

SHRI GURU RAM RAI UNIVERSITY Patel Nagar, Dehradun-248001, Uttarakhand, India [Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s 2(f) of UGC Act 1956]

# 1. Eligibility criteria for Applicants:

An applicant who has passed Post Graduate Degree Examination with at least 55% marks or with an equivalent Grade Point Average (GPA). Relaxation of 5% in the required percentage of marks will be given to applicants belonging to SC/ST/OBC (non-creamy layer)/differently-abled categories.

## 2. Written test:

For RET, there would be two papers i.e. **Paper-I and Paper-II** (Paper-I would be Research Methodology of 50 marks and Paper-II would be Subject specific of 50 marks. Both papers will have 50 questions each with multiple choices). The Entrance Test shall be of two hour duration (i.e. 120 minutes). Applicants have to qualify in aggregate with 50% (45% in case of reserved categories) marks. After qualifying the entrance examination, the applicant has to face a viva voce of 40 marks. Selected applicants list will be displayed on university web site; **www.sgrru.ac.in**.

## 3. Exemption from RET:

The applicants fulfilling at least one of the following conditions:

- Qualified in NET/SET/GATE/GPAT examination of the apex bodies as CSIR/UGC/ICAR/ICMR/DBT/AICTE.
- M.Phil Degree in a relevant subject obtained from any Recognized University.
- Senior citizen of age of 60 years and above with Master's degree.
- Candidate such as Advocate/Doctor/Artist/Industry Professional/Employee of Government/Semi-Government Organizations with Post Graduate Degree (at least 55% marks) and 10 years of professional experience.

The applicants entitled for exemption from RET shall also submit the application form along with relevant supporting documents within the stipulated period.

### **RET Paper I: Research Methodology**

## **Unit I-Concept & Types of Research**

Meaning and importance of Research – Types of Research – Selection and formulation of Research Problem – Research Design, Classification of Research, Pure and Applied Research, Exploring or Formulative Research, Descriptive Research, Diagnostic Research/Study, Evaluation research/Studies, Action Research, Experimental Research, Analytical Study of Statistical Method, Historical Research.

## **Unit II – Methods Research**

Surveys, Case Study, Field Studies General Survey of various Methods including Survey Method, Interdisciplinary Method, Case Study Method, Sampling Method, Statistical Method, Observation Method, Interview Method, Schedule Method, Questionnaire Method, Documentary Method, Library Method, Historical Method and Scientific Method. Characteristic Features of Scientific Method; Empirical Verifiable, Cumulative, Self - Correcting, Deterministic, Ethical & Ideological neutrality (Value Free), Statistical Generalizability.

## Unit III - Data Collection and Data Analysis

Collection, Objectives and Classification of Data, Aims, Methods and Objects of Tabulation of Data, Forms and Processes of Interpretation and Presentation of Data.

Primary, Secondary and Tertiary Data. Construction and adaptation of instruments, administration of questions and tests, Tabulation of data. Data organization in SPSS & Excel, Graphical representation of data

Definition and Aims of Content Analysis, Problems of Content Analysis, Computer and Content Analysis Discussion and Interpretation of results, Testing of Hypothesis: Logical and Statistical Techniques.

### **Unit IV: Report Writing**

Locating Information on a Topic of Interest, Acquiring Copies of Articles of Interest, The Nature of Scientific Variables, Conceptual Versus Operational Definitions of Variables, Levels of Measurement, Various Paradigms, The Basic Format for a Research Report, Identification of the Parts of a Research Report, Citation and Referencing Styles, Essentials of Report Writing, Aids for Writing Good Research Report.

### **References:**

1) Bagchi, Kanak Kanti (2007) Research Methodology in Social Sciences: A Practical Guide, Delhi, Abijeet Publications.

2) Kothari, C.R (2004) Research Methodology: An Introduction, Delhi, New Age.

### **RET Paper II: Subject Specific**

### 1. Soil Science

### UNIT- I

Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms, soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification. Biological nitrogen fixation -types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.

Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions. Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions, sulphur - source, forms, fertilizers and their behavior in soils; calcium and magnesium–factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

Common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions, fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations. Site- specific nutrient management; plant need based nutrient management; integrated nutrient management, soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

## UNIT-II

Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero-charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils. Diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids.

Soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions. Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr-Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnanmembrane equilibrium concept, clay-membrane electrodes and ionic activity measurement,; anion and ligand exchange – innersphere and outer-sphere surface complex formation. Fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena.

## UNIT-III

Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness.

Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.

## UNIT-IV

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration. Soil, water and plant sampling techniques, their processing and handling. Estimation of phosphorus, ammonium and potassium fixation capacities of soils. Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques.

Electrochemical titration of clays; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity. Analysis of soil and plant samples for N, P, K, Ca, Mg, S, Zn, Cu, Fe, Mn, B and Mo. Analysis of plant materials by digesting plant materials by wet and dry ashing and of soil by wet digestion method.

#### 2. SEED SCIENCE AND TECHNOLOGY

#### Unit 1:

SeedBiology, Floral biology, mode of reproduction, sporogenesis, pollination, fertilization, embryogenesis, fruit and seed development and physiological and harvestable maturity. Apomixis, parthenocarpy, polyembryony and somatic embryoids and synthetic seeds. Seed structure of monocot and dicot. Seed maturation and maturation drying in orthodox and recalcitrantseed. Seed chemical composition. Seed dormancy – types, causes, methods to overcome dormancy. Seed germination – phases, types and requirements. Physiological and biochemical changes ingerminating seed. Role of hormones in dormancy and germination.

### Unit 2:

Seed ProductionGenetic purity - concept and factors responsible for deterioration of varieties.Maintenancebreeding.Generation system of seed multiplication.Seed production agencies public and private. Compact area approach / seed village concept in seed production. Seed ReplacementRate, Seed Multiplication Ratio, Seed Renewal Period, Varietal Replacement Rate. Seedproduction planning. Factors affecting pollination and seed set viz., temperature, humidity, windvelocity, insect pollinators and supplementary pollination. Male sterility, self-incompatibility and their role in hybrid seed production. Techniques of hybrid seed production – emasculation andpollination, detasseling, male sterility, sex expression, self-incompatibility and chemicalhybridizing agents. Principles and methods of seed production of varieties and hybrids of cereals- wheat, paddy, sorghum, pearl millet and maize; pulses - chickpea, pigeon pea, green gram, black gram, soybean and cowpea; oilseeds - groundnut, brassica, sesame, sunflower and castor; fibre crops - cotton and jute; vegetable crops - tomato, brinjal, okra, chilli, cabbage, cauliflower, radish, knolkhol, turnip, carrot and cucurbitaceous crops; important forage legumes – lucerne, desmanthus and grasses - cumbunapier and fodder sorghum ; plantation crops - coffee, tea, rubber, cocoa, cardamom, coconut and pepper. Disease free clonal propagation of crops – potato, sugarcane, tapioca, fruit crops - mango, citrus.apple, pear, plum. Clonal propagation of annualand perennial flowers like rose, gladiolus, chrysanthemum, marigold, dahlia, phlox and petunia.Clonal standards and degenerations.Micro propagation.

#### Unit 3:

Seed Processing, Principles of seed processing.Processing sequence for different crops.Layout of seed processingunit. Seed drying – principles and methods. Pre-cleaning, grading, upgrading, seed treatment and packaging.Working principles of seed processing machines viz., cleaner cum grader, specific gravity separator, indented cylinder separator and seed treater.Seed quality maintenance during processing.Seed enhancement techniques – seed coating, pelleting and priming.

