

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

(Formerly West Bengal University of Technology)

Main Campus: NH 12, Haringhata, Post Office-Simhat, Police Station-Haringhata,

Pin - 741249 City Campus: BF-142, Sector -I, Salt Lake, Kolkata -700 064

Research Entrance Test (RET) Syllabi

Discipline: Applied Mathematics

- 1. Analysis:** Real functions; limit, continuity, differentiability; sequences; series; uniform convergence; functions of complex variables; analytic functions, complex integration; singularities, power and Laurent series; inner product spaces; dual spaces, linear operators.
- 2. Algebra:** Basic theory of matrices and determinants; eigen values and eigen vectors; Definition of Groups, Subgroups and Factor Groups, Lagrange's Theorem, Homomorphisms, Normal Subgroups. Quotients of Groups. Basic Examples of Groups including Symmetric Groups, Matrix Groups.; vector space, vector subspace, linear independence of vectors, basis and dimensions of a vector space, inner product spaces, orthonormal basis; Gram-Schmidt process, linear transformations.
- 3. Differential Equations:** First order ordinary differential equations (ODEs); solution of first order initial value problems; singular solution of first order ODEs; system of linear first order ODEs; method of solution of $dx/P=dy/Q=dz/R$; orthogonal trajectory; solution of Pfaffian differential equations in three variables; linear second order ODEs; Sturm-Liouville problems; Laplace transformation of ODEs; series solutions; Cauchy problem for first order partial differential equations (PDEs); method of characteristics; second order linear PDEs in two variables and their classification; separation of variables; solution of Laplace, wave and diffusion equations; Fourier transform and Laplace transform of PDEs.
- 4. Numerical Analysis:** Numerical solution of algebraic and transcendental equations; direct and iterative methods for system of linear equations; matrix eigenvalue problems; interpolation and approximations; numerical differentiation and integration; composite numerical integration; double numerical integration; numerical solution for initial value problems; finite difference and finite element methods for boundary value problems.
- 5. Probability and Statistics:** Axiomatic approach of probability; random variables; expectation, moments generating functions, density and distribution functions; conditional expectation.

6. **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.
7. **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.

Discipline: Bioinformatics

1. **Basic Concepts of atomic structure and bonding:** Electronic configurations and quantum no, Electronic properties as dipole moment, electro-negativity, electron gain enthalpy, ionization enthalpy; non-covalent interactions- hydrogen bonding, dispersion forces
2. **Physics:** Basic concept of resistance capacitance, inductance, the equivalent circuit of electrochemical and physiological systems. - Surface and volume-driven phenomenon in different scales. Scaling laws and fractals.
Thermodynamics: Laws of Thermodynamics. Microcalorimetry and Isothermal Titration Calorimetry. - Spectroscopy (UV, VIS, NIR), Impedance spectroscopy, Noise spectroscopy, Electron microscopy, Atomic force microscopy, and basics of Magnetic resonance (ESR & NMR).
3. **Mathematics and Statistics:** Eigen Value and Eigen Vector; Diagonalization of a Matrix; Vector Algebra; limits and continuity, derivatives, integral calculus, differential equations; Mean, Std, Median, t-test, chi-square test, ANOVA, Linear Regression
4. **Biomolecules:** Structure, conformation and stereochemistry; Principles of biophysical chemistry (pH, buffer, reaction kinetics); Principles of catalysis and enzymes, enzyme kinetics, enzyme regulation, inhibition, isozymes. Concept of thermodynamics and its application to biomolecular structure and folding Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).
5. **Major bioinformatics resources:** NCBI, EBI, ExPASy, Uniprot, PDB, CATH, SCOP, Pfam, Pubmed; Sequence and structure databases and analysis, Phylogeny, Comparative genomics; Molecular modeling. Biological sequence alignments: Elementary ideas about pair-wise and multiple sequence alignments; global and local alignment methods; tools of sequence alignments- BLAST, Clustal tools.
6. **Molecular modeling:** Electrical potential, Lennard-Jones potential; Elementary idea about building the structure of a protein from sequence-homology modeling, threading, ab-initio methods; idea about loop refinement & energy minimization; basics of force-fields; overview of docking methods, drug design, and structure-property relationships;
7. **Basic ideas on omics technology**
Proteomics: Protein analysis: 2-D electrophoresis of proteins; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF

Genomics: Introduction Structural organization of the genome in Prokaryotes and Eukaryotes - Organelle DNA-mitochondrial; chloroplast; -DNA sequencing-principles and translation to large scale projects.

8. Basic knowledge in computer programming: Algorithm, coding (R/Python). - The basic idea of curve fitting - Wetlab data analysis and classification using AI - Biological imaging - Internet of Things (IoT) and coding for a biomedical sensing device using IoT

Discipline: Biotechnology

1. Basics of Biochemistry and Biophysics:

Biomolecules: their Structure, conformation and stereochemistry, Principles of biophysical chemistry (pH, buffer, reaction kinetics); Principles of catalysis and enzymes, enzyme kinetics, enzyme regulation, inhibition, isozymes. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). DNA double helix structure, nucleotides and nucleosides, RNA structure, DNA melting curve, Chargaff's rule, DNase, topoisomerase. Basic metabolism, Oxidative phosphorylation, Photosynthesis.

2. Laboratory Tools and Techniques:

Determination of protein and DNA concentrations from standard curves. Determination of reagent concentrations using $V_1 \times S_1 = V_2 \times S_2$ reaction. Electrophoresis (both Protein and DNA). Microscopic techniques (optical microscope, fluorescence microscope). Centrifugation techniques, Chromatographic techniques. Basic ideas on high throughput techniques like DNA sequencing, Micro array, Flow-cytometry.

