G H RAISONI UNIVERSITY

Established Under UGC (2f) and Madhya Pradesh Niji Vishwavidyalaya
(Sthapana evam Sanchalan) Adhiniyam Act No. 17 of 2007
Accredited by ICAR and Recognised by BCI, PCI, MPNRC & MPPMC
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Syllabus

Syllabus for PET-2025, Winter Session, A.Y. 2025-26,

Admission in Ph.D. in Agricultural Sciences

Agronomy

Unit-1

Crop growth analysis in relation to environment; agro-ecological zones of India. Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit. Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield. Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.

Unit-2

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states. Water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition. Soil, plant and meteorologicalfactors determining water needs of crops; scheduling, depth and methods of irrigation; micro-irrigation system; fertigation; management of water in controlled environments and poly- houses. Water management of the crops and cropping systems; quality of irrigation water andmanagement of saline water for irrigation; water use efficiency. Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage.

Unit-3

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use. Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems. Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies;research need on sustainable agriculture. Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; fertilizer use efficiency and concept of fertilizer use in intensive cropping system. Plant ideotypes for dryland; plant growth regulators and their role in sustainability.

Unit-5

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry. Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers. Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides. Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Unit-6

Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients. Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient

interactions. Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermicompost and residue wastes in crops.

Unit-7

Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices. Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides. Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio-herbicides, mycoherbicides and allele-chemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation. Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control. Integrated weed management; cost: benefit analysis of weed management.

Unit-8

Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture. Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions. Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions. Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moistureconservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); anti-transpirants; soil and crop management techniques, seeding and efficient fertilizer use. Concept of watershed resource management, problems, approach and components.

Entomology

UNIT – 1

External morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions. Principles, utility and relevance: insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation. Head- Origin, **s**tructure 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 postembryonic development; Types of metamorphosis. Insect sense organs (mechano-, photo- and chemoreceptors). Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, endocrine and exocrine glands. Thermodynamics; physiology of integument, moulting; growth, metamorphosis and diapause. 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.

UNIT – 2

Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained. Distinguishing characters, general biology, habits and habitats of Insect orders and economically important

Syllabus

families contained in them. 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: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

UNIT – 3

History and Definition. Basic Concepts. Organization of the Biological world. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalized action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology. Basic concepts of abundance- Model vs Real world. Population growth basic models Exponential vs Logistic models. Discrete vs Continuous growth models. Balance of life in nature- Concepts of Carrying capacity, Environmental Resistance. Vital Statistics- 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- Classification of interspecific interactions – The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of niche, ecological homologues, competitive exclusion. Prey-predator interactions- Defense mechanisms against predators/parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies. Community ecology- Concept of guild, Organisation of communities. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity stability debate, relevance to pest management. Pest management as applied ecology.

UNIT – 4

History and origin, scope and need for IPM, definition and evolution of various related terminologies. Concept and philosophy, ecological principles, economic threshold concept, and economic consideration. Tools of pest management and their integration- legislative, cultural, physical and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; case studies of successful IPM programmes. History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation andconservation. 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 andevaluation. Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemiesQuarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

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UNIT – 5

Definition and scope of insecticide toxicology; history of chemical control, Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Structure and mode of action of organochlorines, 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.

UNIT – 6

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.

Plant Breeding & Genetics

UNIT –1

Beginning of genetics; Cell structure and cell division; Mendel's laws; Multiple alleles, Sex determination, sex-linkage, Sex-influenced and sex-limited traits; in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance. Population Genetics; Hardy-Weinberg equilibrium. Structural and numerical changes in chromosomes; Central Dogma; Genetic fine structure analysis, Jumping gene theory; Overlapping genes, seudogenes, Oncogenes, Gene Regulationin Prokaryotes an eukaryotes; mutation; Bacterial plasmids, Molecular chaperones and gene expression. RNA editing. Gene isolation, synthesis and cloning, genomic andcDNA libraries, PCR based cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).Genomics and proteomics; Metagenomics. Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

UNIT-2

Architecture of chromosome in prokaryotes and eukaryoties; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; artificial chromosome construction and its uses; Special types of chromosomes. Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance – Introduction to techniques for karyotyping; Chromosome banding and painting – in situ hybridization and various applications. Utilization of aneuploids in gene location somatic segregation and chimeras – Endomitosis and somatic reduction ; Evolutionary significance of chromosomal aberrations – balanced lethal and chromosome complexes. Inter- varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding allopolyploids utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis Reversion of autopolyploids to dipoloids; Genome mapping in polyploids – Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) Gene transfer using amphidiploids – Bridge species. Fertilization barriers in

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crop plants at pre- and post fertilization levels- In vitro techniques to overcome the fertilization barriers in crops; of haploids, dihaploids and doubled haploids in genetics and breeding.

UNIT –3

History & objectives of plant breeding, patterns & characteristics of evolution of crop plants; centres of Origin-biodiversity; Genetic basis of breeding self- and cross - pollinated crops; components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding. Selfincompatibility and male sterility; Pure line theory, pure line election and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding; Breeding methods in cross pollinated crops; Heterosis& Hybrid breeding ; seed production of hybrid and their parent arieties/inbreds. Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection. Selfincompatibility and male sterility; Concept of plant ideotype and its role in crop improvement; Transgressive breeding. Mutation breeding; Breeding for abiotic and biotic stresses. Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety
protection and farmers rights.

UNIT-4

Mendelian traits vs polygenic traits; Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic traits - phenotypic, Models of G XE; non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects. ANOVA; MANOVA, biplot analysis; Experimental Designs; Genetic diversity analysis; D2 analyses; correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices; Simultaneous selection models heritability and genetic advance. Generation mean analysis; Mating designs; Concepts of combining ability and gene action; adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis – principles and interpretation. QTL mapping; Marker assisted selection (MAS).

UNIT-5

Ultrastructure of the cell; eukaryotic and prokaryotic cells, macromolecules; Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles Bioenergetics; Ultrastructure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus- Structure and chemical composition; Cell division and physiology of cell division. Historical background of molecular genetics; Genetic material in organisms; Structure and properties of nucleic acid, DNA transcription and its regulation – Transcription factors and their role; Genetic code, regulation of protein synthesis in prokaryotes and eukaryotes – ribosomes, t-RNAs andtranslational factors. Mechanisms of recombination in prokaryote; DNA organization in eukaryotic chromosomes – DNA content variation, types of DNA sequences; organelle genomes; Gene amplification and its significance; Proteomics and protein-protein interaction; Signal transduction; Genes in development; Cancer and cell aging.

UNIT-6

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding. Tissue culture- History, callus, suspension cultures, cloning; Regeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation. Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs etc.), mapping populations (F2s, back crosses, RILs, NILs and DH). Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in

crop plants, Gene pyramiding. Molecular breeding; Genomics and geno-informatics for crop improvement; Integrating functional genomics information on agronomically/economically important traits in plant breeding; Marker- assisted backcross breeding for rapid introgression, Generation of EDVs. Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases. Biotechnology applications in male sterility/hybrid breeding, molecular farming. MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights; Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.

UNIT-7

Variety Development and Maintenance; Definition- variety, cultivar, extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid and population; Variety testing, release and notification systems in India and abroad. DUS testing- Genetic purity concept and maintenance breeding. genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties; Principles & methods of seed production; Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology; of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

Plant Pathology

UNIT 1

Classification of fungi, economic mycology, edible fungi and entomogenous fungi mycorrhizal association, cell organelles, their morphology, functions and chemical composition.

UNIT 2

Nature, composition and structure of viruses and viroids Symptomatology of important plant viral diseases, transmission, properties of viruses , host virus interaction,virus vector relationship. Virus nomenclature and classification, genome organization, replication and movement of viruses. Isolation and purification, electron microscopy, protein and nucleic acid based diagnostics. Myco-viruses, satellite viruses, satellite RNAs, phages, prions. Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses.

