NIFTEM

Research Entrance Test

(RET)-2025

Syllabus Booklet

for

PhD Admission

- The RET-2025 shall comprise of 3 stages.

- ***Stage 1 General Aptitude Test:*** The test will consist of multiple choice questions. The test is for 60 minutes. Each question will carry one mark. There will be no negative marking. It is only qualifying stage. Candidates obtained/secure 40 % OR above marks will be qualified to appear in Stage 2 and Stage 3 [A relaxation of 5% of marks shall be allowed for the candidates belonging to SC/ST/OBC (Non-Creamy layers)/ EWS/ Differently- abled category].

- ***Stage 2 Department level written exam:*** The candidates will appear for a written exam as per entrance paper choice. The test is for 60 minutes. Question papers will be of mixed nature like objective questions, abstract writing, case study etc.

- ***Stage 3 Interview:*** After the written exam the candidates will have to appear for an interview where the candidates would be required to present their research areas/interests before the interview panel. Those who secured less than 50% marks in interview will be considered as NOT FOUND SUITABLE (NFS)

****

STAGE 1

SUBJECT: RESEARCH METHODOLOGY

UNIT 1 Research Aptitude: Research: Meaning, characteristics and types; Steps of research; Methods of research; Research Ethics; Research problem, Meaning of research problem, Sources of research problem, Characteristic of a good research problem. Hypothesis: meaning of hypothesis, Research proposal or synopsis

UNIT 2 Reasoning (Including Mathematical): Number series; letter series; codes; Relationships; classification.

UNIT 3 Logical Reasoning: Understanding the structure of arguments; Evaluating and distinguishing deductive and inductive reasoning; Verbal analogies: Word analogy- Applied analogy, Verbal classification, Reasoning Logical Diagrams: Simple diagrammatic relationship, Multi-diagrammatic relationship, Venn diagram, Analytical Reasoning**.**

UNIT 4 Information and Communicating Technology (ICT): Meaning, advantages, disadvantages and uses; General abbreviations and terminology; Basics of internet and e-mailing, Microsoft office 2007 and 2010.

 UNIT 5 Reading Comprehension and General Knowledge: A passage to be set with questions to be answered, General knowledge and Current affairs (Related to science, engineering and technology).

****

STAGE 2

DEPARTMENT OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

Paper 1: POSTHARVEST TECHNOLOGY

UNIT 1-Post-Harvest Technology of Fruit and Vegetable Crops: Scope and importance of post-harvest management of fruits and vegetables; Factors leading to post-harvest losses; Maturity indices, methods of assessment of maturity, harvesting practices and grading for specific market requirements; Physiological and biochemical changes during maturity and ripening, ethylene evolution and ethylene management; Ripening changes, Influence of pre-harvest practices and other factors affecting shelf life and post-harvest quality; Harvesting methods, harvesting practices for specific market requirements; Pre-cooling methods; pack house unit operations, pre treatments prior to shipment, Pre-packaging and irradiation, packaging of fruits and vegetables, packaging materials; Storage methods - ventilated, refrigerated, MAS, CA storage; Physical injuries and disorders; Transportation and marketing standards for international markets, quality evaluation,

UNIT 2-Processing of fruits and vegetables: Principles and methods of preservation, food processing, canning, juices, beverages, pickles, jam, jellies, candies etc.; Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards and export standards.

UNIT 3-Processing of Plantation Crops and Spices: Prospects of processing and value addition, National and global scenario; Commercial uses of spices and plantation crops. Processing of major spices - cardamom, black pepper, ginger, turmeric, chilli cinnamon, clove, coriander, fenugreek. Extraction of oleoresin and essential oils; Processing of produce from plantation crops, viz. coconut, arecanut, cashewnut, oil palm, date palm, cocoa, tea, coffee, etc; Extraction and analysis of active principles using TLC/HPLC/GC.

