of RNA • **Genetic Code and Protein Synthesis**: Genetic code, Chemistry of Proteins, Components of protein synthesis and Inhibition of protein synthesis
	Physical Chemistry • Importance of basic fundamentals of Physical Chemistry in Pharmacy: Behavior of Gases, Kinetic theory of gases, deviation from ideal behavior and explanation. • **The Liquid State**: Physical properties (surface tension, parachor, viscosity, refractive index, dipole moment); Solutions: Ideal and real solutions, solutions of gases in liquids, colligative properties, partition coefficient, conductance and its measurement, Debye Huckel theory • **Thermodynamics**: First, Second and Third laws, Zeroth law, Concept of free energy, enthalpy and entropy, absolute temperature scale, Thermochemical equations, Phase rule, Adsorption: Freudlich and Gibbs adsorption, isotherms, Langmuir's theory of adsorption

	• **Photochemistry**: Consequences of light absorption, Jabolenski diagram, Quantum efficiency; • **Chemical Kinetics**: Zero, First and Second order reactions, complex reactions, theories of reaction kinetics, characteristics of homogeneous and heterogeneous catalysis, acid base and enzyme catalysis • **Quantum Mechanics**: Postulates of quantum mechanics, operators in quantum mechanics, the Schrodinger wave equation.
Module 3	**Pharmacology and Related Subjects**
Contents	**Topics Covered**
	• Basic Principles, causes, pathogenesis and morphology of **Cell Injury**, Adaptations and cell death • Basic Mechanisms involved in the process of **inflammation and repair**, Vascular and cellular events of acute inflammation, chemical mediators of inflammation, pathogenesis of chronic inflammation, brief outline of the process of repair • **Immunopathophysiology**: T and B cells, MHC proteins, antigen presenting cells, immune tolerance, pathogenesis of hypersensitivity reactions, autoimmune diseases, AIDS, Amyloidosis • **Pathophysiology of Common Diseases**: Asthma, diabetes, rheumatoid arthritis, gout, ulcerative colitis, neoplasia, psychosis, depression, mania, epilepsy, acute and chronic renal failure, hypertension, angina, congestive heart failure, neoplastic diseases, atherosclerosis, myocardial infarction, congestive heart failure, peptic ulcer, anemias, hepatic disorders, tuberculosis, urinary tract infections and sexually transmitted diseases • **Fundamentals of General Pharmacology**: Dosage forms and routes of administration, mechanism of action, combined effect of

	drugs, factors modifying drug action, tolerance and dependence; Pharmacogenetics; Principles of Basic and Clinical pharmacokinetics, Absorption, Distribution, Metabolism and Excretion of drugs, Adverse Drug Reactions; Bioassay of Drugs and Biological Standardization • **Pharmacology of Peripheral Nervous System**: Neurohumoral transmission (autonomic and somatic), Parasympathomimetics, Parasympatholytics, Sympathomimetics, Adrenergic receptors and neuron blocking agents, Ganglion stimulants and blocking agents, Neuromuscular blocking Agents, Local anesthetic Agents • **Pharmacology of Central Nervous System**: Neurohumoral transmission in the C.N.S., General Anesthetics, Alcohols and disulfiram, Sedatives, Hypnotics, Anti-anxiety agents and Centrally acting muscle relaxants, Psychopharmacological agents (anti-psychotics), anti-maniacs, and hallucinogens, Antidepressants, Anti-epileptic drugs, Anti-Parkinsonian drugs, Analgesics, Antipyretics, Narcotic analgesics and antagonists, C.N.S. stimulants, Drug Addiction and Drug Abuse • **Drugs Acting on the Hemopoietic System**: Hematinics, Anticoagulants, Vitamin K and hemostatic agents, Fibrinolytic and anti-platelet drugs, Blood and plasma volume expanders. • **Drugs Acting on the Respiratory System**: Anti-asthmatic drugs including bronchodilators, Anti-tussives and expectorants, Respiratory stimulants. • **Drugs acting on the Gastrointestinal Tract**: Antacids, Anti-secretory and Anti-ulcer drugs, Laxatives and anti-diarrhoeal drugs, Appetite Stimulants and Suppressants, Emetics and anti-emetics, Miscellaneous: Carminatives, demulcents, protectives, adsorbents, astringents, digestants, enzymes and mucolytics. • **Pharmacology of Endocrine System**: Hypothalamic and pituitary hormones, Thyroid hormones and anti-thyroid drugs,