UNIT 3

Importance of phytopathogenic bacteria. Evolution, classification and nomenclature of phytopathogenic procaryota and important diseases caused by them. Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procaryota. General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios. Procaryotic inhibitors and their mode of action against phytopathogenic bacteria. Survival and dissemination of phytopathogenic bacteria.

UNIT 4

Importance, definitions and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development. Host parasite interaction, recognition concept and infection, symptomatology, disease development- role of enzymes, toxins, growth regulators;

defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker- assisted selection; genetic engineering for disease resistance. Disease management strategies.

UNIT 5

Pure culture techniques, use of selective media to isolate pathogens. Preservation of plant pathogens and disease specimens, use of haemo-cytometer, micrometer, centrifuge, pH meter, camera lucida. Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of references.

UNIT 6

Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds. Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens. Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection. Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

UNIT 7

Molecular mechanisms of pathogenesis, process of infection, variability in plant pathogens. Mechanism of resistance. Host defense system. Antiviral protein.SAR, active oxygen radicals. Hypersensitivity and its mechanisms Tissue culture, elementary genetic engineering. Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

UNIT 8

Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications. Development of IDM- basic principles, biological, chemical and cultural disease management.IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed, mustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.

(Horticulture) Fruit Science

UNIT-1

Importance and management of tropical sub tropical temperate and dry land fruits grown in India. Commercial varieties of regional, national and international importance. Recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bio-regulators. Physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential. Agri. Export Zones (AEZ) and industrial supports. Crops Mango, Banana, Citrus, Papaya, Guava, Sapota, Jackfruit, Aonla, Pomegranate, Ber, Apple, Pear, Grapes, Plums, Peach, Nuts- walnut, Almond Minor fruits- Bael, Fig and Jamun.

UNIT-2

Sexual propagation, apomixis, polyembryony, chimeras. Asexual propagation – rooting of soft and hard wood cutting under mist by growth regulators. Rooting of cuttings in hotbeds. Rejuvenation through top working–Progeny orchard and scion bank. Micro- propagation– principles and concepts, commercial

exploitation in horticultural crops. Nursery–types, structures, components, planning and layout. Nursery management practices for healthy propagule production.

UNIT-3

Principles of biodiversity in germplasm conservation of fruit crops. Present status of gene centers; exploration and collection of germplasm *in situ* and *ex situ;*I ntellectual property rights. Crops Mango, citrus, guava, banana, papaya, coconut.

UNIT-4

Principles and practices of breeding of fruit crops. Breeding systems, breeding objectives, approaches for crop improvement-introduction, selection, hybridization, mutation breeding, polyploidy breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses in the following selected fruit crops. Crops Mango, banana, citrus, grapes, guava, papaya.

UNIT-5

Principles and practices in canopy management of fruit crops. Canopy managementimportance and advantages; factors affecting canopy development. Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Canopy management through plant growth inhibitors, training and pruning and management practices in temperate fruits, grapes, mango, guava, citrus and ber. Role of hormones in different horticultural crops- fruit thinning, fruit drop, ripening, dormancy breaking and propagation.

(Horticulture) Vegetable Science

UNIT-1

Production technology of vegetable crops. Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties / hybrids, sowing / planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvestmanagement, plant protection measures and seed production of vegetable crops like - solanaceous crops, root crops, bulb crops, cucurbitaceous crops, sweet potato, okra and leafy vegetables.

UNIT-2

Breeding methods (introduction, selection, hybridization, mutation) of vegetable crops. Resistance breeding for biotic and abiotic stress, quality improvement, molecularmarker, genomics like - Potato, tomato, okra, peas, cabbage, cauliflower, carrot, radish, melons and pumpkins.

UNIT-3

Role of auxins, gibberellilns, cyktokinins and abscissic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

UNIT-4

Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production, methods of hybrid seed production. Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control. Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, okra and leafy vegetables.

UNIT-5

Production technology of underutilized vegetable crops. Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties / hybrids, sowing / planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching,

physiological disorders, harvesting, post harvest management, plant protection measures and production of: Asparagus, Elephant foot yam, lima bean, Sweet gourd, spine gourd and pointed gourd.

UNIT-6

Organic farming in vegetable production. Importance, principles, perspective, concept and component of organic production of vegetable crops. Organic production of vegetables crops, *viz.*, solanaceous crops, cucurbits, cole crops, root and tuber crops. Methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, Panchagavvya, Bio-dynamics, preparation etc.

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Syllabus

Syllabus for PET-2025, Winter Session, A.Y. 2025-26,

Admission in Ph.D. in Pharmaceutical Sciences

UNIT I: Research Methodology, Biostatistics, Research Ethics and Publication Ethics

Process of selection of research question including prioritization and feasibility, process of writing a research proposal, scientific writing for thesis and research publications. Review of literature, need for review of literature, primary and secondary sources for review, bibliographic databases, electronic databases, information retrieval, information processing, critical evaluation, organization of materials collected and writing of review, methods of writing references and bibliography. Ethics and biomedical research: General principles on ethical considerations involving human subjects, ethical review procedures, Institutional ethics committee, its organization and functions, general ethical issues. Specific principles for clinical evaluation of drugs/devices/diagnosis vaccines/herbal remedies, specific principles in epidemiological studies, specific principles in human genetic research, specific principles for research in transplantation including fetal tissue implantation, Publication ethics.

UNIT II: Basics of Pharmaceutics, Drug Delivery systems and Regulatory Affairs

Properties of matter, micromeritics, surface and interfacial phenomenon, viscosity, rheology, dispersion systems – principles, properties and applications, classification, preparation, analysis and applications of complexes, kinetics and drug stability. Stoichiometry, Importance of unit processes in manufacturing – fluid flow, heat transfer, evaporation, distillation, drying, size reduction, mixing, filtration and centrifugation, crystallization, humidity control, refrigeration and air conditioning. Materials of plant construction, material handling systems, automated reactors, computer aided manufacturing, industrial hazards and safety systems.

Controlled and novel drug delivery systems, drug targeting. Techniques for invitro and in-vivo testing. In vitro – In vivo correlation. Pre-formulation studies. Physical, chemical and therapeutic incompatibilities. General considerations & concepts of chemical kinetics and drug stability. Biopharmaceutical aspects of dosage form design, principles of pharmacokinetics.

Bioavailability and bioequivalence studies, dosage regimens, repetitive dosing and dose adjustments in renal and hepatic failure, individualization of dosage regimen. BCS Classification of drugs, ICH guidelines. Concept of pharmaceutical quality management, requirements of GMP, GLP, GCP, regulatory requirements of drugs and pharmaceuticals.

UNIT III: Pharmaceutical and Medicinal Chemistry

Basic organic chemistry regarding synthesis and reactions of the main organic functional groups, organic stereochemistry, substitution (free radical, nucleophilic, electrophilic); elimination reactions; addition reactions; rearrangement reactions, General pathways of drug metabolism, Basic concepts and application of pro-drug design, Biochemical mechanism of drugs, categories of drug with special reference to SAR, Mode of action, Classification and synthesis of anticancer, NSAIDs, antiinfective, antihistaminic, anxiolytics, sedatives, hypnotics, anticonvulsants, adrenergic antagonists and general anesthetics. Radiolabelling, Drug designing and screening, concepts of QSAR and CADD.

UNIT IV: Pharmacology and Therapeutics of drugs

Types of receptors, drug-receptor interaction including signal transduction, mechanism, drug action, side effects, and contraindications of drugs acting on central nervous system, autonomous nervous system, anticancer agents, NSAIDs, anti-infective, antidiabetic, antihypertensive, antiasthmetic, antiulcers and antihistaminic. Pharmacological screening, general principles, various screening models, screening methodologies (in-vitro and in-vivo tests). Bioassay methods, principles of toxicology, basics of chemotherapy and pathophysiology.

UNIT V: Pharmacognosy and Biotechnology

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General methods of extraction, isolation, purification and characterization of natural products. Various separation techniques used for isolation of natural products. Biosynthetic pathways of various metabolites (e.g. Alkaloids, glycosides, tannins, lignans, saponins, lipids, flavonoids, coumarins, anthocyanidines etc.). Quality control of crude drugs, phytochemical screening methods, plant tissue culture. Recombinant DNA technique, Fermentation, Immunology and vaccines.