3. Cellular Organization and Fundamental Biological Processes:

Brief History of Cell Biology, Chemical Components of Cells, Protein Structure and Function, Enzymes, Membrane Structure & Transport, Cell Signalling & Cellular communication, Intracellular Compartments and Protein Transport, Cytoskeleton-Proteins & Movement, Cell cycle and Cancer.

4. Molecular Biology:

Organization of genes and chromosomes: gene families, structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, transposons, DNA replication, transcription and regulation, transcription factors, RNA processing, RNA export and RNA stability, post-transcriptional modification, translation, genetic code, post-translational modification of proteins, regulation of gene expression: operons, regulation at the level of DNA structure: Super coiling, DNA methylation, nucleosome.

5. Basic Idea on General and Applied Microbiology:

Microbial diversity (General idea and classification of bacteria, Fungi, Virus, Protozoa, Archaea, Prion), Bacterial Characteristics (Bacterial growth, staining, nutrition, metabolism), Bacterial genetics, Microbial control (antibiotic and antibiotic resistance), Interaction with microbes with environment (biogeochemical cycles, biofilm, microbiome, pre and probiotic)

Applied microbiology (Biofertilizer, Bioremediation, Biopesticide, host pathogen interaction) , Application of microbes (industrial, agricultural, medical).

6. Basic Idea on Immunology and Oncology:

Fundamental concepts of the immune system; Innate and adaptive immunity; Organs and cells of the immune system; structure and function of antibody molecules; MHC; Antigen presentation; Antigen- antibody interactions; Autoimmunity; Hypersensitivity, Complement system, Immunological techniques; Vaccine. Chemical carcinogenesis; Viral and cellular oncogenes, tumour suppressor genes.

7. Recombinant DNA Technology and its Applications:

Molecular cloning and Enzymes: Gene transfer methods, Vectors including expression vectors, blotting & hybridizations, PCR, gene Expression, genomic and cDNA libraries; in vitro mutagenesis, gene knock out in bacterial and eukaryotic organisms; DNA sequencing methods, micro array-based techniques, DNA footprinting, molecular markers, RNAi, microRNA and their applications.

8. Current Trends in Various Branches of Applied Biotechnology: (Basic ideas on the following):

- a. Food and Fermentation Biotechnology
- b. Plant Biotechnology
- c. Animal Biotechnology
- d. Environmental Biotechnology and toxicology
- e. Nano Biotechnology
- f. Immunotechnology
- g. Bioprocess technology
- h. Agricultural biotechnology
- i. Medical Biotechnology

9. Basic Ideas on Omics Technology:

- a. **Genomics:** Different types of mutation detection and PCR process.
- b. **Proteomics:** Protein analysis; 2-D electrophoresis of proteins; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF

10. Basics Idea on Biosafety, Bioethics and IPR:

Intellectual property right and its importance; Types of IPR; Basic idea on Patent, copyright, trademark, industrial design. Basic idea on Bioethics; Bioethics in research; animal rights; genetically engineered food; bio piracy; Bioweapons. Biosafety and Biosecurity; primary containment for biohazards; biosafety levels; biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals.

11. Mathematics & Statistics:

Basics of mathematics and statistics

12. Bioinformatics:

Major bioinformatics resources (NCBI, EBI, ExPASy); Sequence and structure databases and analysis, Sequence analysis, Phylogeny, Comparative genomics; Molecular modelling.

13. Inheritance Biology:

- A) Mendelian principles: Dominance, segregation, independent assortment.
- B) Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests
- C) Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
- D) Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.
- E) Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.
- F) Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.
- G) Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.
- H) Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis.

Discipline: Chemistry

Inorganic Chemistry

1. Periodic properties of elements.
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).
3. Concepts of acids and bases, HSAB concept, Non-aqueous solvents.
4. Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.
5. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.
6. Organometallic chemistry: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis, self-assembly of supramolecular two and three dimensional architectures, host-guest chemistry, metal-organic frameworks, covalent-organic frameworks and their applications.
7. Analytical chemistry- separation, spectroscopic, electro- and thermo analytical methods.
8. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron- transfer reactions; metal complexes in medicine.
9. Characterisation of inorganic compounds by IR, Raman, NMR, EPR, UV-vis, Mass, electron spectroscopy and microscopic techniques.

Physical Chemistry:

10. Basic principles of quantum mechanics: Postulates; exactly- solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momentum; tunnelling.
11. Approximate methods of quantum mechanics: Variation principle; perturbation theory up to second order in energy; applications. Atomic structure and spectroscopy.
12. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π -electron systems.
13. Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.
14. 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's principle; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.
15. Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.
16. Electrochemistry: Nernst equation, redox systems, electrochemical cells; DebyeHuckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.
17. 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.
18. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.

Organic Chemistry:

19. Stereochemistry: Configurational and conformational isomerism in cyclic and acyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.
20. Aromaticity: Benzenoid and non-benzenoid compounds – generation and their reactions. Common named reactions and rearrangements – their applications in organic synthesis.
21. Organic intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzyne and nitrenes.
22. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
23. 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.
24. Pericyclic reactions – electrocycloisatation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.
25. Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).

26. Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.
27. Structure determination of organic compounds by IR, UV-Vis, ^1H & ^{13}C NMR and Mass spectroscopic techniques.