### Unit 4:

Seed Quality ControlSeed legislation – the Seeds Act 1966, Seed Rules 1968, Seed Control Order, 1983 and Seed Bill2004.Seed certification – history, concept, organization, phases and Indian

minimum seedcertification standards.Field inspection principles and methods.Inspection at harvesting,threshing and processing.Pre-and post-processing quality testing of seed. Seed testing conceptsand objectives, its role in seed quality control. Seed sampling, seed moisture testing, purityanalysis, germination testing, tolerance limit and seed testing equipments.Quick viability test andseed standards.Seed vigour, its significance and testing methods. Testing for genuineness ofvarieties – principles and methods based on seed, seedling and plant characters, biochemicaltechniques – electrophoresis of proteins and isoenzymes and DNA fingerprinting. InternationalSeed Testing Association (ISTA), its role in development of seed testing procedures, rules and seed quality assurance for international seed trade. OECD seed certification guideline –agricultural and vegetable crops.

#### Unit 5:

Seed StorageSeed storage – principle – purpose and types – short, medium and long term storage. Factorsaffecting seed storage and role of moisture, temperature and relative humidity. Viabilitynomographs.Longevity of orthodox and recalcitrant seeds.Seed deterioration causes andmethods of control.Physiological, biochemical and molecular changes in seed ageing. Controlled storage.Germplasm storage.Cryo preservation.Seed storage containers, types – safe moisture content.Storage structures.Methods of stacking and their impact on seed quality.Seed storage godown maintenance and sanitation.Management of carry over seed.

#### Unit 6:

SeedHealthSignificance of seed health.Procedures for seed health test and rules. Externally and internallyseed – borne pathogens, mode of infection, development and spread, methods of detection.Important seed-borne diseases of cereals, oilseeds, pulses, fibre crops, vegetables and theircontrol measures.Quarantine and International procedures of phytosanitary certificates. Important storage pests, their identification, monitoring and detection. Use of pesticides, botanicals, mycotoxins for seed treatments. Carry over infestation, principles of fumigation and safe use of fumigants.

#### Unit 7:

Seed Industry Development and Marketing National and International seed industry development. Role of OECD and WTO in International seed trade.International Seed Federation (ISF). Market survey, demand forecasting, pricing policies, marketing channels, planning and sales promotion. Economics of seed production.Role of Government, semi Government, cooperative and private sectors in seed trade.Responsibilities of seed companies and dealers in Seed Act.Seed import and export.

#### **Unit 8:**

Protection of Plant Varieties Plant Variety Protection (PVP) and its significance. International Union for the Protection of New Varieties of Plants (UPOV) and its role in development of Plant Breeders Rights and Seed Industry Development. UPOV 1978 and 1991 Acts.Plant Breeders Rights and exceptions to it.Breeders exemption and farmers privilege. Plant patent v/s Plant breeders rights.

Impact of PVP on seed supply system.Protection of Plant Varieties and Farmers' Right Act, 2001, its essential features.Criteria for protection of different types of plant varieties.DUS testing principles and application.Breeders, Researchers and farmers rights.Compulsory licensing. Indian Biological Diversity Act, its essential features. Access to Biological resources, benefit sharing.

#### 3. Entomology (Agriculture)

#### **Insect Morphology**

Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation, Head-Origin, structure and modification; types of mouthparts and antennae, tentorium and neck sclerites, Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications, Abdomen-Segmentation and appendages; Genitalia and their modifications; embryonic and post-embryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemo- receptors), Structure of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands.

#### **Principles of Integrated Pest Management**

History and origin, definition and evolution of various related terminologies. Concept of IPM. Economic decision levels of insect pest population. Insect dominance, increase in agriculture pest problem, pest outbreak and factors affecting it; Categories of pest, Tools of pest management and their integration- legislative, cultural, physical and mechanical methods, host plant resistance, biological control, semiochemicals, botanicals and chemical control, insecticide resistance management; sampling, survey, surveillance and forecasting. Controversies, criticism and constraints in IPM. Case studies of successful IPM programmes. Pest control appliances and their maintenance.

#### **Insect Taxonomy**

Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Super class Hexapoda. Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families of orders Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota – Archaeognatha, Thysanura. Subclass: Pterygota, Division Palaeoptera– Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Grylloblattodea, Dermaptera, Orthoptera, Phasmatodea, Mantophasmatodea, Embioptera, Zoraptera), Subdivision: Hemipteroid orders (=Paraneoptera): Psocoptera, Phthiraptera, Thysanoptera and Hemiptera, Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera– Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Megaloptera, Neuroptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders:

Hymenoptera.

#### **Insect Physiology & Nutrition**

Scope and importance of insect physiology and nutrition, physiology of different systemsdigestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands, thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapauses, Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra- cellular microorganisms and their role in physiology; artificial diets,

#### **Toxicology of Insecticides**

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India, classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organo- chlorines, organophosphates, carbamates, pyrethroids, tertiary amines, neonicotinoids, oxadiazines, phenyl pyrozoles, insect growth regulators, microbials, botanicals, new promising compounds, etc., principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides- synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity, Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management and pest resurgence, Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides; diagnosis and treatment of insecticide poisoning.

#### **Pests of Field Crops**

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors, Insect pests of cereals and millets and their management. Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.), Insect pests of pulses, tobacco, oilseeds and their management, Insect pests of fibre crops, forages, sugarcane and their management.

#### **Biological Control of Crop Pests and Weeds**

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation, Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects, Mass production of quality biocontrol agents-techniques, formulations, economics, field release/application and evaluation, Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies- Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

#### **Storage Entomology**

Introduction, history and concepts of storage entomology. Post-harvest losses. Factors responsible for grain losses. Important pests namely insects, mites, rodents, birds and micro-organisms associated with stored grains and agricultural products. Association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage. Sources of infestation. Type of losses in stored grains and their effect on quality including biochemical changes. Ecology of insect pests of stored commodities. Stored grain deterioration process. Type of storage structures. Ideal storage conditions. Management of rodent and bird pests. Preventive and curative measures for the management of insect pests of stored grains. Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management.

#### **Pests of Horticultural and Plantation Crops**

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops, Fruit Crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, *ber*, fig, citrus, *aonla*, pineapple, apple, peach and other temperate fruits, Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, french beans, chow-chow, brinjal, okra, all gourds, gherkin, drumstick, leafy vegetables etc., Plantation crop-coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc.; Spices and Condiments- pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, beetlevine etc., Ornamental, medicinal and aromatic plants and pests in polyhouses/ protected cultivation.

#### **Insect Ecology**

History and Definition. Basic Concepts. Organisation of the Biological world. Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation. Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain-web and ecological succession. Interspecific interactions-Basic factors governing the interspecific interactions

#### 4. Botany

#### Unit I

Cryptogams and Phanerogams: A General account, Diagnostic features for classification of flowering plants; ICN, Taxonomic Tools and evidences, Nature, causes and classification of plant pathogen; Dissemination and methods of preservation and control of plant diseases, Host-parasite relationship, plant defense mechanism.

#### Unit II

Fungal and Bacterial disease of plant crops- rice, wheat, maize, sugarcane, cotton and groundnut; fruit crops- apple, peach, mango, citrus and grapes; vegetable crops- crucifers, tomato, potato and brinjal; other crops- tobacco, turmeric and coriander. Introduction to mushroom groups, taxonomic study of order Agaricales, Ecology of mushrooms, role of mushrooms in forest ecosystems, Mycorrhiza: VAM fungi, ectomycorrhiza and forest ecosystem. Tissue culture of wild mushrooms; Preparation of herbarium: methods of collection, identification and preserving wild mushrooms. Cultivation of edible and medicinal mushrooms: Volvariella, Agaricus, Pleurotus, Lentinus, Ganoderma.

### Unit III

Physiology and Biochemistry: Functions of biological molecules, cell and organisms as biochemical entities; Metabolism and biochemical energetic, Palynology: General Introduction and history, Importance of Palynology in plant taxonomy, pollen biotechnology, aerobiology and pollen allergy, forensic palynology, melissopalynology, palaeopalynology and in hydrocarbon exploration.

### Unit IV

Plant Breeding: Objectives, activities and achievements. Breeding methods for self, cross pollinated and clonal crops; Breeding for resistance to various stresses and quality; Biotechnology applications in crop improvement, IPR and plant breeders rights (PBR). Green Revolution.