UNIT 4-Post Harvest Unit Operations: Grading, cleaning, washing, sorting, shelling, dehusking, decortication, milling, polishing, pearling, drying (evaporative, osmotic and freeze drying), pasteurization and sterilization of liquid foods, kinetics of microbial death, size reduction, cryogenic grinding, granulation, crystallization, membrane separation processes viz. micro filtration, ultra-filtration, nanofiltration, reverse osmosis.

****

Paper 2: ENVIRONMENT SCIENCES

UNIT 1-Ecological Concepts and Principles: Ecosystem- types; trophic structure, food chain, food web, ecosystem function; Biodiversity: Concepts, Threats to biodiversity and conservation approaches; Concept of sustainability and sustainable development.

Unit 2-Problems associated with Natural Resources: Renewable and non-renewable energy sources; Land degradation; mining and dam building impacts on environment, forests, biodiversity and tribal populations; floods, droughts, conflicts over water (international & inter-state); Human population growth and impact on environment.

UNIT 3-Environmental chemistry: Atmospheric Chemistry: Chemical composition of atmosphere, the changing global atmosphere, Global warming and greenhouse effect, sources and sinks of major green house gases, Climate change; Stratospheric ozone layer depletion-effect of UV radiation, acid-rain, Photochemical smog, Water Chemistry: Water quality parameters, standards, acidity, alkalinity, BOD, COD, DO determinations, water pollution due to heavy metals, organic pollutants, Soil Chemistry: CEC, soil acidity and salinity.

UNIT 4-Pollution and Pollutants: Air pollution: sources, Effects of air pollutants and mitigation measures for combating air pollution; Soil and water pollution: sources and types of soil and water pollutants; Effects of pollutants on soil health and productivity; major types of water pollutants, their impacts on environment and agro-ecosystems; Waste water treatment- primary, secondary and tertiary treatments; Marine pollution, Solid Waste Management: Causes, Effects and Control Measures.

UNIT 5-Analytical Techniques: Principles and applications of spectroscopy-UV, visible, fluorescence, and AAS; Chromatography: Basic principles, paper and thin layer chromatography; reverse phase chromatography; HPLC; Gas Chromatography (GC); Applications in food technology.

****

Paper 3: LIFE SCIENCES

UNIT 1-Microbiology and Microbial Biotechnology: morphology and growth kinetics of bacteria, yeast, molds, and actinomycetes, microbial production and purification of fermented food and food products, recombinant proteins, industrial enzymes bioremediation; microbes in agriculture: symbiotic nitrogen fixation, rhizobium, cyanobacteria (anabaena, azolla), mycorrhiza.

UNIT 2-Biomolecules, Enzymology, and Bioprocess Technology: Structure and function of biomolecules (carbohydrates, lipids and proteins), basic metabolic pathways (glycolysis, TCA cycle, oxidative phosphorylation), protein structures, folding/misfolding and function correlation; enzymes-classification and general properties; enzyme kinetics, regulation and inhibition; quantification of enzyme activity; enzyme immobilization, use of enzymes in food processing; microbial enzymes; fermentation medium, types of bioreactor types: parts and their functions;

UNIT 3-Bioseparation and Analytical Techniques: Filtration, centrifugation, sedimentation, flocculation, isolation and purification of proteins, analytical techniques, spectroscopy: UV, visible and fluorescence; Chromatography: basic principles, paper and thin layer chromatography; Gel permeation, ion exchange, hydrophobic interaction, reverse phase, affinity, HPLC and FPLC, Electrophoresis: agarose, PAGE, 2D gels, capillary electrophoresis, western blotting

UNIT 4-Molecular Biology: DNA replication, transcription, and translation in prokaryotes and eukaryotes, DNA damage repair mechanisms, and regulation of gene expression (operons, transcription factors). Recombinant DNA technology (cloning, expression vectors) and gene-editing tools (CRISPR-Cas9).

UNIT 5- Bioinformatics: Application of bioinformatics, sequence analysis (BLASTn and BLASTp, sequence alignments), database searching, primer design, and applications in genomics/proteomics, next-generation sequencing (NGS).