Interdisciplinary topics

28. Computational Chemistry
29. Chemistry in nanoscience and technology.
30. Medicinal chemistry.
31. Supramolecular chemistry.
32. Environmental chemistry.

Disciplines: Computer Science & Engineering, Information Technology, Artificial Intelligence, Cyber Security, Data Science and Geoinformatics

1. Engineering Mathematics

Discrete Mathematics: Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Groups

Graphs: Connectivity, matching, coloring.

Combinatorics: Counting, recurrence relations, generating functions.

Linear Algebra: Matrices, determinants, systems of linear equations, eigenvalues and eigenvectors, LU decomposition.

Calculus: Limits, continuity and differentiability. Maxima and minima. Meanvalue theorem. Integration.

Probability: Random variables. Uniform, normal, exponential, poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.

2. Digital Logic

Boolean algebra: Combinational and sequential circuits. Minimization. Number representations and computer arithmetic (fixed and floating point).

3. Computer and Architecture

Machine instructions and addressing modes. ALU, data- path and control unit. Instruction pipelining. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).

4. Programming and Data Structures

Programming in C: Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.

5. Algorithm

Searching, sorting, hashing. Asymptotic worst-case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide- and- conquer. Graph search, minimum spanning trees, shortest paths.

6. Theory of Computation

Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and context-free languages, pumping lemma. Turing machines and undecidability.

7. Compiler Design

Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation.

8. Operating System

Processes, threads, inter- process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems.

9. Databases

ER- model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.

10. Computer Networks

Concept of layering. LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP). Basics of Wi-Fi. Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

Discipline: Energy Studies

Energy Conversion - Materials for Energy Conversion & Storage - Solar Energy-Wind Energy - Biomass Energy - Geo Thermal Energy – Nuclear Energy – Ocean & Tidal Energy - Hydel Power- Distributed Generation - Power Systems - Fuel Technology - Energy Storage - Energy Management -Energy & Environment - Energy Policy & Regulation – Industrial Energy Analysis – Safety & Disaster Management.

Discipline: Food Technology

Food Microbiology: Microbial nutrition, macronutrients, micronutrients and growth factors; nutritional types of microorganisms based on sources of carbon, energy, and electron; uptake of nutrients by cell (passive and facilitated diffusion, active transport, group translocation, iron uptake); Culture media and culture techniques; Microbial growth curve, growth rate and generation time; measurement of cell number and cell mass; Continuous culture (chemostat, turbidostat); different environmental factors influencing microbial growth (water activity, pH, temperature, oxygen concentration, pressure, radiation); Biofilms.

Food borne diseases (Botulism, Salmonellosis, Listeriosis, Campylobacteriosis, Shigellosis, E.coli diarrhea and colitis, Cholera, Giardiasis, toxoplasmosis, viral gastroenteritis, cryptosporidiosis) and intoxication (botulinum toxin, aflatoxins, fumonisins, ergotism, major genera involved in food-borne intoxication), Food hygiene and sanitation: Contamination during handling and processing and its control; indicator organisms Detection of food-borne pathogens (selective culture media, antigen detection by ELISA, radioimmunoassay technique; molecular techniques using labelled probes linked to variety of enzymatic, isotopic, chromogenic or luminescent/fluorescent markers, serotype specific probes and PCR techniques, food-borne pathogen fingerprinting).

Nutritional biochemistry: Enzymes, Enzyme kinetics including inhibition in enzyme kinetics, Coenzyme & Co-factors, Enzyme in clinical diagnosis, Vitamins, Free radical, ROS & 7 Oxidation, Xenobiotics & its Metabolism. Food components and nutrients affecting immune systems, behaviour and performance.

Principles of Food Processing Technology: Processing and preservation by heat – blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying, etc. Processing and preservation by low-temperature- refrigeration, freezing, CA, MA, and dehydro-freezing.

Fermentation Technology: Downstream processing for microbial products- Separation of insoluble products: filtration, centrifugation, sedimentation, flocculation; cell disruption; Separation of soluble products: liquid- liquid extraction, precipitation, chromatography, reverse osmosis, crystallization, ultra and micro filtration; drying and packaging.

Fermented foods and beverages- Food ingredients and additives by fermentation; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours, flavours and alcoholic beverages; process wastes- whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria. Food Fermentations; Traditional fermented foods of India and other Asian countries; saurkraut, youghurt, miso, tempeh, idli, dosa.

Mathematical Techniques for Food Science: Linear Algebra: Basics, Vectors, matrices, determinants; Matrix addition and multiplication. Integral calculus: Basic concept of integral

calculus with respect to Differential Calculus, integration techniques of some simple basic derivatives, Simple applications of integration for calculation of area & volume. Simpson Rule for graphical integration.

Analytical techniques and Research methodology: Spectroscopic techniques using UV/Vis, fluorescence, IR, FTIR, NIR, NMR, atomic absorption, ICP, polarimetry, refractometry, microscopic techniques in food analysis (light microscopy, SEM, TEM, XRD, particle size analysis, image analysis etc.). MODULE III: Chromatographic techniques: Adsorption, column, partition, affinity, ion exchange, size exclusion, GC, GLC, HPLC, HPTLC, GCMS, LCMS.

Food Chemistry: Properties of minerals, vitamins, pigments, anti-oxidants, flavour components, allergens, toxins and anti-nutritional factors in foods; Interaction of constituents in food systems; Changes during storage and processing; Browning reactions in foods. Pectic Substances its occurrence, structure, properties and uses in foods. Enzymes in foods, and food industry, bio-deterioration of foods, food contaminants, additives and toxicants.