#### Unit V

Biodiversity: Concept, biodiversity of major groups including microbial biodiversity, distribution, maintenance and loss of biodiversity. Conservation of Biodiversity: Concept, Environmental policies, Biosphere Reserves, National Parks, Sanctuaries, Botanical Gardens, Pollen storage and Seed Banks, Tissue culture and role of biotechnology in conservation of biodiversity; Cryopreservation. CITES, IUCN, Ethnobotany: A General account. Forest types of Uttarakhand and other Himalayan provinces, Forest heritage in Garhwal Himalaya; Classification; forest products (NTFPs, medicinal and aromatic plants, fibre, etc.),

## 5. Chemistry

## Unit I

Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications. Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis. Cages and metal clusters. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; nitrogen fixation, metal complexes in medicine. Solid state: Crystal structures; Bragg's law and applications; band structure of solids

## Unit II

Basic principles of quantum mechanics: Postulates; operator algebra; exactly- solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling.Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.

## Unit III

Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.Common named reactions and rearrangements – applications in organic synthesis.Pericyclic reactions – electrocyclisation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.

## Unit IV

Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S), Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids.Polymer chemistry: Molar masses; kinetics of polymerization

## Unit V

Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques. Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis. Structure determination of organic compounds by IR, UV-VIS, 1H & 13C NMR and Mass spectroscopic techniques.

### 6. Mathematics

## UNIT – I

**Linear Algebra:** Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification of quadratic forms.

## UNIT – II

Complex Analysis: Algebra of complex numbers, the complex plane, polynomials, power series,

Transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Taylor series, Laurent series, and calculus of residues.

Algebra: Permutations, combinations, Euler's Ø- function, primitive roots.Groups, subgroups, normal subgroups, quotient groups, homomorphism, cyclic groups, permutationgroups, Cayley's theorem, class equations, Sylow theorems.Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal idealdomain, Euclidean domain.Polynomial rings and irreducibility criteria.Fields, finite fields, field extensions, Galois Theory.

## UNIT – III

#### **Ordinary Differential Equations (ODEs):**

Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs.General theory of homogenous and non-homogeneous linear ODEs, variation of parameters,Sturm-Liouville boundary value problem, Green's function.

#### **Partial Differential Equations (PDEs):**

Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs.Classification of second order PDEs, General solution of higher order PDEs with constant Coefficients. Method of separation of variables for Laplace, Heat and Wave equations.

### UNIT - IV

**Numerical Analysis:**Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rateof convergence, Solution of systems of linear algebraic equations using Gauss elimination andGauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numericaldifferentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler andRunge-Kutta methods.

### UNIT –V

Descriptive statistics, exploratory data analysisSample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate); expectation and moments.Independent randomvariables, marginal and conditional distributions. Characteristic functions. Standard discrete and continuous univariate distributions.Linear programming problem, simplex methods, duality.Elementary queuing and inventory models.Steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C,M/M/C with limited waiting space, M/G/1.

## 7. Biotechnology

## Unit I

Plasma membrane: Structure, organisation, lipid bilayer, proteins & glycoconjugates, liposomes. Function- Ionic transport, types of transport (symport antiport, active & passive,), channel proteins. Intracellular compartmentalization Structure, organization and functions of Nucleus, Mitochondria, lysosome, Golgi body, Chloroplast, Peroxisome, Endoplasmic reticulum (Rough and smooth) Cell motility and shape: Structure and functions, Microfilament, Microtubules and Intermediate filament

## Unit II

Mechanism of DNA replication in prokaryotes and eukaryotes, Mechanism of transcription in prokaryotes and eukaryotes, Reverse transcription, Post transcriptional processing of RNA: (capping, polyadenylation, splicing, RNA editing), Mechanism of translation in prokaryotes and eukaryotes.

## Unit III

DNA sequencing: chemical and enzymatic methods, PCR. Site directed mutagenesis, Ribonuclease protection assay, Gel retardation assay, DNA foot printing, DNA finger printing, DNA profiling, Genomic analysis: Exon-intron trapping, S-1 mapping, RFLP, RAPD, AFLP. Gene therapy: Principles, strategies and ethics of gene therapy, Sequence alignment and applications: Local and Global alignment, Scoring Matrices; Homology and related concepts; Dot matrix; general gap, gap penalty.

## Unit IV

Spectroscopic methods: principle and applications of UV-visible, IR, NMR, ESR Measurement of radioactivity: GM Counter, gamma counter, liquid scintillation counter. Tracer techniques of Autoradiography, Radioimmunoassay, Chromatography - General principle, types and application, Electrophoresis - General principle and application, Centrifugation: Basic principles. Common centrifuges used in laboratory, Microscopy.

### Unit V

Carbohydrate – Classification, structure and functions, TCA cycle, Glycolysis, Amino acids & Proteins structures, Introduction to Monoclonal Antibodies and Hybridoma technology, Antigen-Antibody Interactions: Precipitation Reaction, Agglutination Reactions, RIA, ELISA, Western Blotting, Immuno precipitation, Immuno-fluorescence.

#### 8. Microbiology

#### Unit I

Landmark achievements in 20th century: Refutation of a biogenesis: discovery of penicillin: discovery of vaccination: proposal of one gene one enzyme hypothesis: discovery of double helix structure of DNA: discovery of recombinant DNA technology. Major contribution of scientists– Leeuwen hoeck, Edward Jenner, Alexander Flemming, Joshep Lister, Robert Koch, Louis Pasteur, Hargobind Khorana.

#### Unit II

Whittaker's five- kingdom concept of living organism-(General characteristics of those five groups), characteristics and importance of yeast, moulds (Penicillium Aspergillus), protozoa, Giardia, Plasmodium, plant diseases (brown spot of rice, stem rot of jute, black stem rust of wheat, apple scab, grey blight of tea, bacterial blight of rice, citrus canker).

### Unit III

Principles and applications, dark field, bright field, resolving power, numerical aperture, chromatic aberration, phase contrast microscopy, fluorescent microscopy, inverted microscopy, stereo microscopy, electron microscopy, TEM and SEM. Stains and staining- Principles of staining, simple staining, negative staining, differential staining, Gram and acid fast staining, flagella staining, capsule and endospore staining.

#### Unit IV

Introduction to biomolecules- Outline structure, function and examples of carbohydrate, lipid, protein (primary, secondary, tertiary and quaternary). Amino acids, DNA, RNA Control of microbes-Sterilisation, disinfection, antiseptic, tyndallisation, pasteurization: Physical- dry heat, moist heat, UV light, ionizing radiation, filtration, HEPA filter, Chemical-phenol and phenolic compounds, (halogen aliphatic alcohol, formaldehyde, ethylene oxide, heavy metals) anionic and cationic detergent Cell structure and sub cellular organelles of bacterian– Slime layer, capsule, cell wall, flagella, pili, fimbriae, nucleoid, plasmid and episome (F, R, Ti as example) ribosome,

Virology-General classification of virus, (structure, nucleic acid, cultivation of bacteriophage, coliphage), animal virus (chick embryo, tissue culture, plant virus, TMV using carborandum). Importance of viruses, life cycle of viruses, lytic cycle (T4) and lysogenic (lambda).

Unit V

Air microbiology- Microorganisms in the air, sampling techniques, air borne pathogens.

Microbiology of water-Microbiology of fresh water and wastewater (sewage), BOD, COD (definitions), general outline of water treatment process: septic tank, sedimentation Activated sludge and trickling filter process. Important water borne diseases– cholera, typhoid, (name of pathogen, preventive measures). Outlines of method for detection of microorganisms in drinking water (presumptive, confirmatory and completed tests). Distinction between fecal and non-fecal coliforms, IMVIC tests.

### 9. Zoology

Animal Diversity: General characters and Classification of Non Chordate Phyla, General character and Classification of chordates.

Cell Biology: Theories in Origin of cell and cell as a unit of life, Structure of Prokaryotic and eukaryotic Cell, Cellular Oragnaelles and their functions : Plasma membrane and its various models, ionic transport, type of transport, cell cycle and its regulation Molecular basis of signal transduction. Cancer and its types, Apoptosis and necrosis, oncogenes and tumour suppressor gene Viral and cellular oncogene.