	parathormone, calcitonin and Vitamin D, Insulin, glucagons, incretins, oral hypoglycemic agents and insulin analogs, ACTH and corticosteroids, Androgens and anabolic steroids, Estrogens, progesterone and oral contraceptives, Drugs acting on the uterus. • **Chemotherapy**: General Principles of Chemotherapy, Bacterial resistance; Sulfonamides and Cotrimoxazole, Antibiotics-Penicillins, Cephalosporins, Aminoglycosides, Chloramphenicol, Macrolides, Tetracyclines, Quinolones, fluoroquinolones and Miscellaneous antibiotics; Chemotherapy of tuberculosis, leprosy, fungal diseases, viral diseases, HIV and AIDS, urinary tract infections and sexually transmitted diseases, malaria, amoebiasis and other protozoal infections and Anthelmentics. Chemotherapy of malignancy and immunosuppressive agents. • **Principles of Toxicology**: Definition of poison, general principles of treatment of poisoning with particular reference to barbiturates, opioids, organophosphorous and atropine poisoning, Heavy metals and heavy metal antagonists. • **Basic Concepts of Pharmacotherapy**: Clinical Pharmacokinetics and individualization of Drug therapy, Drug delivery systems and their Biopharmaceutics and Therapeutic considerations, Drugs used during infancy and in the elderly persons (Pediatrics and Geriatrics), Drugs used during pregnancy, Drug induced diseases, The basics of drug interactions, General principles of clinical toxicology, Common clinical laboratory tests and their interpretation. • **Pharmacology of cardiovascular system:** Drugs used in management of congestive cardiac failure, antihypertensive drugs, anti-anginal and vasodilator drugs, calcium channel blockers, beta blockers, ant arrhythmic drugs, antihyperlipidemic drugs, drugs used in therapy of shock

	• **Drugs acting on urinary system:** Diuretics, fluid and electrolyte balance • **Autocoids:** Histamine, antihistaminic drugs, 5HT agonists and antagonists, Prostaglandins, Leukotrines, angiotensin, Bradykinin, Substance P and other vasoactive peptides, non-steroidal anti-inflammatory agents and anti-gout agents.
Module 4	**Pharmacognosy, Biotechnology, Forensic Pharmacy, Microbiology and Statistical methods**
Contents	**Topics Covered**
	Pharmacognosy: • Sources, Classification, Cultivation, Collection, Processing, Storage and Quality Control of Crude Drugs • **Complete Pharmacognosy of** Alkaloids, Glycosides, Terpenes, Carbohydrates and derived products, Lipids, Resins, Tannins, Volatile Oils, Fibers Marine drugs • **Biosynthetic Studies and Basic Metabolic Pathways / Biogenesis of** Carotenoids, Terpenes, Glycosides, Alkaloids, Lignans, quassanoids and flavonoids • **Role of plant-based drugs on National economy, Standardization and Quality control of herbal drugs, WHO guidelines for their standardization** • **Phytochemical Screening:** Isolation of active constituents of crude drugs, Extraction methods, Screening of alkaloids, saponins, cardenolides and bufadienolides, flavonoids, tannins and polyphenols, anthraquinones, cynogenetic glycosides, amino acids in plant extracts • **Studies of Traditional Drugs**: Basic theory of Ayurveda, Siddha, Unani and Homeopathy drugs and formulations