Technology of cereals, pulses and oilseeds: Wheat: Types and physicochemical characteristics; wheat milling - products and by-products; factors affecting quality parameters; physical, chemical and rheological tests on wheat flour; additives used in bakery products; flour improvers and bleaching agents; manufacture of bakery products, pasta products and various processed cereal-based foods; manufacture of whole wheat atta, blended flour and fortified flour. Bakery and confectionary industry; raw materials and quality parameters; dough development; methods of dough mixing; dough chemistry; rheological testing of dough-Farinograph, Mixograph, Extensograph, Amylograph / Rapid Visco Analyzer, Falling number, interpretation of the data. Technology for the manufacture of bakery products-bread, biscuits, cakes and the effect of variations in formulation and process parameters on the quality of the finished product; quality consideration and parameters; Staling and losses in baking; machineries used in bakery industry. Rice: Classification, physicochemical characteristics; cooking quality; rice milling technology; by- products of rice milling and their utilization; Parboiling of ricetechnology and effect on quality characteristics; aging of rice - quality changes; processed products based on rice.

Technology of milk and milk products: Present status of milk & milk products in India and Abroad; market milk Composition of milk of various species, quality evaluation and testing of milk, procurement, transportation and processing of market milk, cleaning & sanitization of dairy equipments. Special milks such as flavoured, sterilized, recombined & reconstituted toned & double toned. Indigenous milk products - Present status, method of manufacture of yoghurt, dahi, khoa, burfi, kalakand, gulabjamun, rosogolla, srikhand, chhana, paneer, ghee, lassi etc; probiotic milk products.

Waste Management of Food Industries: Treatment methods for liquid wastes from food process industries; Design of Activated Sludge Process, Rotating Biological Contactors, Trickling Filters, UASB, Biogas Plant. Treatment methods of solid wastes: Biological composting, drying and incineration; Design of Solid Waste Management System: Landfill

Digester, Vermicomposting Pit. Biofilters and Bioclarifiers, Ion exchange treatment of waste water, Drinking-Water treatment, Recovery of useful materials from effluents by different methods.

Statistical Techniques for Food Science: Sampling theory –Statistical population, Sample from population, Random sample; Statistical Hypothesis - Test of significance, Test for proportion, means & standard deviations, Chi-square test of goodness of fit, t-test, F-test. Correlation & Regression (linear) - Associated test of significance, simple problems. Exposure to software packages like Matlab or Scilab, R, Python, Statistica, SPSS. Solving real life application problem related to food science and technology field (data analytic concept with the help of some language like R, Python).

Technology of meat, poultry and fish: Chilling and freezing of carcass fish and meat; canning, cooking, drying, pickling, curing and smoking; prepared fish and meat products like salami, kebabs, sausages, sliced, minced, corned; intermediate moisture and dried meat products; meat plant hygiene – GMP and HACCP; Packaging of meat products. Poultry industry in India, microbiology of poultry meat, spoilage factors; Lay-out and design of poultry processing plants, Plant sanitation; Poultry meat processing operations, equipment used. Packaging of poultry products, refrigerated storage of poultry meat, by products – eggs, egg products, Whole egg powder, Egg yolk products, their manufacture, packaging and storage.

Food safety and quality control: Concepts of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Sampling procedures and plans; Food Safety and Standards Act, 2006; Domestic regulations; Global Food safety Initiative; Various organizations dealing with inspection, traceability and authentication, certification and quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS); Labeling issues; International scenario, International food standards. Quality assurance, Total Quality Management; GMP/GHP; GLP, GAP; Sanitary and hygienic practices; HACCP; Quality manuals, documentation and audits; Indian & International quality systems and standards like ISO and Food Codex;

Process Control and Instrumentation: Flow measurement by Hot – Wire anemometer and magnetic flow meters. Visualization by shadow-graph and interferometer. Liquid level measurement in open vessels and in pressure vessels. Thermal conductivity measurement of solids, liquids and gases. Measurement of diffusivity in gases. Block diagrams. Transfer function closed-loop and open-loop control systems. Response of first order systems and first order systems. Response of time constant.

Discipline: Forensic Sciences

• Forensic Science: Definition, History & Development, Scope, Ethics in Forensic Science • Physical Evidence: Nature, Types, Search methods, Collection, Preservation, Packing & Forwarding of Physical & Trace evidence for forensic analyses, Chain of Custody • Crime Scene: Nature, Types, Preservation of Scene of Crime • Criminal Investigations: Unnatural

deaths, Criminal assaults, Sexual offences, Poisoning, Vehicular accidents • Courts: Types, powers and jurisdiction, Admissibility of evidence in Courts, Definition of Experts, Provisions in Cr.P.C.,1973 & Indian Evidence Act relating to experts & their reports; Court Procedures pertaining to Expert Testimony & Witness • Organization of Forensic Science Laboratories of Centre and State, NCRB and NICFS • Fundamental Rights: Right of Equality (Articles 14 to 18) and Right of Freedom (Articles 19 to 22) as per Constitution of India • Criminal Profiling: Profile of victim and culprit, its role in crime investigation, Lie detection (Polygraphy), Narco analysis, Brain mapping, scope and limitations • Concept of quality control management in Forensic institutions