Molecular Biology :DNA replication. Genetic code. Transcription and translation in prokaryotes and eukaryotes.RNA Synthesis and processing. Mutations & DNA repair systems. Theories in support of DNA as a geneticmaterial, The central Dogma of Molecular Biology. DNA: Structure and conformation, supercoiling,packing of DNA into chromosomes. Structural polymorphism of DNA & RNA. Threedimensional structure of t-RNA. Cell communication and cell signaling

Genetics : Mendelian laws (Law of dominance, Law of Independent assortment,)Exception of Mendelian laws, lethal allele, multiple allels gene interaction (modification ofdihybrid ratios) Sex linked inheritance, linkage and crossing over,Fine Structure of gene, Giant Chromosome (Polytene and lampbrush chromosome), Pedigreeanalysis in man, genetic disorders, cytoplasmic inheritance and extrachromosomal inheritance, Operon hypothesis, Hardy-Weinberg law and its application, Mutation and its types.

Evolution and Systematics: Concepts of organic evolution and evolutionary theories. Origin of life (including aspects of prebiotic environment and molecular evolution). Micro and macroevolution. Synthetic theory of evolution,Natural selection. History of animal taxonomy. Species concepts (Typological, Nominalistic, Biological and Evolutionary). Linnean hierarchy. Zoological Nomenclature: ICZN; Taxon, Rank and Categories. Preparation of Keys, Techniques of museum preparation. The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Stages in primate evolution including Homo.

Biostatistics and Tools and Techniques :Calculation of mean, median, mode, range, variance, standard deviation. Concepts of co-efficient of variation, skewness & kurtosis. Simple correlation. Elementary idea of random variables. Students-t, chi-square and F- test of significance. Introduction to some distributions of random variables: Binomial, Poisson, normal. Microsocopy, principle & applications - Light microscope and phase contrast microscope ,Fluorescence microscope, Electron microscope , General Principle and applications of, Colorimeter , Spectrophotometer, Flame photometer Separation techniques- Chromatography, principle type and applications. Electrophoresis, Centrifugation , Ultra centrifuge.

Animal Physiology: Physiology of digestion & absorption: Mechanism of Digestion and absorption of proteins, fats and carbohydrates. Physiology of respiration: Exchange of respiratory gases at the pulmonary surface. Transport of respiratory gases by blood. Oxyhaemoglobin dissociation curve. Neural and chemical control of respiration. Physiology of cardiovascular system: Characteristics of vertebrate cardiac muscle. Initiation, conduction and regulation of heart beat. ECG and myocardial infarction. Blood pressure and its regulation. Blood groups.Coagulation of blood. Physiology of excretion: Formation of urine: Functional anatomy of the kidney. Glomerular filtration and its control. Counter current mechanism. Functions of aldosterone, antidiuretic hormone and renin-angiotensin system in renal physiology. Nervous system: Functional differentiation of brain, Neuron - the basic functional unit. Ionic basis of resting and action potentials of neurons, Mechanism of synaptic transmission. Reflexes and types of reflexes.Mechanism of thermoregulation in poikilotherms, homeotherms and heterotherms.

Developmental Biology :Potency, commitment, Specification, Cell Fate and Cell lineages, Stem Cells, Programmed cell death, Aging and Senescence. Development and differentiation of sperm and oocytes, capacitation, vitellogenesis. Mechanism of fertilization acrosomal reaction, cortical reaction and fertilization membrane. Blocks to polyspermy, Parthenogenesis. Cellular differentiation (transcriptional regulation of gene expression, differential RNA processing and translation). axes and pattern formation in Drosophila, amphibia and chick; organogenesis –eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development-larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Ecology :Definition, Scope, Importance, Application. Limiting Factors: Liebig's law of the minimum,Shelford's law of tolerance. Combined concept of limiting factor, Factor interaction. Homeostasis. Biogeochemical cycle (nitrogen, phosphorus, carbon & water cycle). Ecosystem. Concept; Energy flow; Food chains & Ecological pyramids. Habitat Ecology: Concept of habitats & ecological niche. Population: Concept & attributes: Biotic potential, Density, Natality, Mortality; Intrinsic rate of natural increase, survivorship curves. Population growth forms; Carrying capacity; Population regulation (Density dependent and independent). Community: Concept & characteristics: Density, Dominance, Diversity& Stratification. Succession of communities; Key stone species.

Immunology :Overview of The Immune System. Cells and Organs of The Immune System. Antigens,Haptens& Epitopes Immunoglobulins: Structure andFunction. Major Histocompatibility Complex. Cytokines, Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis. Hypersensitivity and Autoimmunity. Introduction to Transplantation. Vaccines: Active and Passive Immunization Introduction to Monoclonal Antibodies and Hybridoma technology. Antigen-Antibody Interactions: Precipitation Reaction, Agglutination Reactions, RIA, ELISA, Western Blotting, Immuno precipitation, Immuno-fluorescence.

## 10. Education

Unit-I Philosophical & Sociological Bases of education Unit-II Advanced Educational Psychology Unit-III Research methodology and Statistics in Education Unit-IV Comparative Education and Curriculum Development

## **11. Human Resource Management**

## Unit 1:

Meaning and Definition of Management, Principles of Management, Meaning of Communication and its types, Meaning of Human Resource Management and Human Resource Planning, Meaning of a Company and its formation.

## Unit 2:

Introduction of Economics, Definitions, Principles of Economics, Theory of Demand and Supply, Indifference Curve Analysis, Demand Forecasting, Demand Analysis, Classical approach: Implications – Keynesian approach, Economic Functions of Modern Government – Role of Government in Economic Planning and Market Governance.

## Unit 3:

Overview of Financial Management, Capital Budgeting, Concept of Capital Structure, Characteristics and Objectives of Management Accounting ,Information Integrity of Accounting Information, Professional Organizations - Competence, Judgment, and Ethical Behavior Accounting Systems: Basic Functions of an Accounting System - Designing and Installation Accounting Systems, Introduction to Statistics, Calculation of Mean, Median, Mode and Standard Deviation.

### Unit 4:

Introduction of Marketing and its functions, Pricing Strategies, Introduction to Marketing Research, Qualitative and quantitative research methods, Sampling methods, Questionnaire design, reliability and validity, Emerging Trends in marketing: Rural Marketing, Green marketing, Experiential marketing, Digital Marketing ,e-business, Online marketing, Online retailing, Media marketing and advertising, Brand Management

### Unit 5:

Social Entrepreneurship Social entrepreneurship, social entrepreneurs as change agents, financial sustainability Social entrepreneurship in India and abroad, Business ethics Corporate Social responsibility Corporate governance, Succession Planning Business growth and need of succession Planning in India. Its role and importance in expansion management.

## 12. Marketing

## Unit 1:

Meaning and Definition of Management, Principles of Management, Meaning of Communication and its types, Meaning of Human Resource Management and Human Resource Planning, Meaning of a Company and its formation.

## Unit 2:

Introduction of Economics, Definitions, Principles of Economics, Theory of Demand and Supply, Indifference Curve Analysis, Demand Forecasting, Demand Analysis, Classical approach: Implications – Keynesian approach, Economic Functions of Modern Government – Role of Government in Economic Planning and Market Governance.

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## Unit 5:

Social Entrepreneurship Social entrepreneurship, social entrepreneurs as change agents, financial sustainability Social entrepreneurship in India and abroad, Business ethics Corporate Social responsibility Corporate governance, Succession Planning Business growth and need of succession Planning in India. Its role and importance in expansion management.