****

STAGE 2

FOOD BUSINESS MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT DEPARTMENT

Paper 1: FOOD BUSINESS MANAGEMENT

UNIT 1 Agri and Food business Management: Principles of Agri and Food Business Management ,Rural Markets and services, Agricultural Innovation, Financial Management in Agriculture, Importance of Agriculture business,Agricultural Policy: Instruments of policy, phases in agricultural policy. MSP, PDS. APMC, e-NAM, Globalization, WTO and Agriculture, SAMPADA, Meaning, Scope & importance of managerial Economics, Sustainable Agriculture, Agro Processing Industry.

UNIT 2 Decision Sciences and Operations Management: Operation Research – Linear Programming, Introduction to Operations Research and models, Transportation and assignment problems, Queuing Theory, PERT / CPM, replacement Theory, Decision Theory 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.

UNIT 3 Entrepreneurship and Strategy: 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 FinancialAnalysis 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. 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.

UNIT 4 Finance and Accounting: 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.

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 5 Marketing & Consumer and Industrial Buying Behaviour: Marketing – Concept, Orientation, Trends and Tasks, Customer Value and Satisfaction Market Segmentation, Positioning and Targeting Product and Pricing Decision – Product Mix, Product Life Cycle, New Product development, Pricing – Types and Strategies Placeand promotion decision – Marketing channels and value networks, VMS, IMC, Advertising and Sales promotion.

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 6 Organisational Behaviour & Human Resource Management: Organizational Behavior – 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 Work Force 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 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 Work Force 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.

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.

****

Stage 2
DEPARTMENT OF FOOD ENGINEERING
Paper1: FOOD ENGINEERING

UNIT 1 Engineering Properties and Quality of Biomaterials: Physical and Engineering properties of agro produce (i.e. shape, size, volume, density, porosity, surface areas, friction, rolling resistance, angle of reposeetc). Properties of bulk particulate solids (i.e. specific surface area, mean diameter, flow rate, Aerodynamics drag coefficient and terminal velocity, pressure drop through packed beds etc). Thermal properties (i.e. specific heat, thermal conductivity, thermal diffusivity. Dielectric properties viz.dielectric and microwave radiation, dielectric constant, energy absorption, heatingetc).Optical properties and transmittance and reflectance. Rheological properties and stress- strain-time relationship.

UNIT 2 Heat and Mass Transfer: Fluid transfer &continuity equation, Newtonian and non newtonian fluids, velocity, flow rate, pressure drop etc. Basic laws of thermodynamics, thermodynamic properties and processes, energy equations, heat, work, heat engine, heat pump, refrigeration and Steam generation, boilers and use of Steam tables for determination of quality of steam . EMC, sorption and desorption isotherms, water activity and psychrometry. Heat transfer and heat exchanger. Mass transfer and mass-heat-momentum transfer analogies.

UNIT 3 Post Harvest Unit Operations: Unit operations i.e. cleaning, washing, grading,sorting, shelling, dehusking, decortication, milling, polishing, pearling, drying , pasteurization and sterilization of liquid foods, kinetics of microbial growth , size reduction, cryogenic grinding, granulation, crystallization, filtration, membrane processing, microfiltration, ultra-filtration, nano-filtration, reverse osmosis, evaporation, distillation, mixing, clarification, coagulation, mechanical separation, sedimentation, pressing, expelling, leaching, extraction, , extrusion, fermentation.

UNIT 4 Material Handling, Packaging and Transport: Bulk conveying equipments viz. belt conveyors, screw/auger conveyors, bucket elevators and drag/chain conveyors. Estimation of energy requirement, damage to products during mechanical handling. Packaging material characteristics and selection. Packaging techniques Recent trends in packaging: aseptic, Modified atmosphere packaging, controlled atmosphere packaging, Nano-composite packaging, Smart and active packaging, Edible films, Antioxidant and anti microbial packaging. Transportation of food by bullocks, trailers, trucks, rail wagons and containers, conveyors, elevators etc. Refrigerated containers and trucks for perishable foods. Safety standards in handling, packaging and transport of agricultural produce

UNIT 5 Design of Processing Machinery: Design considerations of grain cleaners, graders, dryers, parboiling plants, size reduction machines, fermenters, centrifuges, cyclones, heat-exchangers, evaporators, filters, extrusion cookers, etc.