- Microscopy: Polarizing, Comparison, Stereoscopic, Fluorescent and Electron Microscopes • Spectrophotometry: UV, Visible, IR, Raman, Atomic absorption, Emission • Neutron Activation Analysis • X – rays and x-ray based techniques such as XRD, XRF • Mass Spectroscopy • Chromatographic Techniques: TLC, GLC, HPLC,HPTLC • Hyphenated Techniques: GC-MS, LC-MS, IR-MS and ICP-MS • Electrophoresis: High and Low voltage electrophoresis, Immunoelectrophoresis • Immunoassays: Principle, Types ,Techniques and applications

- Detection and Identification of Blood stains • Determination of Species of Origin • Blood Group Systems • Techniques of Determination of Blood groups of Blood Stains • Detection of Seminal and other body fluids and their Blood Grouping, Red cells Enzymes, Serum Proteins of forensic significance • Disputed Paternity & Maternity • DNA: Structure, DNA as genetic marker, DNA Extraction and Profiling Techniques • DNA Phenotyping and RNA Profiling & their applications • Wild life Forensics: Wild life (Protection) Act,1972, Scope, Evidences and Identification

- Analysis of Ethyl alcohol in beverages , liquors, biological fluids and breath • Analysis of Methanol and Denaturants • Illicit liquors • Analysis of Chemicals in Trap Cases • Metabolism and Chemical examination of : Insecticides & Pesticides, Tranquillizers & Sedatives, Hypnotics Stimulants, Narcotics, Opiates, Drugs of abuse; Analyses of above and their Toxicity • Plant poisons • Metallic Poisons • Extraction, Isolation & Clean-up procedures, Identification of common poisons from viscera, tissues and body fluids

- Fire arms: Types, Classification, Ammunition and their Compositions • Forensic examination of Firearms, Ammunition, Firearms' projectiles (Bullets, Shots, Slug etc.), Shell case • Gunshot residues analysis • Concept of Velocity, Penetration, Dispersion, Ricochet, Accidental Discharge, Determination of Range in firearm cases • Examination of Country made firearms • Basics of Internal, External and Terminal Ballistics • Tool marks: Meaning, Types and Examination • Restoration of Erased Markings on Metal Surfaces

- Fire and Arson: Analyses of Petroleum Products and other incendiary materials • Explosives: Definition, Types and Analyses • Bombs: Country made bombs, Improvised Explosive Devices (IEDs) and their examination • Investigation in Explosion and Arson related cases • Photography: Types, application in criminal investigation & Forensic evidence examination
- Hair & Fibers: Nature, Types, Structure and Examination • Pollens and Diatoms: Their application in Forensic investigation • Dust & Soil: Nature, Types, Forensic Examination • Paint, Lacquer & Varnishes: Nature, composition and forensic examination • Glass: Composition, Types, Fractures, Examination • Cement, Mortar and Concrete: General Composition, Forensic Analysis • Computer Forensics: Introduction, Types of Computer crimes, Digital evidence- Seizure, Acquisition and Forensic examination • Mobile Phone Forensics
- Fingerprints: History, Characteristics, Types, Classification, Preservation, Development, Lifting and Comparison, Examination of Chance Prints, Computerization of Fingerprints, AFIS • Track Marks: Foot Prints, Shoe Prints, Tire Marks, Their Preservation & Casting, Comparison, Skid marks. Gait pattern • Biometric Systems of Identification and its relevance • Voice Analysis: Introduction, Significance, Structure of Human Voice apparatus, Voice spectrography, Voice analysis, Legal aspects and limitations
- Documents: Definition, Types, Preliminary examination of documents • Reproduction of documents through photographic and mechanical means and their examination • Examination of Alterations such as Erasures, Obliterations & Additions • Indentations, Secret writings and Charred documents • Inks, Papers and their scientific examinations with modern methods • Age of documents • Examination of Typescripts, Printed matter including currency notes and lottery tickets. Mechanical impressions • Hand writings: Class and Individual characteristics of Handwritings, Factors affecting handwritings, Standard samples for comparison, Comparison of hand-written texts • Anonymous and disguised writings • Identification of hand writings, signatures, detection of forged signature and forgeries • Examination of Credit Cards and Similar materials
- Modes & Manner of deaths, Sexual offences and its medicolegal importance, Amendments in law related to sexual offences • Post – mortem examination and Post – mortem changes, Estimation of time since death • Injuries & Wounds: Types, Medicolegal importance, Gunshot wounds • Determination of Species of Origin, Sex , Age, Stature, and individual identification through skeletal remains • Identification through Skull superimposition and facial reconstruction • Human dentition, Type of teeth, determination of Age, Bite marks • Forensic Entomology: Introduction, Insects of forensic importance, Insects on Carrion, Forensic applications

Discipline: Management Sciences

Managerial Economics (Micro) :

Demand Analysis, Demand Functions, Laws of Demand, Elasticity of Demand, Indifference curves, methods of demand estimation, Production and Cost Analysis , Production Function, Costs of Production, Isoquants , Law of supply, elasticity of supply, market equilibrium, Alternate Goals of Managerial Firms, Decision Making under Alternative Market Structures , Break Even Point, Price and output decisions under Monopoly, Monopolistic Competition, Oligopoly.

Indian Economy & Policy (Macro):

Circular Flow of Income, Theory of Income Determination, Money and Asset Market, Inflation and Unemployment, Foreign Trade & International Linkages, Overview of Indian Economy, New Industrial Policy, Banking and Capital Market Reforms, Monetary and Fiscal Policy Reforms, Trade Policy Reforms.

Organizational Behaviour:

Theories of Personality, Perception, Work Motivation, Attitudes and Job Satisfaction, Organizational Approaches, Group Behaviour, Leadership, Conflict in Organizations, Managing Organizational Change.