Enzyme immobilization, Genetics and gene therapy, Fundamentals of cell and molecular biology.

UNIT VI; Pharmaceutical Analysis

Fundamental principles, basic instrumentation, and pharmaceutical applications of UV- Visible spectroscopy, Infrared spectroscopy, PMR, C13 NMR spectroscopy, mass spectroscopy of gas-liquid chromatography, HPLC, HPTLC, Gel chromatography, Electrophoresis and ion-pair chromatography. Introductory principle, instrumentation and application of GC-Mass, HPLC-Mass for complex mixtures.

Theory, methods and applications of enzyme and radioimmunoassay techniques, Thermogravimetric analysis (TGA), Differential scanning calorimetry (DSC), Differential Thermal Analysis (DTA), X-ray diffractometry (XRD), Electron microscopy. Stability indicating assay procedures, analytical method development and validation.Impurity profiling, drug estimation in biological samples. Analytical instrumentvalidation.

UNIT VII: Statistics

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization software's. National and international scenario of pharmaceutical research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracts, pharmacopoeial drug monographs and official standards, national and international research institutions.

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Syllabus

Syllabus for PET-2025, Winter Session, A.Y. 2025-26,

Admission in Ph.D. in Mechanical Engineering

1) Engineering Mathematics: Linear Algebra, Calculus, Differential equations, Complex variables, Probability and Statistics, Numerical Methods
2) Applied Mechanics and Design: Engineering Mechanics, Strength of Materials, Theory of Machines, Vibrations, Machine Design
3) Fluid Mechanics and Thermal Sciences: Fluid Mechanics, Heat-Transfer, Thermodynamics, Applications
4) Materials, Manufacturing and Industrial Engineering: Engineering Materials, Casting, Forming and Joining Processes, Machining and Machine Tool Operations, Metrology and Inspection, Computer Integrated Manufacturing, Production Planning and Control, Inventory Control, Operations Research
5) General Aptitude: Verbal Ability, Numerical Ability, Logical Reasoning

Syllabus for PET-2025, Winter Session, A.Y. 2025-26,

Admission in Ph.D. in Civil Engineering

1) Engineering Mathematics: Linear Algebra, Calculus, Differential Equations, Complex Variables, Probability and Statistics, Numerical Methods
2) Structural Engineering: Mechanics, Structural Analysis, Concrete Structures, Steel Structures,
3) Geotechnical Engineering: Soil Mechanics, Foundation Engineering
4) Water Resources Engineering: Fluid Mechanics and Hydraulics, Hydrology, Irrigation
5) Environmental Engineering: Water and Waste Water Engineering, Air Pollution, Municipal Solid Wastes
6) Transportation Engineering: Highway Pavements, Traffic Engineering
7) Geomatics Engineering: Surveying, Remote Sensing, GIS
8) Construction Management: Project Management Techniques, Construction Planning and Control
9) General Aptitude: Verbal Ability, Numerical Ability, Logical Reasoning

Syllabus for PET-2025, Winter Session, A.Y. 2025-26,

Admission in Ph.D. in Computer Science & Engineering

1) Engineering Mathematics: Mathematical Logic, Probability, Set Theory & Algebra, Combinatorics, Graph Theory, Linear Algebra, Numerical Methods, Calculus,

2) Digital Logic: Boolean algebra, Combinational and sequential circuits, Minimization, Number representations and computer arithmetic, Computer Organization and Architecture:, Machine instructions and addressing modes, ALU, data-path, and control unit, Instruction pipelining

3) Memory hierarchy: cache, main memory, and secondary storage: I/O interface (interrupt and DMA mode), Instruction set architecture, Control unit design

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4) Programming and Data Structures: Programming in C, Recursion, Arrays, stacks, queues, linked lists, trees, graphs, Hashing, sorting, searching algorithms, Asymptotic analysis (best, worst, average cases)

5) Algorithms: Analysis, design, and complexity, Searching, sorting, hashing, Divide and conquer, greedy algorithms, dynamic programming, Graph algorithms, NP-completeness and approximation algorithms

6) Theory of Computation: Regular expressions and finite automata, Context-free grammars and pushdown automata, Turing machines and undecidability

7) Compiler Design: Lexical analysis, parsing, syntax-directed translation, Runtime environments, Intermediate code generation, Code optimization and generation

8) Operating System: Processes, threads, CPU scheduling, Deadlocks, memory management, and virtual memory, File systems and I/O systems

9) Databases: ER-model, relational model, SQL, Normalization, Transactions and concurrency control

10) Computer Networks: ISO/OSI stack, TCP/IP protocol suite, LAN technologies (Ethernet, Token ring), Routing algorithms, Network security and cryptography

11) Software Engineering: Software development life cycle, Software requirements, analysis, and design, Software testing strategies and methodologies

12) Web Technologies: HTML, CSS, JavaScript, Web development frameworks and tools, Client-server architecture, RESTful web services

13) Cyber Security: Cryptography, Network security protocols, Cyber threats and defense mechanisms, Machine Learning and AI (might be included depending on the focus of the program), Supervised and unsupervised learning, Neural networks, Reinforcement learning, Natural language processing

14) General Aptitude: Verbal Ability, Numerical Ability, Logical Reasoning

Syllabus for PET-2025, Winter Session, A.Y. 2025-26,

Admission in Ph.D. in Electronics Engineering

Section 1: Engineering Mathematics

Linear Algebra: Vector space, basis, linear dependence and independence, matrix algebra,

Eigen values and eigen vectors, rank, solution of linear equations- existence and uniqueness.

Calculus: Mean value theorems, theorems of integral calculus, evaluation of definite and improper integrals, partial derivatives, maxima and minima, multiple integrals, line, surface and volume integrals, Taylor series.

Differential Equations: First order equations (linear and nonlinear), higher order linear differential equations, Cauchy's and Euler's equations, methods of solution using variation of parameters, complementary function and particular integral, partial differential equations, variable separable method, initial and boundary value problems.

Vector Analysis: Vectors in plane and space, vector operations, gradient, divergence and curl, Gauss's, Green's and Stokes' theorems.

Syllabus

Complex Analysis: Analytic functions, Cauchy's integral theorem, Cauchy's integral formula, sequences, series, convergence tests, Taylor and Laurent series, residue theorem.

Probability and Statistics: Mean, median, mode, standard deviation, combinatorial probability, probability distributions, binomial distribution, Poisson distribution, exponential distribution, normal distribution, joint and conditional probability.

Section 2: Networks, Signals and Systems

Circuit analysis: Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity. Sinusoidal steady state analysis: phasors, complex power, maximum power transfer. Time and frequency domain analysis of linear circuits: RL, RC and RLC circuits, solution of network equations using Laplace transform. Linear 2-port network parameters, wye-delta transformation. Continuous-time signals: Fourier series and Fourier transform, sampling theorem and applications.

Discrete-time signals: DTFT, DFT, z-transform, discrete-time processing of continuous-time signals.

LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response, group delay, phase delay.

Section 3: Electronic Devices

Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors. Carrier transport: diffusion current, drift current, mobility and resistivity, generation and recombination of carriers, Poisson and continuity equations.

P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell.

Section 4: Analog Circuits

Diode circuits: clipping, clamping and rectifiers. BJT and MOSFET amplifiers: biasing, ac coupling, small signal analysis, frequency response. Current mirrors and differential amplifiers.

Op-amp circuits: Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.

Section 5: Digital Circuits

Number representations: binary, integer and floating-point- numbers. Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders.

Sequential circuits: latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay.

Data converters: sample and hold circuits, ADCs and DACs. Semiconductor memories: ROM, SRAM, DRAM.

Computer organization: Machine instructions and addressing modes, ALU, data-path and control unit, instruction pipelining.