	Biotechnology • **Microbial Transformations**: Introduction, types of reactions mediated by micro-organisms, design of biotransformation, processes, selection of organisms, biotransformation process and its improvements with special reference to steroids. • **Enzyme Immobilization**: Techniques of immobilization, factors affecting enzyme kinetics, Study of enzymes such as hyaluronidase, penicillinase, streptokinase, amylases and proteases, Immobilization of bacteria and plant cells. • **Plant Tissue Culture**: Historical development of plant tissue culture, types of cultures, totipotency, nutritional requirements, growth and their maintenance. Applications of plant tissue culture in pharmacy, Organ culture, Micropropagation, Protoplast fusion, Polyploidy, Embryogenesis • **Animal tissue culture**
	Forensic Pharmacy: • Pharmaceutical Legislations: A brief review; Drugs & Pharmaceutical Industry; Pharmaceutical Education • **An elaborate study of the following:** Pharmaceutical Ethics; Pharmacy Act 1948; Drugs and Cosmetics Act 1940 and Rules 1945;Medicinal & Toilet Preparations (Excise Duties) Act 1955; Narcotic Drugs & Psychotropic Substances Act 1985 & Rules; Drugs Price Control Order. • **A brief study of the following Acts with special reference to main provisions and latest amendments:** Poisons Act 1919; Drugs and Magic Remedies (Objectionable Advertisements) Act 1954; Medical Termination of Pregnancy Act 1970 & Rules 1975; Prevention of Cruelty to Animals Act 1960; States Shops & Establishments Act & Rules; Insecticides

	Act 1968; AICTE Act 1987; Factories Act 1948; Minimum Wages Act 1948; Patents Act 1970. • **A brief study of** the various Prescription/Non-prescription Products. Medical/Surgical accessories, diagnostic aids, appliances available in the market.
	Microbiology: • **Structure of bacterial cell**; Classification of microbes and their taxonomy: Actinomycetes, bacteria, rickettsiae, spirochetes and viruses. • **Identification of Microbes:** Stains and types of staining techniques, electron microscopy; Nutrition, cultivation, isolation of bacteria, actinomycetes, fungi, viruses, etc; microbial genetics and variation. • **Control of microbes by physical and chemical methods**: Disinfection, factors influencing disinfectants, dynamics of disinfection, disinfectants and antiseptics and their evaluation; Sterilization: Different methods, validation of sterilization methods &equipments; Sterility testing of all pharmaceutical products. **Microbial assays** of antibiotics, vitamins & amino acids. • **Immunology and Immunological Preparations**: Principles, antigens and heptans, immune system, cellular/humoral immunity, immunological tolerance, antigen-antibody reactions and their applications. Hypersensitivity, active and passive immunization. Vaccines and sera: their preparation, standardization and storage. • **Genetic Recombination**: Transformation, conjugation, transduction, protoplast fusion and gene cloning and their applications. Development of hybridoma for monoclonal

	antibodies. Study of drugs produced by biotechnology such as Activase, Humulin, Humatrope, HB etc. • **Antibiotics**: Historical development of antibiotics. Antimicrobial spectrum and methods used for their standardization. Screening of soil for organisms producing antibiotics, fermenter, its design, control of different parameters. Isolation of mutants, factors influencing rate of mutation. Design of fermentation process. Isolation of fermentation products with special reference to penicillins, streptomycin, tetracyclines and vitamin B_{12}.
	Statistical methods: • Types of data: parametric and non-parametric, descriptive and inferential data • Collection of data: normal distribution, calculation of co-relation coefficient • **Data processing**: analysis, error analysis, meaning and different methods: Student's 't' test, Chi square method, Analysis of Variance (ANOVA), significance of variance, analysis of covariance, multiple regression, testing linearity/non-linearity of model, testing adequacy of model • Test to be used in data exploration and their choice • Introduction of software used in data analysis

	LIST OF RECOMMENDED BOOKS
Module 1	**Pharmaceutics, NDDS and Related subjects**
	• Ansel, H.C. Popovich, Allen, Jr., 'Pharmaceutical Dosage Forms and Drug Delivery Systems', B.I. Waver ly Pvt. Ltd., New Delhi. • Carter, S.J.(ed) Cooper and Gunn's Tutorial Pharmacy, CBS Publishers and Distr ibutors, Delhi. • Lachman, L., Liberman; H.A., 'The Theory and Practice of Industrial Pharmacy', Varghese Publishing House, Mumbai.