UNIT 6 Novel Food processing techniques: High pressure processing, Pulsed electric field, Pulsed UV light, Ultrasonication, Ohmic heating, Irradiation, Hurdle technology.

STAGE 2

DEPARTMENT OF FOOD SCIENCE AND TECHNOLOGY

Paper1: FOOD SCIENCE AND TECHNOLOGY

UNIT 1 Food Science: Carbohydrates, Proteins, Lipids, Pigments, Food flavours, Enzymatic and non-enzymatic browning; Nutrition: Balanced diet, Essential amino acids and fatty acids, PER, Water soluble and fat soluble vitamins, Role of minerals in nutrition, Antinutrients, Nutritional disorders, deficiency diseases, General Characteristics of microorganisms, Microbial growth in food: Intrinsic and extrinsic factors, Growth and death kinetics, serial dilution method for quantification; Microbial Food spoilage, Food borne illness Food Fermentation.

UNIT 2 Food Products Technology: Processing principles: Canning, chilling, freezing, dehydration, control of water activity, Controlled Atmosphere Storage and Modified Atmosphere Storage, fermentation, hurdle technology, addition of preservatives and food additives, Food packaging, cleaning in place and food laws.; Grain products processing: Milling of rice, wheat, and maize, parboiling of paddy, production of bread, biscuits, extruded products and breakfast cereals, Solvent extraction, refining and hydrogenation of oil; Fruits, vegetables and plantation products processing: Extraction, clarification concentration and packaging of fruit juice, Production of jam, jelly, marmalade, squash, candies, and pickles, pectin from fruit waste, tea, coffee, chocolate and essential oils from spices; Milk and milk products processing: Pasteurized and sterilized milk, cream, butter, ghee, ice-cream, cheese and milk powder; Animal products processing: Drying and canning of fish, post mortem changes, tenderization and freezing of meat, egg powder.

UNIT 3 Basic Food Engineering: Heat transfer: Heat transfer by conduction, convection, radiation, boiling and condensation, Unsteady state heat transfer in simple geometry, NTU- effectiveness relationship of co-current and counter current double pipe heat exchanger; Thermaloperations: Energy requirement and rate of operations involved in process time evaluation in batch and continuous sterilization, evaporation of liquid foods, hot air drying of solids, spray and freeze-drying, freezing and crystallization; Mass transfer operations: Properties of air- water vapour mixture; Humidification and dehumidification operations.

UNIT 4 Food Safety, Toxicology and Nutraceuticals: Risk Analysis framework (Risk assessment, Management, Communication); LD_{50}, Acute, Subacute, subchronic and Chronic toxicity; Adverse Reactions to Food or Food Ingredients: Food Allergy, Food Toxicity (Poisoning); Common food adulterants, their toxicity & Detection; Toxicants derived from plants, Marine toxins, Microbial toxins and Mycotoxins, Carcinogens and toxicants generated during food processing and packaging; Food additives toxicity, Regulatory aspects of additives; Safety Determination of direct and Indirect Food

Additives, Acceptable daily intake (ADI), estimated daily intake (EDI); Nutraceuticals regulation (FSSAI), Clinical testing of nutraceuticals and health foods; Interactions of prescription drugs, food, alcohol and nutraceuticals; Adverse effects and toxicity of Nutraceuticals

****

STAGE 2
DEPARTMENT OF INTERDISCIPLINARY SCIENCES
Paper 1: APPLIED MATHEMATICS AND STATISTICS

UNIT 1: Matrices and Determinants, Limit, continuity and differentiability; 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. Partial Differential Equations (PDEs): 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. Mathematical modeling: Enzyme and microbial kinetic models (growth and decay/inactivation kinetics), Heat, Mass transfer and momentum equations and solutions. 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.