Section 6: Control Systems

Syllabus

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

Section 7: Communications

Random processes: auto correlation and power spectral density, properties of white noise, filtering of random signals through LTI systems.

Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers.

Information theory: entropy, mutual information and channel capacity theorem.

Digital communications: PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and BER.

Fundamentals of error correction, Hamming codes, CRC.

Section 8: Electromagnetics

Maxwell's equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector.

Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth.

Transmission lines: equations, characteristic impedance, impedance matching, impedance transformation, S-parameters, Smith chart.

Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays.

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Syllabus

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Admission in Ph.D. in Law

Unit - 1: Jurisprudence

Nature and sources of law, Schools of jurisprudence, Law and morality, Concept of rights and duties, Legal personality, Concepts of property, ownership and possession, Concept of liability, Law, poverty and development, Global justice, Modernism and post-modernism

Unit - 2: Constitutional and Administrative Law

Preamble, fundamental rights and duties, directive principles of state policy, Union and State executive and their Interrelationship, Union and State legislature and distribution of legislative powers, Judiciary Emergency provisions, Temporary, transitional, and special provisions in respect of certain states, Election Commission of India, Nature, scope and importance of administrative law, Principle of natural justice, Judicial review of administrative actions – Grounds.

Unit - 3: Public International Law and IHL

International law – Definition, nature and basis, Sources of International law, Recognition of states and governments, Nationality, immigrants, refugees and internally displaced persons (IDPs), Extradition and asylum, United Nations and its organs, Settlement of international disputes, World Trade Organization (WTO) International humanitarian law (IHL) – C

Unit - 4: Law of Crimes (The Bharatiya Nyaya Sanhita)

General principles of criminal liability – Actus reus and mens rea, individual and group liability and constructive liability, Stages of crime and inchoate crimes – Abetment, criminal conspiracy and attempt
General exceptions, Offences against human body, Offences against state and terrorism, Offences against property, Offences against women and children, Drug trafficking and counterfeiting, Offences against public tranquillity, Theories and kinds of punishments, compensation to the victims of crime

Unit – 5: Law of Torts and Consumer Protection

Nature and definition of tort, General principles of tortious liability, General defences, Specific torts – Negligence, nuisance, trespass and defamation, Remoteness of damages, Strict and absolute liability
Tortious liability of the State, The Consumer Protection Act 1986 – Definitions, consumer rights and redressal, mechanism, The Motor Vehicles Act, 1988 – No fault liability, third party insurance and claims
Tribunal, The Competition Act, 2002 – Prohibition of certain agreements, abuse of dominant position and regulation of combinations

Unit – 6: Commercial Law

Essential elements of contract and e-contract, Breach of contract, frustration of contract, void and voidable agreements, Standard form of contract and quasi-contract, Specific contracts – Bailment, pledge, indemnity, guarantee and agency, Sale of Goods Act, 1930, Partnership and limited liability partnership, Negotiable Instruments Act, 1881, Company law – Incorporation of a company, prospectus, shares and debentures
Company law – Directors and meetings, Corporate social responsibility

Unit – 7: Family Law

Sources and schools, Marriage and dissolution of marriage, Matrimonial remedies – Divorce and theories of divorce, Changing dimensions of institution of marriage – Live-in relationship, Recognition of foreign decrees in India on marriage and divorce, Maintenance, dower and stridhan, Adoption, guardianship and acknowledgement, Succession and inheritance, Will, gift and wakf, Uniform Civil Code

Unit – 8: Environment and Human Rights Law

Meaning and concept of ‘environment’ and ‘environmental pollution’International environmental law and UN Conferences, Constitutional and legal framework for protection of environment in India, Environmental

Syllabus

Impact Assessment and control of hazardous waste in India, National Green Tribunal, Concept and development of human rights, Universalism and cultural relativism, International Bill of Rights
Group rights – Women, children, persons with disabilities, elderly persons, minorities and weaker sections
Protection and enforcement of human rights in India – National Human Rights, Commission, National Commission for Minorities, National Commission for Women, National Commission for Scheduled Castes, National Commission for Schedule, Tribes and National Commission for Backward Classes

Unit – 9: Intellectual Property Las and Information Technology Law

Concept and meaning of intellectual property, Theories of intellectual property, International conventions pertaining to intellectual properties, Copyright and neighboring rights – Subject matters, limitations and exceptions, infringement and remedies, Law of patent – Patentability, procedure for grant of patent, limitations and exceptions, infringement and remedies, Law of trademark – Registration of trademarks, kinds of trademarks, infringement and passing off, remedies, Protection of Geographical Indications
Bio-diversity and Traditional Knowledge, Information technology law- digital signature and electronic signature, electronic governance, electronic records and duties of subscribers, Cyber crimes, penalties and adjudication

Unit – 10: Comparative Public Law and System of Governance

Comparative Law – Relevance, methodology, problems and concerns in Comparison, Forms of governments – Presidential and parliamentary, unitary and federal, Models of federalism – USA, Canada and India
Rule of Law – 'Formal' and 'substantive' versions, Separation of powers – India, UK, USA and France
Independence of judiciary, judicial activism and accountability – India, UK and USA, Systems of constitutional review – India, USA, Switzerland and France, Amendment of the Constitution – India, USA, and South Africa, Ombudsman –Sweden, UK and India, Open Government and Right to Information – USA, UK and India

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Syllabus

Syllabus for PET-2025, Winter Session, A.Y. 2025-26,

Admission in Ph.D. in Management

Unit I

Management – Concept, Process, Theories and Approaches, Management Roles and Skills
Functions – Planning, Organizing, Staffing, Coordinating and Controlling. Communication – Types, Process and Barriers. Decision Making – Concept, Process, Techniques and Tools Organisation Structure and Design – Types, Authority, Responsibility, Centralisation, Decentralisation and Span of Control Managerial Economics – Concept & Importance Demand analysis – Utility Analysis, Indifference Curve, Elasticity & Forecasting Market Structures – Market Classification & Price Determination National Income – Concept, Types and Measurement Inflation – Concept, Types and Measurement Business Ethics & CSR Ethical Issues & Dilemma Corporate Governance Value-Based Organisation.

Unit II

Organisational Behaviour – Significance & Theories Individual Behaviour – Personality, Perception, Values, Attitude, Learning and Motivation Group Behaviour – Team Building, Leadership, Group Dynamics Interpersonal Behaviour & Transactional Analysis Organizational Culture & Climate WorkForce Diversity & Cross Culture Organisational Behaviour Emotions and Stress Management Organisational Justice and Whistle Blowing Human Resource Management – Concept, Perspectives, Influences and Recent Trends Human Resource Planning, Recruitment and Selection, Induction, Training and Development Job Analysis, Job Evaluation and Compensation Management

Unit III

Strategic Role of Human Resource Management Competency Mapping & Balanced Scoreboard Career Planning and Development Performance Management and Appraisal Organization Development, Change & OD Interventions Talent Management & Skill Development Employee Engagement & Work-Life Balance Industrial Relations: Disputes & Grievance Management, Labour Welfare and Social Security Trade Union & Collective Bargaining International Human Resource Management – HR Challenge of International Business Green HRM

Unit IV

Accounting Principles and Standards, Preparation of Financial Statements Financial Statement Analysis – Ratio Analysis, Funds Flow and Cash Flow Analysis, DuPont Analysis Preparation of Cost Sheet, Marginal Costing, Cost Volume Profit Analysis Standard Costing & Variance Analysis Financial Management, Concept & Functions Capital Structure – Theories, Cost of Capital, Sources and Finance Budgeting and Budgetary Control, Types and Process, Zero base Budgeting Leverages – Operating, Financial and Combined Leverages, EBIT–EPS Analysis, Financial Breakeven Point & Indifference Level.