	• Osol (ed) Remington's Pharmaceutical Sciences, Mack Publishers, Pennsylvania. • E.A.Rawlins, Bentley's Textbook of Pharmaceutics, Bailliere Tindall, London; All India Traveller Books seller, Delhi. • H. C. Ansel, Introduction to Pharmaceutical Dosage forms, Lea & Febiger, Philadelphia. • Aulton, M.E. Pharmaceutics, The science of dosage, form design Churchill Living-stone, London. • Extra Pharmacopoeia IP, BP, USP - current editions. • David Gandertion, "Unit Processes in Pharmacy". • Roussal Gackenback, "Material selection for process plants". • Stainer, "Plant Engineering Handbook", Macmillan Publications. • Perry and Chilton, "Chemical Engineers Handbook", McGraw Hill, Delhi. • Lachman L., Libberman H. A. "Theory and Practice of Industrial Pharmacy". Varghese Publishing House. • K. Samabamurthy, "Pharmaceutical Engineering", New age International (P) Ltd., Publishers, New Delhi. 1997. • W. L. Badger, Banchero J.T., "Indroduction to Chemical Engineering",Tata Mcgraw Hill, Delhi, 1998. • Martin, A. N., 'Physical Pharmacy', B. I. Waverley, IVth Edition, New Delhi,1994. • Remington's Pharmaceutical Sciences, ed. osol. (Mack), Easton, Penn,1995. • Cooper & Gunn's 'Dispensing for Pharmaceutical students' Ed.Cartr,Pitman Medical, CBS Publishers, 12th edition, 1975. • Husa's Pharmaceutical Dispensing' Ed. Martin (Mac Publication) • Sprowl "Prescription Pharmacy". J. B. Lippincott. 2n d edition 1970. • W. F. Hassan, 'Hospital Pharmacy', 5th edition 1986, Lea & Febiger Publications.

	• M C Allwood & J. T .Fell Blackwell "Textbook of Hospital Pharmacy" Scientific Publications Oxford London 1980. • J. J. Perkins "Principles and Methods of Sterilization in Health Sciences, Charles Thomas publication. • Kenneth & Michael J. Aberson 'Sterile preparations for the hospital pharmacists and procedures 'ANN' Arbor science publisher. • Tipnis, H. P., Bajaj A. N. 'Hospital Pharmacy', Career Publications, Nashik, India, 2007. • Kuchekar B.S. & Khandatare A.M., Forensic Pharmacy including Industrial and Labour Laws. Nirali Publication, Pune, 1989. • 'Code of Pharmaceutical Ethics', Pharmacy Council of India (P.B. No. 337), New Delhi. • Current Government of India Publications of all Drugs Acts and Rules. • Bharti, 'Manual of Drugs and Pharmacy Laws in India', Paramount Law Publications Year 1987. • Mehta, "Hand book of Drug Laws", University Book Agency,Allahabad. • "*Laws of Drugs and Medicines", Beotr Law Book Co. Allahabad.*
Module 2	**Pharmaceutical/Medicinal Chemistry, Organic Chemistry Pharmaceutical Analysis, Biochemistry and Physical Chemistry**
	• Foye, W.O. Principles of Medicinal Chemistry, K. E. Varghese and Company, Mumbai-31, Sixth Edition, 2010. • Wilson, C. Gisvold, O., and Doerge, J. B., Textbook of Organic Medicinal and Pharmaceutical Chemistry, J. B. Lippincot Company, Toronto, Eleventh Edition, 2004. • Burger, A. B. Medicinal Chemistry Part I, II and III , John Wiley & Sons. Inc. New York. • Medicinal Chemistry by Ashutosh Kar, 4th Edition, New Age International Publishers, 2007.. • Profiles of Drug Synthesis- Gogte, Vol. I – III