UNIT 2: Borel-contelliLemma,Tchebycheff's and Kolmogorov's inequalities, Various modes of convergence: in probability, almost sure, in distribution and in mean square and their interrelationship. Properties of a good estimator, Concept of likelihood function, Cramer-Rao inequality, Bhattacharya Bounds, Minimum mean square estimation, Rao-Black well theorem**.**

UNIT 3: Descriptive Statistics, exploratory data analysis, Binomial, Poisson, Geometric, Normal, Exponential, Beta and Gamma distributions.Sampling distributions; Student-t distribution, F distribution and Chi-square distribution. Simple tests based on t, f, Chi-square and normal variate z. Probability sampling. Sampling with equal and unequal probabilities: pps sampling with replacement and without replacement sampling. Stratified sampling. Proportional allocation, optimum allocation.Basic principles of experimental design.Construction and analysis of completely randomized, randomized blocks and Latin-square designs. Factorial experiments: symmetrical factorials. Factorial experiment with each factor at two levels.

UNIT 4: Correlation and Regression, Multiple correlation and regression, Sampling and Design of Experiments: Random Sampling methods, RBD, CRD, LSD , Linear Programming: simplex method, Methods of findings BFS for the transportation problems, Inference : Testing of hypothesis , simple against simple, properties of good estimators, Time Series: Methods of measuring : linear trend , seasonal variations, Vital Statistics: Measures of fertility and Mortality, Queues and Stochastic

Processes : Basics of queues : Markovchain; Markov Process, Multivariate Normal distribution Marginal and Conditional distributions. Estimation of the mean vector and covariance matrix, maximum likelihood estimator of the parameters of multivariate normal distribution. The distribution of the sample mean vector and sample dispersion matrix. Hotteling's T2 and Mahalanobis-D2 Statistic; distribution and uses. Principal components and Canonical correlation in the population.

****

Paper 2: CHEMISTRY

UNIT 1 Physical Chemistry: Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance. Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations. 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. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis. Polymer chemistry: Molar masses; kinetics of polymerization.

UNIT 2 Organic Chemistry: Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways. Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids. Stereochemistry, Photochemistry, Pericyclic and Rearrangement reactions.

Unit 3 Inorganic Chemistry: Concepts of acids and bases, Hard-Soft acid base concept, Non- aqueous solvents. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms. 18/16 electron rule - metal carbonyls - bonding - phosphines -bonding ligands - metal–metal bonds - Fischer and Schrock carbenes - structure, bonding & reactivity – metallocenes - electronic structure and bonding in ferrocene.

Unit 4 Bio-organic and bio-inorganic Chemistry: Various elements in organisms - vitamin and coenzyme B12 - functions - photosynthesis - dioxygen uptake, transport and storage - hemoglobin and myoglobin - hemerythrin - hemocyanin - catalysis through hemoproteins - electron transfer, oxygen activation and metabolism - cytochrome –iron-sulfur and other non-heme iron proteins - ferritin - nickel-containing enzymes - copper-containing proteins-Zinc containing enzymes such as Alcohol dehydrogenase, Carbonic anhydrase, Carboxypeptidase A, Zinc finger proteins.

Unit 5 **Analytical Chemistry**- separation, spectroscopic, electro- and thermoanalytical methods, Principles of optical, fluorescence and electron microscopy, spectrophotometry, UV and VIS, fluorimetry, turbidometry and atomic absorption spectrophotometry. Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques. Structure determination of organic compounds by IR, UV-Vis, ^{1}H & ^{13}C NMR and Mass spectroscopic techniques. Radioisotopic techniques – scintillation counters and autoradiography and their application in biological sciences. Chromatographic techniques - paper, thin layer, column chromatography, GC and HPLC.