Unit V

Value & Returns – Time Preference for Money, Valuation of Bonds and Shares, Risk and Returns Capital Budgeting – Nature of Investment, Evaluation, Comparison of Methods; Risk and Uncertainly Analysis Dividend – Theories and Determination Mergers and Acquisition – Corporate Restructuring, Value Creation, Merger Negotiations, Leveraged Buyouts, Takeover Portfolio Management – CAPM, APT Derivatives – Options, Option Payoffs, Option Pricing, Forward Contracts & Future Contracts Working Capital Management – Determinants, Cash, Inventory, Receivables and Payables Management, Factoring International Financial Management, Foreign exchange market

Unit VI

Strategic Management – Concept, Process, Decision & Types
Strategic Analysis – External Analysis, PEST, Porter's Approach to industry analysis, Internal Analysis – Resource Based Approach, Value Chain Analysis Strategy Formulation – SWOT Analysis, Corporate Strategy – Growth, Stability, Retrenchment, Integration and Diversification, Business Portfolio Analysis – BCG, GE Business Model, Ansoff's Product Market Growth Matrix
Strategy Implementation – Challenges of Change, Developing Programs Mckinsey 7s Framework Marketing – Concept, Orientation, Trends and Tasks, Customer Value and Satisfaction

Syllabus

Market Segmentation, Positioning and Targeting Product and Pricing Decision – Product Mix, Product Life Cycle, New Product development, Pricing Types and Strategies Place and promotion decision – Marketing channels and value networks, VMS, IMC, Advertising and
Sales promotion

Unit VII

Consumer and Industrial Buying Behaviour: Theories and Models of Consumer Behaviour Brand Management – Role of Brands, Brand Equity, Equity Models, Developing a Branding Strategy; Brand Name Decisions, Brand Extensions and Loyalty Logistics and Supply Chain Management, Drivers, Value creation, Supply Chain Design, Designing and Managing Sales Force, Personal Selling. Service Marketing – Managing Service Quality and Brands, Marketing Strategies of Service Firms. Customer Relationship Marketing – Relationship Building, Strategies, Values and Process. Retail Marketing – Recent Trends in India, Types of Retail Outlets. Emerging Trends in Marketing – Concept of e-Marketing, Direct Marketing, Digital Marketing and Green Marketing International Marketing – Entry Mode Decisions, Planning Marketing Mix for International Markets

Unit VIII

Statistics for Management: Concept, Measures Of Central Tendency and Dispersion, Probability Distribution – Binominal, Poison, Normal and Exponential Data Collection & Questionnaire Design Sampling – Concept, Process and Techniques Hypothesis Testing – Procedure; T, Z, F, Chi-square tests Correlation and Regression Analysis Operations Management – Role and Scope Facility Location and Layout – Site Selection and Analysis, Layout – Design and Process Enterprise Resource Planning – ERP Modules, ERP implementation Scheduling, Loading, Sequencing and Monitoring Quality Management and Statistical Quality Control, Quality Circles, Total Quality Management. KAIZEN, Benchmarking, Six Sigma; ISO 9000 Series Standards Operation Research – Transportation, Queuing Decision Theory, PERT / CPM

Unit IX

International Business – Managing Business in the Globalization Era; Theories of International Trade; Balance of Payment Foreign Direct Investment – Benefits and Costs Multilateral regulation of Trade and Investment under WTO International Trade Procedures and Documentation; EXIM Policies Role of International Financial Institutions – IMF and World Bank Information Technology – Use of Computers in Management Applications; MIS, DSS Artificial Intelligence and Big Data Data Warehousing, Data Mining and Knowledge Management – Concepts Managing Technological Change

Unit X

Entrepreneurship Development – Concept, Types, Theories and Process, Developing Entrepreneurial Competencies Intrapreneurship – Concept and Process Women Entrepreneurship and Rural Entrepreneurship Innovations in Business – Types of Innovations, Creating and Identifying Opportunities, Screening of Business Ideas Business Plan and Feasibility Analysis – Concept and Process of Technical, Market and Financial Analysis Micro and Small Scale Industries in India; Role of Government in Promoting SSI Sickness in Small Industries – Reasons and Rehabilitation Institutional Finance to Small Industries – Financial Institutions, Commercial Banks, Cooperative Banks, Micro Finance.

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Admission in Ph.D. in Mathematics

Real Analysis:

Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral. Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems. Metric spaces, compactness, connectedness. Normed linear Spaces. Spaces of continuous functions as examples.

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

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, Maximum modulus principle, Schwarz lemma, Open mapping theorem. Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations.

Modern Algebra:

Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements. Fundamental theorem of arithmetic, divisibility in Z, congruences, Chinese Remainder Theorem, Euler's Ø- function, primitive roots. Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems. Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain. Polynomial rings and irreducibility criteria. Fields, finite fields, field extensions, Galois Theory.

Topology:

Basis, dense sets, subspace and product topology, separation axioms, connectedness and compactness.

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.

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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.

Numerical Analysis :

Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods, Finite differences, Lagrange, Hermite and spline interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler, modified Euler and Runge-Kutta methods.

Calculus of Variations:

Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations. Linear Integral Equations: Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and eigenfunctions, resolvent kernel.

Classical Mechanics:

Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle and principle of least action, Two-dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis, theory of small oscillations.

Statistics

Descriptive statistics, exploratory data analysis Sample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate); expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Probability inequalities (Tchebyshef, Markov, Jensen). Modes of convergence, weak and strong laws of large numbers, Central Limit theorems (i.i.d. case). Markov chains with finite and countable state space, classification of states, limiting behaviour of n-step transition probabilities, stationary distribution, Poisson and birth-and-death processes. Standard discrete and continuous univariate distributions. sampling distributions, standard errors and asymptotic distributions, distribution of order statistics and range. Methods of estimation, properties of estimators, confidence intervals. Tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests. Analysis of discrete data and chi-square test of goodness of fit. Large sample tests. Simple nonparametric tests for one and two sample problems, rank correlation and test for independence. Elementary Bayesian inference. Gauss-Markov models, estimability of parameters, best linear unbiased estimators, confidence intervals, tests for linear hypotheses. Analysis of variance and covariance. Fixed, random and mixed effects models. Simple and multiple linear regression. Elementary regression diagnostics. Logistic regression. Multivariate normal distribution, Wishart distribution and their properties. Distribution of quadratic forms. Inference for parameters, partial and multiple correlation coefficients and related tests. Data reduction techniques: Principle component analysis, Discriminant analysis, Cluster analysis, Canonical correlation. Simple random sampling, stratified sampling and systematic sampling. Probability proportional to size sampling. Ratio and regression methods. Completely randomized designs, randomized block designs and Latin-square.

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Syllabus

Syllabus for PET-2024, Admission in Ph.D. in Computer Science

1. Analysis of Algorithms

Analyzing algorithms, Designing algorithms. Growth of Functions: Asymptotic notation, Standard notations and common functions. Divide-and-Conquer: The maximum-subarray problem, Strassen's algorithm for matrix multiplication, the substitution method for solving recurrences.

Dynamic Programming, Greedy Algorithms: An activity-selection problem, Elements of the greedy strategy, Huffman codes. Elementary Graph Algorithms: Representations of graphs, Breadth-first search, Depth-first search. Minimum Spanning Trees: Growing a minimum spanning tree, Algorithms of Kruskal and Prim. Single-Source Shortest Paths,NumberTheoretic Algorithms and NP – Completeness,research ethics, reviewing literature, design and creation, experiments, Quantitative data analysis

2. Advanced Networking Concepts

Networking Protocol layer and their services, Network Applications like Web, HTTP, FTP and Electronic Mail in the Internet, Domain Name System, Transport-Layer Services, Multiplexing and Demultiplexing, UDP, TCP,Internet Protocol (IP), Routing Algorithms,

Routing in the Internet.,Network Virtualization: The Virtual Enterprise, Transport Virtualization-VNs, Central Services Access: Virtual Network Perimeter, A Virtualization

Technologies primer: theory, Network Device Virtualization, Data-Path Virtualization, Adhoc Networking: Routing protocols,Wireless Sensor networks, Wireless Sensor networks:sensing and communication range, design issues, localization scheme, clustering of SNs, Routing layer, Sensor networks in controlled environment and actuator