## 13. Economics

# Unit-I

Theory of Consumer Behavior: Basic concepts; Marshall's Approach; Ordinal Utility Theory: Optimizations, derivation of demand function, income-leisure, substitution and income effects; Theory of revealed preference, Consumer Surplus and Elasticity of Demand. Public Revenue: Sources of Revenue, Taxation – characteristics of a good taxation system. Agrarian Reforms: Land Reforms, New agricultural policy; Production structure of Indian Agriculture;

# Unit- 2

Keynesian Theory of Income Determination: Concepts and Functions; Two sector, Three sector and four sector Models of Income Determination; Investment Multiplier; Balanced Budget Multiplier. Theories of Consumption: Keynesian Theory; Consumption Puzzle; Absolute Income Hypothesis, Relative Income Hypothesis. Planning commission v/s NITI Aayog. Concepts and uses of sampling. Conceptualization of Trade: Classical, Neo Classical and New Theories of trade, Planning for Rural Development:

# Unit- 3

Banking – Theories of Banking; Commercial and Central Banking Systems – Functions, Credit Creation and Credit Control; Banking and Non-Banking Financial Intermediaries in India; RBI – Functions, Monetary Policy – Methods and Recent Changes in India; International Monetary policy transmission mechanism. Regional and Multinational agreements. Structure and Working of International Monetary Fund and World Bank. LPG policy in India. Managing Agriculture: role of agri-business, linking farmers with new markets, diversifying agriculture.

# Unit- 4

Perfect competition, monopoly, oligopoly, monopolistic competition and non-price competition. The labour market, Equilibrium in the economy. Economic growth and the economic cycle. Unemployment, Inflation, Exchange rates. International trade, balance of payments and protectionism, Protectionism and globalization. Human Development Index and Physical Quality of Life Index. Industrial Economics, Banking and Non-Banking Institutions. Introduction to Credit Rating - CRISIL and ICRA. Population and Population Policy in India.

#### 14. Music

## UNIT-I

History of Music-Vadic Time to 20<sup>th</sup> century. Gharana and style of Music-Gwalior,Agara,Banaras,Dilli,Punjab etc.

### UNIT -II

Detail study of Sangeet Utpatti; Musical scales (Indian and western); Detail study of Gram, Murchchhana and Chatussarna; Jaati Lakshana, Jaati Bhed, concept of Raag, Raag-Lakshan. Classification of Raag: 1) Gram Raag and Deshi Raag Classification 2) Male Raag classification 3) Thaat Raag classification 4) Shuddha, Chhayalag and Sankeerna Raag classification 5) Raag-Raagini classification 6) Raagang classification; Time theory of Raagas; Placement of shuddha and vikrit swaras on shruties in Ancient, Medieval and Modern Period; Description of popular Raagas and Taalas;

## UNIT -III

Notation systems of Hindustani, Karnataka and Western Music; Merits and demerits of a vocalist (Gayak); Comparative studies of Hindustani and Karnatak Swaras and Taalas; Karnatak names of Popular Hindustani Ragas; Knowledge of different Layakaaries such as dugun, Tigun, Chaugun, Aad, Kuad and Viaad.

### UNIT -IV

1-Critical Study of Ragas and-Bhairav Bhoopali, Yaman, Malkauns, Chandrakauns, Bhimpalasi etc. 2-Critical study of Talas. Teental, Chartal, Ektal, Dhamar tal etc.

### UNIT-V

Rasa, Principles of Rasa according to Bharata and others. Rasa nishpatti and its application to Indian Classical Music. Bhava and Rasa Rasa in relation to swara, laya, tala, chhanda and lyrics.

#### 15. Pharmacology

#### Unit 1.Systemic Pharmacology and Chemotherapy -

**a.**Central nervous System- General anesthetics. Alcohols and disulfiram. Sedatives, hypnotics and centrally acting muscle relaxants, Psychopharmacological agents: Antipsychotics, antidepressants, antianxiety agents, anti-manics and hallucinogens. Anti-epileptic drugs.Anti-parkinsonism drugs.Nootropics.Narcotic analgesics, drug addiction, drug abuse, tolerance and dependence. **b.**Pharmacology of cardiovascular system - hemodynamics and Electrophysiology of heart. Anti-

**b.**Pharmacology of cardiovascular system - hemodynamics and Electrophysiology of heart. Antihypertensive drugs, Anti-anginal agents, Anti-arrhythmic drugs. Drugs used in congestive heart failure. Anti-hyperlipidemic drugs. Drugs used in the therapy of shock. Haematinics, anticoagulants and haemostatic agents. Fibrinolytics and antiplatelet drugs. Blood and plasma volume expanders.

**c.**Chemotherapy - Sulphonamides and co-trimoxazole. Antibiotics- Penicillins, cephalosporins, chloramphenicol, Macrolides, quinolones and fluoroquinolons,.Tetracyclines.Aminoglycosides and miscellaneous antibiotics. Chemotherapy of tuberculosis, leprosy, fungal diseases, viral diseases, AIDS, protozoal diseases, worm infections, urinary tract infections and sexually transmitted diseases. Chemotherapy of malignancy.

#### **Unit 2. Experimental Pharmacology:**

Common laboratory animals in pharmacological research, limitations of animal tests, alternatives to animal use, anesthetics used in laboratory animals, some standard techniques used in laboratory animals, euthanasia of experimental animals. Regulations for the care and use of laboratory animals. In vivo and in vitro experimentation, its advantages and disadvantages

*Preclinical evaluation:* Pharmacological evaluation of acute, sub acute, and chronic toxicity studies. *Clinical Evaluation:* Justification and purpose, clinical evaluation including phase I, II, III and IV studies, ethical and legal aspects of clinical trials, methods of randomization, size, documentation, monitoring and management of clinical trials

### Unit 3. Pharmacological methods and Toxicology -

#### 1. Essentials of Toxicology:

**a.**Physicochemical, Biochemical and genetic basis of toxicity, principles of mutagenesis and carcinogenesis.

**b.**Guidelines and regulatory agencies – CPCSEA, OECD, FDA, WHO etc.

c.cellular and sub-cellular toxicity hypersensitivity and immune response.

d.Acute poisoning and its treatment

2.Pharmacological Techniques to evaluate drugs belonging to following categories.

**a.** Cardiovascular pharmacology– Anti-hypertensives, anti-arrythmics, vasodilators and diuretics.

b.Drugs for neurodegenerative diseases like Parkinsonism, Alzheimers,

c.Respiratory pharmacology - Anti- asthmatics, Anti- allergic and antitussives

**d.**Reproductive pharmacology – and anti- fertility agents.

**e.**Analgesics, anti- inflammatory and antipyretic agent.

**f.** CNS pharmacology – behavioural and muscle co-ordination, CNS stimulants and depressants, anxiolytics, anti-epilepticsandNootropics

**g.** Gastrointestinal drugs – Anti- ulcer, anti-emetic, anti-diarrhoeal and laxatives.

**h.** Anti-cancer agents.

**i.** Drugs for metabolic disorders like anti-diabetic, anti- hyperlipidemic ,antiobesity, and hepatoprotective agents.

## Unit 4.Recent advances in Pharmacology

**a.** Programmed Cell Death (Apoptosis):Molecular biology, physiological and pharmacological implications and the rapeutic potentials of apoptosis.

**b.** Cytokines and Chemokines:Classification, physiology, pharmacology, pathological, and therapeutic implications of various cytokines and chemokines.

c. Growth Factors: Biology and therapeutic potentials of various growth factors.

**d.** Biology of Vascular Endothelium:Pharmacology of endothelins and nitric oxide. Clinical implications of endothelial dysfunction.

e. Nucleic Acid Therapies: Basic concepts and clinical potentials of gene therapy,

**f.** Genomics:Impact of human genome sequence on the discovery of newer pharmacological agents. Basic concept and applications of bioinformatics in drug discovery.

g. Stem Cell Therapeutics: Biology of stem cells and their potentials in various disorders.

**h**.Pharmcoeconomics:Principles, methods, and applications of pharmcoeconomics to pharmacotherapy and managed health care.