****

Paper 3: BIOCHEMISTRY, MICROBIOLOGY AND BIOTECHNOLOGY

Unit 1 Biochemistry: Structure of atoms and molecules, Chemical bonding in biological systems, pH and buffers, Structure, function and metabolism of carbohydrates, lipids and proteins; Major classes of enzymes, general properties, kinetics. Isolation, purification and measurement of enzyme activity.Enzyme units.Enzyme engineering .Role of enzymes in agriculture, industry, and medicine.Spectrophotometry, UV and VIS, fluorimetry, turbidometry and atomic absorption spectrophotometry.gel electrophoresis, isoelectric focusing, pulsed field gel electrophoresis, immunoelectrophoresis. Chromatographic techniques - paper, thin layer, column chromatography, GC and HPLC. Centrifugation - principles of sedimentation in various rotors, differential centrifugation, density gradient centrifugation and ultracentrifugation.

Unit 2 Microbiology: Common microbes in food, Microbial classification and growth kinetics, Isolation, techniques for microbiological analysis of foods, characterization and identification of microbes, food borne diseases and microbiological food safety, conventional and rapid detection of microorganisms in food, spoilage of food, microbiology of food fermentations for dairy products, baked goods, oriental fermentations, Indian fermented foods, fermented meat and fish products, alcoholic beverages etc; Starter culture development, process development, strain improvement, upstream and downstream processing, probiotics and synbiotics, gut microbiome, control of microorganisms in food and hurdle technology, Mircobes for improved nutrition.

Unit 3 Biotechnology: Basics of recombinant DNA technology, Plant and animal tissue culture, Role of enzymes in various food processing sectors, fermentative production of enzymes and microbial metabolites used in food industry. Chemical structure of nucleic acids, introduction to Genetics, DNA replication, transcription and translation; DNA repair mechanism; modifying enzymes; recombinant DNA technology; mutation and polymorphism and their detection; molecular techniques like PCR, RT-PCR, electrophoresis, electroblotting, genome sequencing; genetically modified foods; Application of bioinformatics, analysis and interpretation of DNA and protein sequences, bioinformatics databases, annotation, homology searches: BLASTn and BLASTp, Sequence alignments.

Unit 4 METHOD VALIDATION (International Regulations & ISO/IEC 17025:2017): The principles and practices of analytical method validation and verification in line with ISO/IEC 17025:2017 and international guidelines (ILAC, ICH Q2(R1), FDA, EU, FSSAI, Codex), including validation parameters (accuracy, precision—repeatability/reproducibility, specificity, linearity, range, LOD, LOQ, robustness), estimation of measurement uncertainty, system suitability testing, traceability and calibration, proficiency testing and inter-laboratory comparisons, preparation of validation plans and reports, quality control procedures, documentation requirements, and accreditation processes for food testing laboratories.

****

Paper 4: FOOD SCIENCE AND FOOD SAFETY

Unit 1: Carbohydrates: Monosaccharide, Disaccharides, Oligosaccharides, Polysaccharides. Chemical reaction with acids, alkali, oxidation-reductions, amines. Modified food starch systems. Polysachharides: amylose, amylopectin, starch, gums, seaweed polysaccharides, cellulose, hemicellulose. Dietary fibre and carbohydrate digestibility; Vitamins: Structure and general properties, stability and modes of degradation, bioavailability; Enzymes : Enzymes endogenous to foods and their control- Enzyme activities related to color, flavor and textural quality of food; Proteins: Structural and functional properties of proteins, nutrition and anti-nutritional factors in proteins, Physicochemical properties of amino acids, processing induced physical, chemical and nutritional changes in proteins. Lipids: Physicochemical properties and classification of lipids, saturated and unsaturated fatty acids, phospholipids, sphingolipids. Chemical deterioration of lipids: Hydrolytic and oxidative reactions, Lipid oxidation, Lipid processing: refining, neutralization, bleaching, deodorization, blending, hydrogenation, etc. Quality parameters of oils and fats: significance and determination, Sterols, Cholesterol, Antioxidants, Steroids, Glycosides Alkaloids, Flavonoids.