3. Database Systems

DBMS,RDBMS,Distributed Database Concepts,DDBMS Architecture,Distributed database design,Transaction Management, Concurrency Control, DBMS reliability, Database System, Parallel query evaluation, Object Oriented Database, Languages and Design, Temporal and

Spatial Database, Introduction to Temporal Database, Spatial Database, Deductive Database,

Interpretation of model, Active Database, OLTP,OLAP, Datawarehousing, Data mining

4. Artificial Intelligence and Machine Learning

State space search: Generate and test, Simple search, Depth First Search (DFS), Breadth First

Search (DFS), Comparison and quality of solutions. Heuristic Search: Heuristic functions,

Best First Search (BFS), Hill Climbing, Local Maxima, Beam search, Tabu search. Finding Optimum paths: Brute force, branch & bound, refine search, Dijkstra's algorithm, A* algorithm. Admissibility of A* algorithm.Learning-Standard Linear methods,Selection and improvements of linear learning methods ,Non-Linear Learning methods,Support Vector machines, Principle Component Analysis and Clustering

5. Operating Systems

Operating system booting process GRUB-I, GRUB-II. ,File Systems: Files, Directories, File

System Implementation, Security, Protection mechanisms in different Linux versions , The Linux Kernel – its functions, essential hardware drivers. Libraries - Surface Manager, Media framework, SQLite, WebKit, OpenGL. Android Runtime - Dalvik Virtual Machine, Core Java Libraries. Application Framework - Activity Manager, Content Providers, Telephony Manager, Location Manager, Resource Manager.

Syllabus

6. Compiler Construction Theory

The structure of a compiler, A simple approach to the design of lexical analyzers, Regular expressions, Finite automata, From regular expressions to finite automata, Minimizing the number of states of a DFA, Context-free grammars, Derivations and Parse trees, Parsers, Shift-reduce parsing, Operator-precedence parsing, Top- down parsing, Predictive parsers. LR parsers, The canonical collection of LR(0) items, Constructing SLR parsing tables, Constructing canonical LR parsing tables, Constructing LALR parsing tables, Using ambiguous grammars, An automatic parser generator,Syntax-directed translation schemes, Implementation of syntax-directed translators, Tiger compiler, bindings for the Tiger compiler, type checking expressions, type-checking declarations, activation records, stack frames, frames in the Tiger compiler,The principle sources of optimization, Loop optimization: The DAG representation of basic blocks, Dominators, Reducible flow graphs, Depth-first search, Loop-invariant computations, Induction variable elimination, Some other loop optimizations.

7. Cloud Computing

Web Service as distributed application, SOAP Based Web Services, Web Services Security, Wire-Level Security, WS-Security. Architecting on AWS, Building complex solutions with Amazon Virtual Private Cloud (Amazon VPC), Leverage bootstrapping and auto configuration in designs, Architect solutions with multiple regions.

8. Network and Communication Security

Principles of Security, Different Attacks: malicious and non-malicious program, Types of

Computer Criminals. Security: Security requirements, Integrity, Confidentiality, Availability, Reliability of Database, Sensitive data, Multilevel database, Proposals for multilevel security. Firewall (ACL, Packet Filtering, DMZ, Alerts and Audit Trials) – IDS,IPS and its types (Signature based, Anomaly based, Policy based, Honeypot based). Virtualization System Security Issues: e.g. ESX and ESXi Security, ESX file system security- storage considerations, backup and recovery- Virtualization System Vulnerabilities,Mobile system architectures, Overview of mobile cellular systems, GSM and UMTS, Security & Attacks, Vulnerabilities in Cellular Services, Cellular Jamming Attacks & Mitigation, Security in Cellular VoIP Services, Mobile application security. Securing Wireless Networks:

Overview of Wireless Networks, Scanning and Enumerating 802.11 Networks, Attacking 802.11 Networks

G H RAISONI UNIVERSITY

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Syllabus

Syllabus for PET-2025, Winter Session, A.Y. 2025-26,

Admission in Ph.D. in Zoology

UNIT I

1. A) MOLECULES AND THEIR INTERACTION RELAVENT TO BIOLOGY, B) CELLULAR ORGANIZATION C) FUNDAMENTAL PROCESSES

A) a) Structure of atoms, molecules and chemical bonds. b) Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). c) Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). d) Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties). e) Stability of proteins and nucleic acids. f) Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

B) a) Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility). b) Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, chromatin, transposons). c) Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle). Stress response.

C) a) DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extra chromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination). b) RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport). c) Control of gene expression at transcription and translation level (regulating the expression of phage, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

UNIT II

2. A) Cell communication and cell signalling, B) Developmental biology

A) a) Host parasite interaction Recognition and entry processes of different pathogens like bacteria, viruses into animal, b) Cell signalling Hormones and their receptors, c) Cancer Genetic rearrangements in progenitor cells, oncogenes, tumour suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth. d) Innate and adaptive immune system Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules, humoral and cell mediated immune responses, the complement system, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial

(Tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiency, vaccines.

B) a) Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenic in analysis of development b) Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals, zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers

in animals. c) Morphogenesis and organogenesis in animals, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination. Programmed cell death, aging and senescence

UNIT III

3 A) SYSTEM PHYSIOLOGY- ANIMAL , B) INHERITANCE BIOLOGY

A) a) Blood and circulation - Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. b) Blood and circulation, Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump m ,. Respiratory system , Nervous system, Sense organs, Excretory system ,.Thermoregulation , Stress and adaptation, Digestive system ,Endocrinology and reproduction, Endocrine glands, mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation

B) a) Mendelian principles: Dominance, segregation, independent assortment. Co- dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity. b) Concept of gene : Allele, multiple alleles, c) Concept of gene: Allele, multiple alleles, pseudo allele, gene interactions, linkage and crossing over, sex linkage, sex limited and sex influenced characters, Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, Genetic disorders. d) Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. e) Homologous and non-homologous recombination including transposition.

UNIT IV

4 A) DIVERSITY OF LIFE FORMS, B) ECOLOGICAL PRINCIPLES C) EVOLUTION AND BEHAVIOUR

A) a) Principles & methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals and microorganisms. b) Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications. c) Outline classification of animals important criteria used for classification in each taxon. Classification of animals. Evolutionary relationships among taxa, d) Organisms of conservation concern: Rare, endangered species. Conservation strategies.

B) a) The environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; resource, biodiversity. b) Ecosystem ecology, Ecosystem structure, ecosystem function. c) Applied ecology; Environmental pollution, Global environmental change d) Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

C) a) Emergence of evolutionary thoughts Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection, Mentalism, The first cell; Evolution of prokaryotes; b) Origin of eukaryotic cells; Evolution of unicellular eukaryotes, c) The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Stages in primate evolution including Homo, d) Molecular Evolution: Population genetics – e) Population genetic , Gene pool, Gene frequency; natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms, Speciation. ; Isolating mechanism, Convergent evolution; Sexual selection co-evolution \

UNIT V

Syllabus

5 A) APPLIED BIOLOGY, B) METHODS IN BIOLOGY

A) Microbial fermentation and production of small and macro molecules, Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for animals, transgenic animals, and molecular approaches to diagnosis and strain identification, Genomics and its application to health including gene therapy, Bio resource and uses of biodiversity, Breeding in animals.

B) Molecular Biology and Recombinant DNA methods, Histochemical and Immune techniques, Biophysical Method, Statistical Methods, Radio labelling techniques, Microscopic techniques, Electrophysiological methods, Methods in field biology.

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Syllabus

Syllabus for PET-2025, Winter Session, A.Y. 2025-26,

Admission in Ph.D. in Physics

UNIT 1. Mathematical Methods of Physics:

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Eigenvalues and eigenvectors. Ordinary and partial Differential equations of first and second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, Central limit theorem, :root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Finite difference methods, Tensors.