	• The art of Drug synthesis, Eds., Douglas S. Johnson and Jie Jack Li, Wiley Interscience, 2007. • The Organic Chemistry of Drug Synthesis, Daniel Lednicer, Vols. 1-7, Wiley • Principles of Instrumental Analysis: Douglas A. Skoog (Author), F. James Holler, Stanley R. Crouch, 6th edition, Publisher: Brooks Cole. 2006. • Practical Pharmaceutical Chemistry: A. H Beckett and J. B. Stenlake, 4th edition, Part II, CBS Publishers, 2011 • Instrumental Methods of Analysis: S. S. Mahajan, Popular Prakashan Pvt. Ltd., Mumbai, 2010. • Spectrometric Identification of Organic Compounds: R. M. Silverstein, Francis X. Webster and David Kiemle, 7th edition, Wiley Publication, NY., U. S. A., 2005 • Quantitative Analysis of Drugs in Pharmaceutical Formulations: P. D. Sethi, 3rd edition, CBS Delhi. 2008. • Morrison R.T.and Boyd R.M. Organic Chemistry, Prentice Hall of India Pvt. Ltd, New Delhi 110 001 • Hendrickson J.B., Cram D.J. and Hammond G.S. , Organic Chemistry, International Student Edition,Mc.Graw-Hill, Kogakusha Ltd, New Delhi. • Eliel E.L. Stereochemistry of Carbon Compounds, Tata Mc.-Graw Hill Publishing Co.Ltd New Delhi. • Finar I.L., Organic Chemistry Vol I& II E.L.B.S. Longman Group Ltd London • Harper's Biochemistry by Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell, Twenty-fourth edition, Prentice-Hall International • Biochemistry by Conn & Stump, Latest Edition and latest reprint. • Principles of Biochemistry by Lehninger A.L., Nelson D.L. and Cox • M.M., CBS Publishers and Distributors, Delhi, 2n d edition, 1993. • Textbook of Biochemistry by Praful Godkar, 2007.

	• Biochemistry by U.Satyanarayana and U. Chakrapani, Third edition, Books and Allied (P) Ltd., 2010. • P. J. Sinko, "Martin's Physical Pharmacy and Pharmaceutical Science", Lippincotts Willians and Wilkin, Indian Education Distributed by B. I. Publications Pvt. Ltd, 5th Edition (2006). • B. S. Bahl, A. Bahl, G. D. Tuli, "Essentials of Physical Chemistry", S. Chand and Company Ltd, New Delhi, Revised Multicoloured Revised Edition (2009), Reprint 2010. • C. V. S. Subrahmanyam, Essentials of Physical Pharmacy, Vallabh Prakashan, Delhi, 1st Edition (2003), Reprint 2008. • U. B. Hadkar "A Textbook of Physical Pharmacy", Nirali Prakashan, Pune, 6th Edition (2006).
Module 3	**Pharmacology and Related Subjects**
	• Tripathi K.D., 'Essentials of Medical Pharmacology', Published by Jaypee brothers,New Delhi, India, 6th edition, 2007. • Sheth S.D., 'Textbook of Pharmacology', Published by Churchill Livingston Pvt. Ltd., New Delhi, India, 3rd edition, 2008. • Goodman and Gilman, 'The Pharmacological basis of therapeutics', Published by Mc Graw-Hill, International edition, New York, U.S.A, 12th edition, 2011. • Satoskar R.S., Bhandarkar S.D., Ainapure S.S., 'Pharmacology and Pharmacotherapeutics', Published by Popular Prakashan, Mumbai, India, 18th edition, 2009. • Waugh A, Grant A. Ross & Wilson's Anatomy and Physiology in Health, Churchill Livingstone, New York 11th Edition (2010) • Tortora G J, Grabowaski S.R. Principle of Anatomy & Physiology John Wiley & Sons Inc, New York, USA 13th Edition (2012) • Guyton A C, Half J. Textbook of Medical Physiology W.B. Saunders Company , Pensylvania, USA, 12th Edition (2011)