Unit 2 : Food toxicology, safety and nutraceuticals: Risk Analysis framework (Risk assessment, Management, Communication); LD50, Acute, Subacute, subchronic and Chronic toxicity; Adverse Reactions to Food or Food Ingredients: Food Allergy, Food Toxicity (Poisoning); Common food adulterants, their toxicity & Detection; Toxicants derived from plants, Marine toxins, Microbial toxins and Mycotoxins, Carcinogens and toxicants generated during food processing and packaging; Food additives toxicity, Regulatory aspects of additives; Safety Determination of direct and Indirect Food Additives, Acceptable daily intake (ADI), estimated daily intake (EDI); Nutraceuticals regulation (FSSAI), Clinical testing of nutraceuticals and health foods; Interactions of prescription drugs, food, alcohol and nutraceuticals; Adverse effects and toxicity of Nutraceuticals

Unit 3 : Micro-organisms in natural food products and their control. Microbial contamination in different categories of food products: vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing. Microbial growth in food: Intrinsic and extrinsic factors, Growth and death kinetics, serial dilution method for quantification; Microbial Food spoilage, Food borne illness, Food Fermentation.

Unit 4: Sources of food and their classification- plant foods, animal foods, sea foods. Types of preservatives, advantages, mechanism and techniques of food preservations: thermal/heat

processing (microwave, dielectric), chilling, freezing, chemical, fermentation, irradiation, different types of packaging for food products, smart and active packaging materials, food packaging interactions.

UNIT 5: Biosensors: Immunology (innate/adaptive immunity, antigen–antibody interactions, complement, MHC, cytokines), key immunoassays (ELISA, LFIA, RIA, blotting, flow cytometry), biosensor applications (nano-enabled POCT, paper-based strips), quality/regulatory frameworks (ISO, WHO, FSSAI, USAID, EU), and cutting-edge trends (CRISPR diagnostics, lab-on-chip, AI) alongside applied topics in vaccines, monoclonal, polyclonal antibody production, autoimmunity, hypersensitivity, and host–pathogen interactions.

****

Paper 5: DIGITAL TECHNOLOGIES IN FOOD SECTOR

Unit 1 Introduction to Digital Technologies : Computing Devices, Memory Systems, Storage devices, Data Structure, Data Communications, Automation concepts, Tools used in the Agriculture sector, Introduction to Information Systems, E-Agriculture, Concepts and Applications of Agriculture Information Systems, Smart App, and Agriculture Expert Systems.

Unit 2 Discrete Structures and Optimization: Propositional and Predicate Logic, Propositional Equivalences, Normal Forms, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference, Set Operations, Equivalence Relations, Partially Ordering, Probability, Bayes' Theorem, Groups, Subgroups, Simple Graph, Multigraph, Weighted Graph, Paths and Circuits, Shortest Paths in Weighted Graphs, Eulerian Paths and Circuits, Hamiltonian Paths and Graph Coloring, Bipartite Graphs, Trees and Rooted Trees, Prefix Codes, Tree Traversals, Spanning Trees and Cut-Sets.

Unit 3 Programming Languages: Introduction to MATLAB, R programming language, R data stricture, importing data, manipulating data, Using functions in R, Chart and Plot, Python language, operators, Built-in data types, Condition statement and loop, file processing, modules, Software engineering.

Unit 4 Artificial Intelligence: Heuristic Search Techniques, Nature Inspired Algorithm (NIA), Knowledge Representation, Planning, Natural Language Processing: Grammar and Language; Parsing Techniques, Semantic Analysis and Pragmatics, Multi-Agent Systems, Fuzzy Sets, Fuzzy Relations, Fuzzy Rules and Fuzzy Inference; Fuzzy Control System and Fuzzy Rule-Based Systems, Artificial Neural Networks (ANN): Supervised, Unsupervised and Reinforcement Learning; Single Perceptron, Multi-Layer Perceptron, Self-Organizing Maps, Hopfield Network.

Unit 5 Technologies used for Food Industries: IoT, Cloud Computing, SaaS, PaaS, IaaS, Public and Private Cloud, Virtualization, Virtual Server, Cloud Storage, Resource Management, Service Level Agreement, Big Data, Machine Learning, Geographical Information Systems (GIS), Remote sensing, Data Mining, Data Clustering, and Technique, Classification, Precision Farming, E-commerce, ERP, PERT, MIS Report.

****