UNIT 2. Classical Mechanics:

Central force motions. Two body Collisions - scattering in laboratory and Centre of mass frames. Rigid body dynamics- moment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity- Lorentz transformations, relativistic kinematics and mass–energy relation, Poisson brackets and canonical transformations. Symmetry, invariance and Noether's theorem. Hamilton-Jacobi theory.

UNIT 3. Electromagnetic Theory:

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations, boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Fresnel's law, Dynamics of charged particles in static and uniform electromagnetic fields, Lorentz invariance of Maxwell's equation. Radiation- from moving charges and dipoles

UNIT 4. Quantum Mechanics:

Wave-particle duality. Schrödinger equation (time-dependent and timeindependent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time- independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, WKB approximation

UNIT 5. Thermodynamic and Statistical Physics:

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases.Blackbody

radiationandPlanck'sdistributionlaw,Bose-Einsteincondensation.Diffusion equation. Random walk andBrownian motion. Introduction to nonequilibrium processes.

UNIT 6. Electronics and Experimental Methods:

Semiconductor devices (diodes, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors) Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting,

UNIT 7. Atomic & Molecular Physics:

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born- Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Optical pumping, population inversion

UNIT 8. Condensed Matter Physics:

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids: metals, insulators and semiconductors. Superconductivity: type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Quasi crystals.

UNIT 9. Nuclear and Particle Physics:

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model. Shell model, Nature of the nuclear force, , charge-independence and charge- symmetry of nuclear forces. Deuteron problem. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions. Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

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Syllabus

Syllabus for PET-2025, Winter Session, A.Y. 2025-26,

Admission in Ph.D. in Chemistry

Inorganic Chemistry

1. Chemical periodicity
2. Chemical bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory), MO Theory.
3. Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents.
4. Atomic Structure: Concept of proton, neutron, electron, atom and molecule. Bohr's theory and its limitation, Heisenberg Uncertainty principle, Madelung Constant, atomic orbitals and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (only graphical representation). Quantum numbers (*n*, *l*, *m* and *s*) and its significance. Stability of half-filled and full-filled orbitals. Electronic configuration, Hund's rule, Pauli exclusion principle. Afbau principle.

5. Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.
6. Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.

7. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.
8. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.
9. Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.
10. Ring, Cages and metal clusters.
11. Analytical chemistry- separation, spectroscopic, electro- and thermoanalytical methods.
12. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron-transfer reactions; nitrogen fixation, metal complexes in medicine.
13. Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.

Organic Chemistry

1. IUPAC nomenclature of organic molecules including regio- and stereoisomers.
2. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.
3. Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.
4. Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.
5. 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.

6. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.
7. Concepts in organic synthesis: Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.
8. Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst

controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic.

9. Pericyclic reactions – electrocyclisation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.

10. Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).

11. Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.

12. Structure determination of organic compounds by IR, UV-Vis, 1H & 13C NMR and Mass spectroscopic techniques.

Physical Chemistry:

1. 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.

2. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.

3. Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.

4. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems.

5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.

6. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.

7. 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.

8. Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.

9. Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.

10. 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.

11. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.

12. Solid state: Crystal structures; Bragg's law and applications; band structure of solids.

13. Polymer chemistry: Molar masses; kinetics of polymerization.

14. Data analysis: Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

Interdisciplinary topics

Chemistry in nanoscience and technology, Catalysis and green chemistry, Medicinal chemistry, Supramolecular chemistry, Environmental chemistry.

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Syllabus

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1) Fundamental Organization of structure and functions of prokaryotic and eukaryotic cells:

Cell wall and Cell Membrane: physical structure of model membranes in prokaryotes and eukaryotes, lipid bilayer, membrane proteins, other constituents; diffusion, osmosis, active transport, regulation of intracellular transport and electrical properties. Structural organization and functions of cell organelles: nucleus, mitochondria, Golgi bodies, endoplasmic reticulum, lysosomes, Chloroplast, peroxisomes, vacuoles. Cytoskeletons structure and motility function.

2) Biomolecular structure and function in living system:

Covalent structure of Amino acids, proteins, nucleic acids, carbohydrates and lipids. Forces that stabilize biomolecules: electrostatic and van der Waal's interaction, hydrogen bonding. Interactions with solvents, Hydrophobic effect. Protein Structure: Structural characteristics of α-helix, β-sheet and β-turn. Ramachandran plot. Protein domains and domain architecture. Quaternary structure of proteins. Conformation of Nucleic acids: Structural characteristics of A, B and Z-DNA. 3D structure of t-RNA, ribozymes and riboswitches

3) Basic Thermodynamics:

Laws of thermodynamics. Concepts of ΔG, ΔH and ΔS. Physical properties of water and their role in biology. Concepts of pH, ionic strength and buffers. Chemical kinetics: Concepts of order and molecularity of a chemical reaction. Derivation of first and second order rate equation, measurement of rate constants.Concept of activation energy. Enzymology: Introduction to enzymes. Types of enzymatic reaction mechanisms, Michaelis-Menten kinetics. Competitive, Non-competitive and Un-competitive inhibition. Bi-substrate reaction kinetics. Allostery.

4) Cellular processes:

DNA replication, repair and recombination. Transcription of various types of RNAs and their processing and modifications. Transcription factors and machinery including RNA polymerases, formation of initiation complex, elongation and termination of transcription. Regulation of transcription: activators (enhancers) and repressors, Locus control regions. Structure and function of different types of RNA and mRNPs. RNA transport, localization and function. Protein synthesis, processing and transport of proteins: Ribosome, mRNA structure, genetic code, aminoacylation of tRNA, aminoacyl tRNA synthetase. Mechanism of translation: Initiation, elongation and termination factors and translational proofreading. Regulation of Translation- global vs mRNA-specific. Translation inhibitors, Post- translational modifications of proteins. Protein trafficking and transport

5) Genetics:

Phylogeny & Evolution: Chromosomal inheritance: Principles of Mendelian inheritance, codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, linkage and cross-over, sexlinked inheritance, Population Genetics and Hardy-Weinberg equilibrium. Extrachromosomal inheritance: Maternal inheritance (mitochondria and chloroplast). Gene concept: Allele, multiple alleles, pseudoalleles. Genetic

analysis: Linkage maps, mapping with molecular markers, tetrad analysis, gene transfer in bacteria: transformation, conjugation, transduction, sex-duction, fine structure analysis of gene. Mutation: Spontaneous, induced, lethal, conditional, reversion, mutagenic suppression, germinal and somatic mutation, insertion, deletion, duplication, translocation, transposition, ploidy.

6) **Techniques in Biotechnology**:

Concepts of precision and accuracy in experimental measurements. Concept of signal to noise ratio. Biostatistics: Measures of Central Tendency. Fundamental ideas of probability and probability distributions: Binomial, Poisson and Gaussian distributions. Concept of the Central Limit Theorem. Hypothesis testing. Correlation and regression. Basic concepts of design of Experiments. Biochemical Methods: Chromatography: Ion exchange, Gel Filtration and Affinity chromatography. Electrophoresis: Native and SDS-PAGE. Isoelectric focusing. 2D-PAGE and its applications. UV/Vis spectrophotometry. Beer-Lambert‟s law and its use in determination of protein/ nucleic acid concentration.Density gradient centrifugation. Sedimentation velocity and Sedimentation equilibrium. Separation of sub-cellular components and macromolecules using high speed and ultracentrifugation. Microscopy: Bright field, phase contrast, fluorescence, confocal, and electron microscopy. Fundamentals of X-ray, NMR and cryo-electron microscopy for determination of biomolecular structure.

7) **Recombinant DNA Technology:**

Enzymes used in Recombinant DNA technology. Isolation and purification of DNA (genomic and plasmid) and RNA. Various methods of separation, characterization of nucleic acids including Southern and Northern hybridizations. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors and their purification. Western blotting. Generation of genomic and cDNA libraries. Plasmid, phage, cosmid, BAC and YAC vectors. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms. Isolation and amplification of specific nucleic acid sequences, PCR, RT PCR and qRT PCR. DNA sequencing methods, strategies for genome sequencing. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques. Analysis of DNA polymorphism: RFLP, RAPD and AFLP techniques.