## **Unit 5. Biostatistics**

**a.** Basic Definitions and Concepts

**b.** Statistical Inference: Estimation and Hypothesis Testing:Statistical Estimation (Confidence Intervals), Statistical Hypothesis Testing, Comparison of Variances in Independent Samples, Test of Equality of More than Two Variances confidence limits for variance Tolerance Intervals

**c.** Analysis of Variance:One- Way Analysis of Variance Planned Versus a Posteriori (Unplanned) Comparisons in ANOVA, Another Example of One- Way Analysis of Variance: Unequal Sample Sixes and the Fixed and Random Models, Two-Way Analysis of Variance (Randomized Blocks), Statistical Models, Analysis of Covariance, ANOVA for pooling regression lines as related to stability data.

**d.** Nonparametric Methods:Data Characteristics and an Introduction to Nonparametric Procedures, Sign Test, Wilcoson Signed Rank Test, Wilcoson Rank Sum Test (Test for Differences Between Two Independent Groups), Kruskal Wallis Test (One- Way ANOVA)

#### 16. Pharmacognosy

### Unit I

Plant drug cultivation: General introduction to the importance of Pharmacognosy in herbal drug industry, Indian Council of Agricultural Research, Current Good Agricultural Practices, Current Good Cultivation Practices, Current Good Collection Practices, Conservation of medicinal plants- Ex-situ and In-situ conservation of medicinal plants.

## Unit II

Extraction and Phytochemical studies: Recent advances in extractions with emphasis on selection of method and choice of solvent for extraction, successive and exhaustive extraction and other methods of extraction commonly used like microwave assisted extraction, Methods of fractionation. Separation of phytoconstituents by latest CCCET, SCFE techniques, including preparative HPLC and Flash column chromatography.

## Unit III

Evaluation of cosmetic products: Determination of acid value, ester value, saponification value, iodine value, peroxide value, rancidity, moisture, ash, volatile matter, heavy metals, fineness of powder, density, viscosity of cosmetic raw materials and finished products. Study of quality of raw materials, general methods of analysis of raw material used in cosmetic manufacture as per BIS.

## Unit IV

Herbal drug industry: Infrastructure of herbal drug industry involved in production of standardized extracts and various dosage forms. Current challenges in upgrading and modernization of herbal formulations. Entrepreneurship Development, Project selection, project report, technical knowledge, Capital venture, plant design, layout and construction. Pilot plant scale – up techniques, case studies of herbal extracts. Formulation and production management of herbals.

### Unit V

Different tissue culture techniques: Organogenesis and embryogenesis, synthetic seed and monoclonal variation, Protoplast fusion, Hairy root multiple shoot cultures and their applications. Micropropagation of medicinal and aromatic plants. Sterilization methods involved in tissue culture, gene transfer in plants and their applications.

#### 17. (A). Pharmaceutical Chemistry (M.Sc. based)

### Unit I

Structure, formation, reaction, stereochemistry and stability of Carbocation, Carbanions, free radicals, carbene, and nitrene. Mechanism involving free radical, nucleophile & electrophile mediated reactions.  $S_N 1$ ,  $S_N 2$  and mixed  $S_N 1$  and  $S_N 2$  mechanism and its stereo chemical aspects. Factor influencing neucleophilic substitution reactions, Reactivity effects of substrate structure, attacking nucleophilic group, leaving group and reaction medium, ambient nucleophile. Mechanisms involving Aromatic electrophilic reaction, Aromatic nucleophilic reactions, free radical reactions and elimination mechanism. Mechanism and stereo chemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemo selectivity, orientation and reactivity. Addition to cyclo propane ring. Geometrical isomerism & stereochemistry of olefins. Stereoisomerism of rings, stability of rings, ease of ring formation, Actual shape of six membered rings & its relation to properties & reactivity. Optical rotation, its significance, instrumentation.Optical rotatory dispersion-terminology, plain curve, rotatory dispersion & circular dichroism and octane rule.

#### Unit II

Chromatography: principles , instrumentation and application of following separation techniques Paper chromatography, Thin layer chromatography, Column chromatography, HPLC, GC, HPTLC, Electrophoresis, Ion exchange and Gel filtration chromatography. UV-Visible spectroscopy: Theory, absorption law, Colorimetric Methods, Chromophore and auxochrome concept, Solvent effect, Instrumentation and applications, Woodword's Fieser, Fieser Kuhn and Nelson rule, Spectral correlation with structures. Atomic spectrophotometry: Atomic emission & Atomic absorption spectrophotometry: principle, instrumentation, interferences and applications. Infrared spectroscopy, Interpretation of IR, spectra of simple compounds. NMR, Spectrometry: Principle, ionization techniques, instrumentation, fragmentation pattern & applications. GC-MS and LC-MS: Principle, Instrumentation and Applications.

### Unit III

Carbohydrate : Introduction, classification, mutarotation, constituent of glucose, ring structure of glucose, configuration of monosaccharides, structure elucidation of disaccharides- sucrose, maltose, lactose, polysaccharides- starch. Glycosides arbutin ,amygdaline.

Alkaloids : General introduction, distribution in plants, classification, isolation & purification. General methods of structure determination. Structural elucidation of atropine, quinine, Nicotin, Terpenoids : General introduction, classification, isolation & purification, isoprene, structure elucidation of citral, menthol, camphor, Structures of abietic acid and  $\beta$ -carotene. Plant Pigments: Occurrence, nomenclature and general methods of structure determination. Isolation and synthesis of cyanidin, and quercetin. Porphyrins: General Introduction of haemoglobin and chlorophyll. Chemistry of chlorophyll (without synthesis). Structure and synthesis of haem.

Heterocyclic compounds: General chemical behaviour of aromatic heterocycles, classification (structural type), Heteroaromatic reactivity and tautomerism in aromatic heterocycles Strain –bond angle and torsional strains and their consequences in small ring heterocycles. Conformation of sixmembered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interactions. Stereo-electronic effects, aromatic and related effects. Attractive interactions - hydrogen bonding and intermolecular nucleophilic, electrophilic interactions., Small Ring Heterocycles: Three-membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, thiiranes, azetidines, oxetanes and thietanes, Benzo-Fused Five-Membered Heterocycles: Synthesis and reactions including medicinal applications of benzopyrroles, benzofurans and benzothiophenes, Six-Membered Heterocycles with One, Two or More Heteroatoms: Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridinium & thiopyrylium salts and pyridines Synthesis and reactions of quinolizinium and benzopyrylium salts, coumarins and chromones Synthesis and reactions of diazines, triazines, tetrazines and thiazines

## Unit-IV

Concept of isosterism and bioiososterism and their applications in drug design, Antimetabolite approach to drug design, Analog drug design, Prodrugs and drug latentiation – Carrier-linked prodrugs – Bioprecursors – Role of functional groups in prodrug design, General pathways of drug metabolism

Specific and non-specific drug action, Drug receptors, Basic concept and classification of receptors, Forces involved in drug receptors- interactions, Receptor agonism and antagonism, Stereochemical aspects of drug action – Setereoselectivity of optical isomers – Role of planarity in drug action – Stereoselectivity of conformational isomers,

### Unit-V

Green chemistry: History, need, and goals. Green chemistry and Sustainability. Dimensions of sustainability, Limitations/Obstacles in pursuit of the goals of Green Chemistry. Opportunities for the next generation of materials designers to create a safer future. Hazard assessment and mitigation in chemical industry , Future trends in Green Chemistry: Oxidation-reduction reagents and catalysts, Statistical data analysis: Accuracy and precision, significant figures and computations, mean and standard deviation, distribution of random errors, reliability of results, confidence interval, comparison of results, comparison of means of two samples, paired t-test, number of replicate determinations and its use, correlation and regression, linear regression, analysis of variance, rejection of data.

### 13(B). Pharmaceutical Chemistry (M. Pharma based)

### **UNIT 1 Concept of organic reactions**

Organic reaction mechanism : Methods of determining reaction mechanisms (kinetic and non-kinetic methods); Energy profile diagrams, reaction intermediates, crossover experiments and isotopic labelling; Order of reactions, reversible, consecutive and parallel reactions, solvent, ionic strength and salt effects; Acid-base catalysis; Nucleophilic substitution reactions; Uni- and bimolecular reactions, attacking and leaving groups, steric and electronic effects; Neighbouring group participation; Formation and hydrolysis of esters, amides and acyl halides; Different mechanisms. Electrophilic substitution reactions; Aromatic electrophilic substitutions including Friedel-Crafts reactions; Addition and elimination reactions.