Legal & Business Environment:

Legal Aspects of Business, Indian Contracts Act, 1872; Sale of Goods Act, 1930; Negotiable Instruments Act, 1881; Companies Act, 1956; Consumer Protection Act, 1986; Intellectual Property Right; Economic Indicators – Consumer Price Index, Interest Rate, Inflation Rate and impact on Business; Business Risk; Intellectual Property Regime (WTO Guidelines); Legislation for Anti-competitive and Unfair Trade Practices.

Quantitative Techniques

Descriptive Statistics: Measures of Central Tendency, Dispersion and Shape (for Uni-variate data); Measures of Association (for Bi-variate data) – Correlation and Regression.

Inferential Statistics: Probability and its basic rules; Probability distributions – Discrete (Binomial, Poisson) and Continuous (Uniform, Normal, t-distribution, Exponential); Sampling and sampling distributions; Point and Interval Estimation; Hypothesis Testing; Chi-square and ANOVA

Linear Programming: Formulation and examples, Methods of solution (Graphical and simplex methods), Artificial Variables, Big-M method, Principle of Duality, Shadow Price, Sensitivity analysis

Transportation problem: Formulation and examples; Initial feasible solutions – North-West Corner Rule, Least Cost Method, Vogel’s Approximation Method; Finding the optimal solution – Stepping stone method, MODI method; Variations in Transportation problem. Assignment problem: Formulation and examples; The Hungarian method; Unbalanced assignment, Maximization problem, Restrictions on assignment.

Marketing Management:

Core Concepts of Marketing, Marketing Environment, Market Segmentation, Targeting and Positioning, Consumer Behaviour and Marketing Research, Marketing Mix & its components, Market potential estimation, Product decisions, Branding & Packaging, Pricing decisions, Integrated Marketing Communication, Distribution & Channel Management, Strategic Marketing Decisions.

Operations Management

Introduction to Productions and Operations Management, Differences and similarities between Manufacturing and Services, Product Process Matrix capacity planning, Production Cycle, Production Planning & Control Concept; Characteristics of Manufacturing Systems

Plant location and layout; Need for a good plant location and layout, Factors influencing Plant Location, Characteristics of a Good Layout, Process Layout vs. Product Layout; Maintenance Management: Breakdown and Preventive Maintenance; Total Productive Maintenance

Purchase Management; Purchasing Procedure; Value Analysis; Vendor Selection;

Inventory Management: Classification of inventory items ABC,FSN, VED;EOQ and EBQ; MRP – Concepts of MRP; II, JIT and ERP

Total Quality Management: Acceptance Sampling and Control Charts; Scheduling: Sequencing – Definition and Assumptions; Different aspects, – Gantt Charts, Johnson’s Rule; Project Management – CPM and PERT, Importance of the Critical Path

Work Study: Definition, different processes and importance

Management Information Systems

Basic concepts of Information Systems, Different types of Information Systems, How Businesses use Information Systems, Information Systems, Organizations and Strategy, Ethical and Social Issues

Information Technology infrastructure; IT infrastructure and emerging technologies, Networks and Telecommunications, Foundations of Business Intelligence: Databases and Information Management, Data Warehousing and Data Mining, Big Data

Key system applications for the digital age; E-commerce – Digital Markets, Digital Goods; E-business; Enterprise Applications – ERP, CRM, SCM, Knowledge Management, Information system planning

Information system security and control; Threats of project failure, accidents and malfunctions, computer crimes, Virus, hacking, phishing, spyware, spam, physical threats, Methods for minimizing risks, security measures, firewall, encryption

Human Resource Management:

Meaning, Scope, Objectives and Functions of HRM, Human Resource Planning, Recruitment and Selection, Human Resource Development, Performance Appraisal Systems, Compensation Management, Industrial Relations in India, Workers' Participation in Management, Discipline Management, Strategic HRM.

Entrepreneurship:

Meaning and Concept of Entrepreneurship, Innovation and entrepreneurship, Contributions of entrepreneurs to the society, risk-opportunities perspective and mitigation of risks, Steps of Innovation Management, Idea Management System, Divergent v/s Convergent Thinking, Qualities of a prospective Entrepreneur, Idea Incubation : Factors determining competitive advantage, Market segment, blue ocean strategy, Industry and Competitor Analysis , Entrepreneurial Motivation: Design Thinking - driven Innovation, Government incentives for entrepreneurship, Incubation, acceleration, Funding new ventures – bootstrapping, crowd sourcing, angel investors, Government of India's efforts at promoting entrepreneurship and innovation, Applications and Project Reports Preparation.

Project Management

Definitions of Project and Project Management, Project Life Cycle – Initiation, Planning, Implementation, and Closure.

Feasibility Studies –Technical and Commercial feasibility, Capital Budgeting, Social Cost Benefit Analysis, Preparation of Detailed Project Report,

Project Planning –Steps of Project Planning, Project Scope, Work Breakdown Structure and Organization Breakdown Structure

Project Scheduling and Costing – Gantt chart, CPM and PERT Analysis, Identification and significance of the Critical Path, Calculation of Floats and Slacks, Crashing, Time Cost Trade-off Analysis, Project Cost Reduction Methods.