8) **Bioinformatics & Computational Biology:**

Major Bioinformatics Resources: Sequence databases, Gene Expression database: GEO, SAGE, 3D Structure Database: PDB, NDB, Knowledge driven Databases & utility, Pattern Sequence: InterPro, Prosite, Pfam, ProDom, Gene Ontology. Database Searches: Keyword-based searches using tools like ENTREZ and SRS Sequence based searches: BLAST and FASTA. Sequence Analysis, Basic concepts: Sequence similarity, identity and similarity, definitions of homologues, orthologues, paralogues, Tandem and Interspersed repeats, repeat finding. Scoring Matrix, Pairwise sequence alignments, Multiple sequence alignments (MSA), Application in Taxonomy and phylogeny, Comparative genomics. Structural Biology: 3-D structure visualization and simulation, Basic concepts in molecular modeling: different types of computer representations of molecules. External coordinates and Internal Coordinates,

Syllabus

9) **Plant Biotechnology:**

Tissue Culture, Transgenic Technologies and Biotechnology. Totipotency; Tissue culture media; Plant hormones and morphogenesis; embryogenesis; Cell suspension culture; Micropropagation – shoot tip culture, somatic embryos, artificial seeds; Applications of tissue culture; shoot tip culture, Anther culture and dihaploids. Production of alkaloids and other secondary metabolites; Protoplast isolation and purification; Protoplast culture; Protoplast fusion; Somatic hybrids; Cybrids. Direct transformation of protoplasts using PEG; electroporation; Transformation by particle bombardment; Chloroplast transformation. Ti plasmid-based transformation; Ti and Ri plasmids, T-DNA genes, borders, Ti plasmid virulence genes and their functions, Monocot transformation, binary vector; Floral dip transformation; Targeted gene delivery and methods of detection. Promoters, Plant selectable markers; Reporter genes; Selectable marker elimination; Transgene silencing and strategies to avoid transgene silencing. Genetic engineering of crops; Codon optimization in the expression of genes in plants, Commercial status of transgenic plants; Herbicide resistance, glyphosate, sulfonyl urea, phosphinothricin, atrazine; Pest resistance, Bt toxin; Protease inhibitor; GNA and other lectins; a-amylase inhibitor; nematode resistance; Genetic engineering for male sterility-Barnase-Barstar; Delay of fruit ripening; polygalacturanase, ACC synthase, ACC oxidase;Improved seed storage proteins; Improving and altering the composition of starch and plant oils; Golden rice for ß-carotene accumulation; Production of antibodies and pharmaceuticals in plants. Biofuels, Bacillus thuringiensis: molecular basis of insecticidal activity. Agriculturally important microorganisms and their application. Abiotic and Biotic Stress Biology a) Abiotic stress: Acclimation and crop adaptation to water, salinity, photo oxidative, heavy metal, heat and cold, nutrient stress. Metabolite engineering for abiotic stress tolerance, Functional genomics of stress tolerance. Induced systemic tolerance. b) Biotic stress: Plant response to pathogens and herbivores, biochemical and molecular basis of host plant resistance , toxins of fungi and bacteria, systemic and induced resistance, pathogen derived resistance, signaling - gene for gene hypothesis, genetic engineering for biotic stress resistance, gene pyramiding. Induced systemic resistance, systemic acquired resistance.

10) **Animal Biotechnology:**

Immunology: Cells of immune system, clinical and transplantation immunology, tumor immunology and immunodeficiency. Nude and SCID mice biology and immunosuppression. Primary culture, secondary culture, sub-culturing, Cell lines, cloning & selection. Media, serum free media (advantage & disadvantages). Large scale culturing, Preservation and maintenance of anial cell lines. Cryopreservation, Cell culture products, Hybridoma technology. Gene transfer (transfection) methods, Embryonic stem cell transfer, In vitro fertilization and embryo transfer.Gene therapy, Animal cloning & ethical issues. Genetic diagnostic methods and microarray technology. Tissue and organ transplant, vaccines &peptide vaccines, Proteins as therapeutic agents, Applications, delivery and targeting of therapeutic proteins. Engineering human interferons and human growth hormones. Enzymes as therapeutic agents: Use of genetically engineered DNase I and alginate Lyase for treatment of Cystic Fibrosis

11) **Environmental Biotechnology:**

Syllabus

Basic Ecological Concepts and Principles: Ecosystem: types, development and evolution; Homeostasis, energy transfer in ecosystem, Energy budget, trophic structure, food chain, food web, ecological efficiency, biogeochemical cycles. Chemistry of organic and inorganic chemicals polluting Environment (air, water and soil). Environmental Pollution; Types, Detection and Measurement of Pollutants; Environmental monitoring techniques. Water Pollution: sources, measurement and management. Waste Water Treatment systems: primary, secondary and tertiary treatments; Biological Treatment Processes, Biochemistry and Microbiology of Aerobic and Anaerobic Treatment, Bioreactors for waste water treatment, Disinfection. Pollution monitoring: chemical, biological and molecular methods; Environmental impact assessment, Biodiversity and its conservation, GMOs and Biosafety. Global environmental problems: Ozone depletion, UV-B and green house gases

12) **IPR, Biosafety & Bioethics:**

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS. Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation. Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT 9 application. Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs, Patent infringementmeaning, scope, litigation, case studies and examples. Biosafety: Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol. Bioethics: Concepts; Philosophical considerations; Epistemology of Science; Ethical Terms; Principles & Theories; Relevance to Biotechnology; Ethics and the Law Issues: Genetic Engineering, Stem Cells, Cloning, Medical techniques, Trans-humanism, Bioweapons; Research concerns - Animal Rights, Ethics of Human Cloning, Reproduction and Stem Cell Research; Emerging issues: Biotechnology's Impact on Society; DNA on the Witness Stand - Use of genetic evidence in civil and criminal court cases; Challenges to Public Policy – To Regulate or Not to Regulate; Improving public understanding of biotechnology products to correct misconceptions.

Syllabus

13) I**MMUNOLOGY**:

Innate immunity, cell, CD nomenclature; Experimental Systems used in the Immunology; Acquired immunity, T-cells, B-cells; Immunoglobulins, class, sub-class and structure; Super Antigens and T-Cell Activation; Antibody combining sites, conformational changes; Immunoglobulin superfamily, affinity, avidity; Complement System, Antigenecity & Immunogenecity; Antigen Processing & Presentation; Cell-cell interaction, adhesion molecules; Antigen Processing & Presentation; B-cell activation and differentiation – generation of humoral response; Antibody mediated Effector mechanisms; Cell mediated Effector mechanism; Immunization strategies; Cytokines, characteristics and function; Monoclonal antibody production; Antibody screening Assays; Cytokine classes and their biological activities; Characterization of monoclonal antibodies.

14) MICROBIOLOGY:

Development of microbiology as a scientific discipline, Methods of studying microorganisms, Organization and structure of microbes- morphology of bacteria, yeast and molds, algae, protozoa, virus, prions. Microbial morphology: capsule, slime layer, pili, flagella, cell wall, matrix material, chemo-taxis bacterial growth and reproduction – pure culture and cultural characteristics. Control of microorganisms – physical and chemical agents; antibiotics and chemotherapeutic agents.

15) **BIOSTATISTICS & COMPUTERS**:

Definition of selected terms Scale of measurements Related to statistics; Methods of collecting date; Presentation of date statistical Tables; Need for reduction of data measures of averages and location; Measures of dispersion Range quartile deviation mean deviation & relative deviation; Concepts of statistical population and sample need for sampling studies; Simple procedures of random sampling; Methods of sampling; Probability Statistics in Genetics; Introduction to Computer Science; Introduction to Data-Base; Introduction to Windows; Windows Application (Word, Excel, PowerPoint and Multimedia); Introduction to INTERNET & use of Electronic Mail; Introduction to Medical Informatics & use of Statistical Package; Introduction to UNIX & C; Computer Aided Teaching & testing.