### UNIT II Spectral Analysis

UV-Visible Spectroscopy: Brief review of electromagnetic spectrum, UV-Visible range, energywavelength-colour relationships, Interaction of electromagnetic radiation (UVVis) with matter and its effects, Chromophores and their interaction with EMR, BeerLambert's law, Instrumentation of single beam and double beam spectrophotometers and applications.

IR Spectroscopy, Identification of functional groups, confirming the molecules with IR, estimating the purity of compound, finger print region

Mass Spectrometry: Basic principles and brief outline of instrumentation. Ion formation and types, molecular ion, meta stable ions, Fragmentation processes, Fragmentation patterns, Mass spectrum, its characteristics and representation.

NMR : Reference, Chemical shift, solvents used in NMR, D2O exchange, identification of nature of protons and number of protons on particular chemical environment.

### **UNIT III Separation Techniques**

Chromatography: General principles, classification of chromatographic techniques, normal and reversed phase, bonded phase, separation mechanisms.

Column chromatography: Merits and demerits, short-column chromatography and flash chromatography, vacuum liquid chromatography (VLC), medium pressure liquid chromatography, high pressure liquid chromatography (HPLC).

TLC, HPTLC, over pressure layer chromatography (OPLC), centrifugal chromatography.

Counter-current chromatography, droplet counter-current chromatography, ion-exchange, affinity, size exclusion and ion-pair chromatography.

Gas chromatography, introduction to GC-MS and LC-MS techniques.

## **UNIT IV Basics of Drug Action**

General principles, Identification and study of targets for development of various therapeutic agents, Rational approach for drug design, Computer aided drug design, QSAR, Molecular modelling, Combinatorial Chemistry, Study of recently developed drugs and molecules in development pipeline.

Concept of isosterism and bioiososterism and their applications in drug design, Antimetaboliteapproach to drug design, Analog drug design, Prodrugs and drug latentiation, Carrierlinked prodrugs, Bioprecursors, Role of functional groups in prodrug design, General pathways of drug metabolism

Specific and non-specific drug action, Drug receptors, Basic concept and classification of receptors, Forces involved in drug receptors- interactions, Receptor agonism and antagonism, Stereochemical aspects of drug action Setereoselectivity of optical isomers, Role of planarity in drug action, Stereoselectivity of conformational isomers.

## **UNIT V Phytochemistry and Phytopharmaceuticals**

Extraction and Phytochemical studies: Recent advances in extractions with emphasis on selection of method and choice of solvent for extraction, successive and exhaustive extractionand other methods.

General introduction and classification, isolation and purification methods of alkaloids, structure elucidation of reserpine, atroipine and morphine.

Classification, method of isolation, chemistry, degradation, synthetic methods, spectral techniques for structural elucidation and biological activity of flavonoids rutin and quercetin.

Study of chemistry, stereochemical aspects and pharmaceutical importance of plant derived steroids - cardiac glycosides (cholesterol, diosgenin).

General introduction and classification terpenoids; Essential Oils; Production of Essential Oils ; Chemistry and Analysis of Essential Oils ; Biological Activities of Essential Oils ; Aromatherapy with Essential Oils ; Industrial Uses of Essential Oils, Essential Oils Used in Veterinary Medicine; Trade of Essential Oils; Recent EU Legislation on Flavors and Fragrances of Essential Oils.

Recent advances in the chemistry of naturally occurring anti-neoplastic agents (catharanthus alkaloids, camptothecin); antimalarials (cinchona alkaloids, artemisinin derivatives).

## 16. Social Works

## Unit 1

Personality: Concept, Stages of Development with special reference to Indian Concept of life span, Types, Determinants.

Heredity and Environment theories of Personality: Sigmund Freud, Carl Jung, Alfred Alder, All port.

## Unit 2

Concept of Normalcy and Abnormalcy. Defence Mechanism Etiology of Abnormal Behaviour. Symptoms of Abnormal Behaviour. Types of Abnormal Behaviour: Psychosis and Psychoneurosis. Management of Mental disorder.

## Unit 3

Motives & Principles of Social Work. Social Work as a Profession. Philosophy and Basic Values of Social Work. Social Work Education, Training and Knowledge.

### Unit 4

Social Welfare and Development Programmes: Child Development, Youth Development, Women's Empowerment, Welfare of the Aged, Handicapped, Welfare of Backward Classes with special reference to Scheduled Castes/Scheduled Tribes, Labour Welfare. Social Welfare Agencies: Government and Non-Government Organizations. Historical Development of Social Case Work. Social Group Work: Meaning, Objectives, Principles, Processes, Skill and Role of GroupWorker. Community Organization: Meaning, Objectives, Steps, Assumption, Principles, Models andStrategies.

### Unit 5

Methods of Data Collection: Questionnaire Schedule Interview, Observation and Case Study. Eradication of Major Social evils – Dowry, Child Marriage, Child Prostitution, Child Labour, Domestic Violence.

### Unit 6

Latest policy and those awareness, Recent trends in Counselling, Concept of HRM and HRD, its objectives, Scope and Principles. People's Participation in Rural Development, History of Medical and Psychiatric Social Work.

### 18. Cancer Research

### Unit I: Fundamentals of cancer

Introduction to cancer and cancer management, classification of cancers and tumors, Cancer epidemiology.

### **Unit II: Etiology of cancer**

Etiology of cancer, Tobacco and cancer pathogenesis, Virus mediated oncogenesis (RNA and DNA viruses), inflammation and cancer, Chemical & physical carcinogenes, carcinogenesis mechanism, types of carcinogenesis.

## **Unit III: Molecular Biology of Cancer**

Cellular Oncogenes, tumor suppressor genes, onco-signaling, cell cycle regulation, Apoptosis, Necrosis, autophagy, senescence, telomeres Gene Regulation. Genomic Instability, Angiogenesis and its implication in tumor progression, evolution and pathogenesis of metastasis, Models for metastasis, cancer stem cells

## **Unit V: Tumor Immunology and Immunotherapy**

Anti-tumor immune response of regulatory T cells, NK cells, immune surveillance theory, tumor associated antigens, evasion of immune surveillance by cancer cells, Principles of immunotherapy, CART cells.

## Unit VI: Experimental Techniques in Cancer Research

Cancer cell culture techniques, Cell Proliferation assays, Cancer stem cell assays & Radiolabelling Techniques Gene silencing/ over expression Animal models for cancer

# **19.** Computer Science

## Unit-I

## **Programming Skills and Algorithms:**

Procedural programming using C, elementary data structure ,data types, arrays, functions, pointers ,divide & conquer method, binary search, minimum spanning tree and their algorithm, dynamic programing, backtracking, 8-queen problem. DFS, BFS, Analysis of Algorithms, Design of Algorithms, and Complexity of Algorithms, asymptotic notations. Recurrences and Solution of recurrence Equations, Prims Algorithm, Kruskal Algorithm, Single Source.

## Unit-II

## **Computer Network and Architecture:**

Boolean algebra and Minimization of Boolean functions, Combinational Circuit Design, Sequential & combinational Circuit Design, decoder, encoder, multiplexer, flip-flops. Hardwired and Microprogrammed processor design, Instruction formats, Addressing modes, memory types and organizations, Interfacing peripheral devices, Interrupts. Concept of OSI, LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP), authentication, basics of public key and private key cryptography, digital signatures and certificates

## Unit-III

## Software Engineering:-

Definition, software engineering problem, approach and goals of software engineering. Software Processes, component of software processes, characteristics of a software process, SDLC. Software requirement, need for SRS, characteristics and component of SRS. Software maintenance, adaptive ,corrective and perfective maintenance. Computer Aided Software Engineering.