	• Standring S, Gray's Anatomy. Churchill Livingstone USA, 40th Edition, 2009. • Godkar P.B. Textbook of Medical Laboratory Technology Bhalani Publishing House, Mumbai 2 nd Edition 2006 • Walker R. Clinical Pharmacy and Therapeutics. 5th Edition, Churchill Livingstone and Elsevier, 2012. • Tipnis, H. P., Bajaj A. N. 'Clinical Pharmacy' Career Publications, India 2003. • Benett P.N, Brown M.J. Clinical Pharmacology 11th Edition, Elsevier Health Sciences UK, 2012. • Parthisarathi G. Hansen K N, M C Nahata, Text Book of Clinical Pharmacy Practice 2nd Edition. Orient Longman Pvt. Ltd. 2004. • Troy D, Beringer P, Remington The Science and Practice of Pharmacy, 21st Edition, Lippincott Williams Wilkins, 2006. • Bahkar A, Wang D, Clinical Trials: A Practical Guide to Design, Analysis and Reporting

Module 4	**Pharmacognosy, Biotechnology, Forensic Pharmacy, Microbiology and Statistical methods**
Pharmacognosy	• Trease and Evans Pharmacognosy W.B. Saunders Co. Ltd.16th edition, (2009). • Wallis T.E., Textbook of Pharmacognosy, CBS Publishers & Distributors, 5th edition, (2002) • Shah C.S., and Quadri J. S., Textbook of Pharmacognosy,. B. S. Shah Prakashan, Ahmedabad, 7th edition, (1990). Reprint 2011. • Qadry J. S. Pharmacognosy Prof J. S. Qadry 16th edition, (2010). • Kokate C. K., Purohit A. P., Gokhale S. B., Textbook of Pharmacognosy, NiraliPrakashan, Pune, (2011). • Rangari V. D. Pharmacognosy and phytochemistry Part I and II Career Publication Nasik, 1st edition, (2006). • Gokhale S. B. and Kokate C. K. Practical Pharmacognosy, NiraliPrakashan Pune, 14th edition, (2011). • Ayurvedic formulary of India, Part I & II, Government of India, Ministry of Health & Family Welfare, (2009). • Indian Pharmacopoeia Government of India, Ministry of Health & Family Welfare. all editions
Forensic Pharmacy / Jurisprudence	• Drug and cosmetic act1940 and Rules 1945 • Pharmacy Act 1948 • N. Gandhi, Popli, Pharmaceutical Jurisprudence CBS Publisher and Distributors, 2008 • Dr. B. S. Kuchekar, Pharmaceutical Jurisprudence, Pragati Books Pvt. Ltd., 2008 • Mithal B.M. 'Text Book of Forensic Pharmacy', 7th ed, National Book Centre, Calcutta, 1985. • Jain N.K., 'A Text Book of Forensic Pharmacy (Pharmaceutical Jurisprudence)', Vallabh Prakashan, Pune,1989.
Microbiology	• Pelczar, Reid and Chan, 'Microbiology', Tata McGraw Hill Publishing Co. 5th edition,(1993) reprint 2012

	• Frobisher, Crabtree, Good heart. Fundamentals of Microbiology, S. Saunder's Company, 9th Edition, (2010) • Rawlines E. A., Bentleys', Text book of Pharmaceutics, University Printing House Oxford, (1988). • Remington's Pharmaceutical sciences.Mack Publishing Company, 21st edition, (2008) • Anantnarayan and Panikar's, Textbook of Microbiology, 7th Edition, (2006) • Hugo W. B. and Russell A. D.: Pharmaceutical Microbiology, John Wiley and sons, 8th edition, (2011)
Other Subjects	• Statistical methods by S. P. Gupta • Pharmaceutical Statistics by Bolton • Casida L. E. , Industrial Microbiology, New Age International (P) Ltd. ., New Delhi, Reprint 2010. • Chhadda M.S. & Heble M.R., 'Biotechnological Applications of Plant Cell & Tissue Cultures: Problems and Prospects', BARC, 1980. Reprint 2010.

****