Project Monitoring and Control – Role of Project Manager, MIS in Project Monitoring, Project Audit

Corporate Strategy:

Strategic Management process, Environmental Scanning: SWOT Analysis, External Environment Analysis (Economic, Legal, Political, Social, Geographic, Technical); Internal Environment Analysis, Strategic Planning: Corporate; Functional and Managerial Goal Setting, Formulating Strategies: Corporate, Administrative/Executive and Operating Levels, Developing Functional Strategies – Production/Operations, Finance, Marketing, HR, Materials, R & D; BCG Matrix, Portfolio analysis, Implementation of Strategies: Role of Managers, Leadership, Strategic Control System and Measurement, Structural Implementation, Functional Implementation, Strategic Actions: Mergers, Acquisitions, Diversification, Joint Ventures, De-Merger, etc., Evaluation of Strategy.

Discipline: Pharmaceutical Technology

Modern Pharmaceutical Analytical Techniques: UV-Visible spectroscopy: Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy, Choice of solvents and solvent effect and Applications of UV Visible Spectroscopy. **IR spectroscopy:** Theory, Modes of Molecular vibrations, Sample handling, Instrumentation of Dispersive and Fourier -Transform IR Spectrometer, Factors affecting vibrational frequencies and Applications of IR spectroscopy. **NMR spectroscopy:** Quantum numbers and their role in NMR, Principle, Instrumentation, Solvent requirement in NMR, Relaxation process, NMR signals in various compounds, Chemical shift, Factors influencing chemical shift, Spin-Spin coupling, Coupling constant, Nuclear magnetic double resonance, Brief outline of principles of FT-NMR and ¹³C NMR. Applications of NMR spectroscopy.

Drug Delivery: Vaccine delivery systems: Vaccines, uptake of antigens, single shot vaccines, mucosal and transdermal delivery of vaccines. **Sustained Release(SR) and Controlled Release (CR) formulations:** Introduction & basic concepts, advantages/disadvantages, factors influencing, Physicochemical & biological approaches for SR/CR formulation, Mechanism of Drug Delivery from SR/CR formulation. **Polymers:** introduction, definition, classification, properties and application **Dosage Forms for Personalized Medicine:** Introduction, Definition, Pharmacogenetics, Categories of Patients for Personalized Medicines: Customized drug delivery systems, Bioelectronic Medicines, 3D printing of pharmaceuticals, Telepharmacy

Modern & Molecular Pharmaceutics:

Optimization techniques in Pharmaceutical Formulation: Concept and parameters of optimization, Optimization techniques in pharmaceutical formulation and processing. Statistical design, Response surface method, Contour designs, Factorial designs and application in formulation. Study of consolidation parameters; Diffusion parameters, Dissolution parameters

and Pharmacokinetic parameters, Heckel plots, Similarity factors – f_2 and f_1 , Higuchi and Peppas plot, Linearity Concept of significance, Standard deviation, Chi square test, students T-test, ANOVA test.

Targeted Drug Delivery System: Targeting Methods: introduction preparation and evaluation. Nano Particles & Liposomes: Types, preparation and evaluation. Nucleic acid based therapeutic delivery system: Gene therapy, introduction (ex-vivo & in-vivo gene therapy). Potential target diseases for gene therapy (inherited disorder and cancer). Gene expression systems (viral and nonviral gene transfer). Liposomal gene delivery systems. Biodistribution and Pharmacokinetics. knowledge of therapeutic antisense molecules and aptamers as drugs of future.

Advanced Bio-Pharmaceutics & Pharmacokinetics: Biopharmaceutic considerations in drug product design and In Vitro Drug Product Performance: Introduction, biopharmaceutic factors affecting drug bioavailability, rate-limiting steps in drug absorption, physicochemical nature of the drug formulation factors affecting drug product performance, in vitro: dissolution and drug release testing, compendial methods of dissolution, alternative methods of dissolution testing, meeting dissolution requirements, problems of variable control in dissolution testing performance of drug products. In vitro–in vivo correlation, dissolution profile comparisons, drug product stability, considerations in the design of a drug product.

Pharmacokinetics: Basic considerations, pharmacokinetic models, compartment modeling: one compartment model- IV bolus, IV infusion, extra-vascular. Multi compartment model: two compartment - model in brief, non-linear pharmacokinetics: cause of non-linearity, Michaelis – Menten equation, estimation of k_{max} and v_{max} . Drug interactions: introduction, the effect of protein binding interactions, the effect of tissue-binding interactions, cytochrome p450-based drug interactions, drug interactions linked to transporters.

Computer aided drug development: Computers in Pharmaceutical Research and Development: A General Overview: History of Computers in Pharmaceutical Research and Development. Statistical modeling in Pharmaceutical research and development: Descriptive versus Mechanistic Modeling, Statistical Parameters, Estimation, Confidence Regions, Nonlinearity at the Optimum, Sensitivity Analysis, Optimal Design, Population Modeling

Advanced Pharmacology: Neurotransmission: General aspects and steps involved in neurotransmission. Neurohumoral transmission in autonomic nervous system (Detailed study about neurotransmitters - Adrenaline and Acetyl choline). Neurohumoral transmission in central nervous system (Detailed study about neurotransmitters histamine, serotonin, dopamine, GABA, glutamate and glycine]. Non adrenergic non cholinergic transmission (NANC).

Co-transmission : Systemic Pharmacology A detailed study on pathophysiology of diseases, mechanism of action, pharmacology and toxicology of existing as well as novel drugs used in the following systems Autonomic Pharmacology Parasympathomimetics and lytics, sympathomimetics and lytics, agents affecting neuromuscular junction.

Central nervous system Pharmacology : General and local anesthetics, Sedatives and hypnotics, drugs used to treat anxiety. Depression, psychosis, mania, epilepsy, neurodegenerative diseases. Narcotic and non-narcotic analgesics.