# Unit-IV

## **Computer Graphics:-**

Concepts and applications, display types and display devices, color display technique, Line and circle drawing algorithm.3-D Transformations, matrix representation of all homogeneous coordinates composite transformation. Projection, Windowing & clipping, Bezier curves, B-Spline curves, Visible Surface detection Algorithm, A-Buffer, Back face removal,

## Unit-V

**Operating Systems:** Characteristics & Function of operating system, Virtual memory, paging, fragmentation. Concurrent Processing , Mutual exclusion, Critical regions, Semaphores. CPU scheduling, I/O scheduling, resource scheduling, Deadlock and scheduling algorithms. Banker's algorithm for deadlock handling.

## 20. Economics

# Unit-I

Theory of Consumer Behavior: Basic concepts; Marshall's Approach; Ordinal Utility Theory: Optimizations, derivation of demand function, income-leisure, substitution and income effects; Theory of revealed preference, Consumer Surplus and Elasticity of Demand. Public Revenue: Sources of Revenue, Taxation – characteristics of a good taxation system. Agrarian Reforms: Land Reforms, New agricultural policy; Production structure of Indian Agriculture;

# Unit- 2

Keynesian Theory of Income Determination: Concepts and Functions; Two sector, Three sector and four sector Models of Income Determination; Investment Multiplier; Balanced Budget Multiplier. Theories of Consumption: Keynesian Theory; Consumption Puzzle; Absolute Income Hypothesis, Relative Income Hypothesis. Planning commission v/s NITI Aayog. Concepts and uses of sampling. Conceptualization of Trade: Classical, Neo Classical and New Theories of trade, Planning for Rural Development:

# Unit- 3

Banking – Theories of Banking; Commercial and Central Banking Systems – Functions, Credit Creation and Credit Control; Banking and Non-Banking Financial Intermediaries in India; RBI – Functions, Monetary Policy – Methods and Recent Changes in India; International Monetary policy transmission mechanism. Regional and Multinational agreements. Structure and Working of International Monetary Fund and World Bank. LPG policy in India. Managing Agriculture: role of agri-business, linking farmers with new markets, diversifying agriculture.

# Unit- 4

Perfect competition, monopoly, oligopoly, monopolistic competition and non-price competition. The labour market, Equilibrium in the economy. Economic growth and the economic cycle. Unemployment, Inflation, Exchange rates. International trade, balance of payments and protectionism, Protectionism and globalization. Human Development Index and Physical Quality of Life Index. Industrial Economics, Banking and Non-Banking Institutions. Introduction to Credit Rating - CRISIL and ICRA. Population and Population Policy in India.

## 21. Yogic science

UNIT-I: Various Systems of Yoga

- **1.** Gyanyoga, Bhaktiyoga.
- 2. Kramayoga, Rajyoga.
- **3.** Hathyoga, Mantrayoga.

UNIT-II: Introduction Of Yogis And Their Sadhna /Accustom System

- 1. Practice Based Tatv Mimansa and Achara Mimansa of Nyas andvaisheshik.
- 2. Practice Based Tatv Mimansa and Achara Mimansa of Samkhya and Yoga.
- **3.** Practice Based Tatv Mimansa and Achara Mimansa of Mimansa and Vedanta.

Ancient - Mahrishi Patanjali, Adi Shankracharya, Gorakshanath

Mordan - Swami Vivekanand, Shri Aravind, Mahrishi Raman and Swami Dayanand Saraswa

**UNIT-III:** Introduction of Yogic Text

- **1.** Patanjali Yoga Sutra, Hathpradipeeka and Gherand Sanhita.
- **2.** Shiv Samhita and Yoga Vashisht.
- **3.** Sidhsiddhant Paddhati and Hath Ratnawali.

**UNIT-IV:** Nature of Yoga In Fundamental Upnishad

- **1.** Mandukya Upnishad Four Stages of Conciousness & Relation with Omkar.
- 2. Etreya Upnishad Soul, Universe & Brahm.
- **3.** Taitreeya Upnishad Short Summary of Panchkosh, Acharyopdesh (Dikshant), Siksha Valli, Anand Valli and Bhrigu Valli.

**UNIT-V:** Anatomy & Physiology

- **1.** Digestive System structureandfunction.
- **2.** Physiology of Digestion and effect of yogic practices on the digestive system.
- **3.** Respiratory systemstructureandfunction and effects of yogic practices on Respiratory system. Muscle classification, histology and properties of each type distribution.Mechanism of muscle contraction (brief), neuromuscular transmission (brief).Ligaments, tendons, skeletal-bones-types, structural and function, spinal column.Joints type, structure and function. Effect of yoga on Musculo-Skeletal System.

#### 22. MEDICAL ANATOMY SYLLABUS

UNIT I -	General Anatomy	UNIT X -	Embalming
	General Embryology	UNIT XI -	Recent Advances
	General Histology		
UNIT II -	Upper Limb		
	Thorax		
	Applied Anatomy		
	Relevant Osteology		
	Relevant Embryology		
	Relevant Histology		
UNIT III -	Lower Limb		
	Abdomen & Pelvis		
	Applied Anatomy		
	Relevant Osteology		
	Relevant Embryology		
	Relevant Histology		
UNIT IV -	Head and Neck		
	Applied Anatomy		
	Relevant Osteology		
	Relevant Embryology		
	Relevant Histology		
UNIT V -	Brain - Neuroanatomy		
	Applied Anatomy		
	Relevant Embryology		
	Relevant Histology		
UNIT VI -	Histological Techniques		
UNIT VII-	Genetics		
UNIT VIII –	Evolution		
UNIT IX -	History of Anatomy		

#### 23. Hospital Administration

**Unit I:** Definition of management; Productivity, Efficiency and Effectiveness; Managerial Skills Evolution of management thought: Frederic W.Taylor's scientific management, Henry Fayol's principles of management, concept of bureaucracy, human relations approach, Behavioral approach, systems theory of organization, contingency theory of organization, management by objectives (MBO),

**Unit II** Management functions: Nature of management process and managerial functions – Planning • Types(mission, purpose, objective or goals, strategies, policies, procedures, rules, programs, budgets) • Steps in planning. • Decision Making Organizing • Meaning and purpose • Types :a)formal and informal b) functional and matrix c) line and staff d)departmentation • Authority & Power • Centralization & Decentralization • Delegation of Authority Staffing • Recruitment & Selection (Basic Concepts) Directing • Manager vs Leader • Motivation (Concept) • Leadership (Concept).

**Unit III** Health and Disease Concept, Definitions & Dimensions of health, Wellbeing, Determinants of health, Evolution of medicine, Public Health, Health indicators, Health service philosophies, Disease & causation, Natural history of disease, Disease control & prevention, Changing patterns of disease. Medical sociology – Introduction Sociological perspective of health, illness and healing. Institutional perspective and Organizational perspective. Unit 2 Public and Private Health Care Services in India Evolution of public health systems in India (ancient, colonial & post independence), Health Planning in India (Committees, Planning commission, Five year plans, National Health Policies), Public health systems in India (Center, State, District & Village level), Rural development, Corporate philosophy, Evolution and organisation of private health systems in India and Current trends in private health care in India.

**Unit IV** Statistical Measures and Presentation of Data- Basic concepts of statistics – utility and limitations of Statistics Measures of central tendency- Arithmetic Mean, Weighted Arithmetic Mean, Median, Mode, Quartiles; Measures of Variation, Standard Deviation (basic formula and problems) Presentation of data- Bar Diagram, Histogram, Frequency Polygon, Frequency Distribution Curves, Ogive and their managerial implications

**Unit V** Law and establishment of hospitals-private / public hospitals, legal requirements under medical council Acts. West Bengal Clinical establishment Act and rules 2017 (as amended till date). Essentials of contract Act. Contractual obligations in hospital services - requisites of a valid contract - hospital as ' bailer' - sale and purchase of" goods- duties towards patients - code of ethics - violation legal consequences. Legal aspects relating to organ transplantation, MTP Act, 1971, Basics of Drugs and Cosmetic Acts, anesthesia. ESI Act, PNDT Act, AERB, ICMR Guideline of Scientific Research Members, clinical trials.