Cardiovascular Pharmacology: Diuretics, antihypertensives, antiischemics, anti-arrhythmics, drugs for heart failure and hyperlipidemia. Hematinics, coagulants, anticoagulants, fibrinolytics and antiplatelet drugs.

Pharmacological & Toxicological Screening: Preclinical screening of new substances for the pharmacological activity using in vivo, in vitro, and other possible animal alternative models. General principles of preclinical screening.

CNS Pharmacology: behavioral and muscle coordination, CNS stimulants and depressants, anxiolytics, anti-psychotics, anti epileptics and nootropics. Drugs for neurodegenerative diseases like Parkinsonism, Alzheimers and multiple sclerosis.

Drugs acting on Autonomic Nervous System. Preclinical screening of new substances for the pharmacological activity using in vivo, in vitro, and other possible animal alternative models.

Respiratory Pharmacology: anti-asthmatics, drugs for COPD and anti-allergics.

Reproductive Pharmacology: Aphrodisiacs and antifertility agents Analgesics, antiinflammatory and antipyretic agents. Gastrointestinal drugs: anti ulcer, anti-emetic, antidiarrheal and laxatives.

Cardiovascular Pharmacology: antihypertensives, antiarrhythmics, antianginal, antiatherosclerotic agents and diuretics. Drugs for metabolic disorders like anti-diabetic, antidyslipidemic agents. Anti cancer agents. Hepatoprotective screening methods.

Cellular & Molecular Pharmacology: Principles and applications of genomic and proteomic tools DNA electrophoresis, PCR (reverse transcription and real time), Gene sequencing, micro array technique, SDS page, ELISA and western blotting, Recombinant DNA technology and gene therapy Basic principles of recombinant DNA technology-Restriction enzymes, various types of vectors. Applications of recombinant DNA technology. Gene therapy- Various types of gene transfer techniques, clinical applications and recent advances in gene therapy.

Cell culture techniques: Basic equipments used in cell culture lab. Cell culture media, various types of cell culture, general procedure for cell cultures; isolation of cells, subculture, cryopreservation, characterization of cells and their application. Principles and applications of cell viability assays, glucose uptake assay, Calcium influx assays Principles and applications of flow cytometer and Bio-similars.

Endocrine Pharmacology: Molecular and cellular mechanism of action of hormones such as growth hormone, prolactin, thyroid, insulin and sex hormones. Anti-thyroid drugs, Oral hypoglycemic agents, Oral contraceptives, Corticosteroids. Drugs affecting calcium regulation.

Immunopharmacology: Cellular and biochemical mediators of inflammation and immune response. Allergic or hypersensitivity reactions. Pharmacotherapy of asthma and COPD. Immunosuppressants and Immunostimulants. Acute, sub-acute and chronic- oral, dermal and inhalational studies as per OECD guidelines. Acute eye irritation, skin sensitization, dermal irritation & dermal toxicity studies. Test item characterization- importance and methods in regulatory toxicology studies.

Principles of Drug Discovery: An overview of modern drug discovery process: Target identification, target validation, lead identification and lead Optimization. Economics of drug discovery. Target Discovery and validation-Role of Genomics, Proteomics and Bioinformatics. Role of Nucleic acid microarrays, Protein microarrays, Antisense technologies, siRNAs, antisense oligonucleotides, Zinc finger proteins. Role of transgenic animals in target validation.

Clinical research & Pharmacovigilance: Clinical Trials: Types and Design, Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator, Sponsor, Contract Research Organization and its management.

Research Methodology: General Research Methodology: Research, objective, requirements, practical difficulties, review of literature, study design, types of studies, strategies to eliminate errors/bias, controls, randomization, crossover design, placebo, blinding techniques.

Discipline: Physics

Mechanics: Constraints, Newton's Laws, Gravitation, Principle of virtual work, D' Alembert's principle, Lagrangian and Lagrange's Equations, Hamilton's principle, Principle of Least Action, Hamilton's canonical equations. Conservative forces, Rigid Body motion, Euler's Theorem, Rotation, Moment of Inertia, Euler's equation of motion, Coriolis Force, Simple Harmonic Motion, Small Oscillations, Damped and Forced Oscillations, Central Forces, Kepler's Laws, Inverse square force.

Electromagnetism: Vector calculus, Electrostatics, Potentials, Electric Fields in Matter, Magnetostatics, magnetic fields in matter, Electrodynamics, conservation laws, electromagnetic waves.

Relativity: Postulates, velocity addition, time dilation, Lorentz contraction, Lorentz transformation, Lorentz invariant.

Quantum Mechanics: Wave-particle Duality, Uncertainty principle, Schrodinger Equation, wave-functions, operator algebra, wave mechanics, particle in a well, linear harmonic oscillator, potential step, rectangular barrier, square well, WKB approximation, angular momentum, spherically symmetric potentials, scattering, spin, rotations.

Condensed Matter: Drude and Sommerfield theory of metals, crystal lattices, reciprocal lattice, X-Ray diffraction of crystals, electrons in a periodic potential, band theory, tight binding methods, semiclassical model of electron motion, classical and quantum theories of harmonic crystal, phonon dispersions, magnetism.

Statistical Mechanics: Postulates of statistical mechanics, μ -space and γ space, microcanonical, canonical and grand canonical ensembles. Equipartition Theorem, classical ideal gas, Gibb's paradox, canonical partition function, grand canonical partition function, quantum statistics, Bose-Einstein, Fermi-Dirac and Maxwell Boltzman statistics.