



DOCTORAL RESEARCH PROGRAMMES

ADMISSIONS TEST SYLLABUS 2024

QUESTION PAPER PATTERN

SUBJECT TEST (75 MARKS)

Part A: Multiple Choice Questions (30x1 = 30 marks)
Please NOTE that an incorrect response will attract negative marking. (For Multiple Choice question with 5 options, $\frac{1}{4}$ th mark shall be deducted for an incorrect answer.)

Part B: Answer any 9 (out of the following) in about 150 words each (9x5 = 45 marks)

EVALUATIVE TEST IN ENGLISH (50 MARKS)

Part A: Objective Questions (30x1 = 30 Marks)

Part B: Rewrite the following visual into a text of about 150 words (10 Marks)

Part C: Write a paragraph of about 150 words on your reasons for pursuing research, and India's need for original research contributions (10 Marks)

DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

PH.D. IN MATHEMATICS

Linear Algebra

Finite dimensional vector spaces, Linear transformations and their matrix representations, rank, systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton Theorem, diagonalization, Hermitian, Finite dimensional inner product spaces, Gram-Schmidt orthonormalization process, self-adjoint operators.

Complex Analysis

Analytic functions, conformal mappings, bilinear transformations, complex integration, Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Zeros and singularities, Taylor and Laurent's series, Residue theorem.

Real Analysis

Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima; Riemann integration, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, compactness, completeness, Weierstrass approximation theorem; Lebesgue measure, measurable functions; Lebesgue integral.

Ordinary Differential Equations

First order ordinary differential equations, existence and uniqueness theorems for initial value problems, systems of linear first order ordinary differential equations, linear

ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients; method of Laplace transforms for solving ordinary differential equations, series solutions (power series, Frobenius method); Legendre and Bessel functions and their orthogonal properties.

Algebra

Groups, subgroups, normal subgroups, quotient groups and homomorphism theorems, automorphisms; cyclic groups and permutation groups; Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domains, Principal ideal domains, Euclidean domains, polynomial rings and irreducibility criteria.

Functional Analysis

Normed linear spaces, Banach spaces, Hahn-Banach extension theorem, open mapping and closed graph theorems, principle of uniform boundedness; Inner-product spaces, Hilbert spaces, orthonormal bases, Riesz representation theorem, bounded linear operators.

Numerical Analysis

Numerical solution of algebraic and transcendental equations; fixed point iteration; interpolation; error of polynomial interpolation; numerical differentiation; numerical integration; numerical solution of systems of linear equations: direct methods; iterative methods; numerical solution of ordinary differential equations and initial value problems.

Partial Differential Equations

Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems; solutions of Laplace, wave in two dimensional Cartesian coordinates, Separation of variables method for solving wave and diffusion equations in one space variable; Fourier transform method based solutions for the above equations.

Topology

Basic concepts of topology, bases, subbases, subspace topology, order topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma.

Graph Theory

Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Isomorphism; Depth first search and breadth first search.

PH.D. IN COMPUTER SCIENCE

Set Theory & Algebra

Sets; Relations; Functions; Partial Orders, Groups, Boolean Algebra.

Linear Algebra

Algebra of matrices, determinants, systems of linear equations, Linear Transforms, Eigenvalues and Eigenvectors.

Probability

Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions.

Graph Theory

Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Isomorphism; Depth-first search and breadth-first search.

Computer Organization and Architecture

Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Instruction level parallelism – hardware and software techniques (e.g., dynamic scheduling, superscalar, static and dynamic branch prediction, VLIW, loop unrolling), Cache and main memory, multi-level caches, Cache consistency, snoopy protocols, Secondary storage.

Programming and Data Structures

Functions, Recursion, Parameter passing; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Heaps

Object Oriented Programming Concepts

Class, object, instantiation. Inheritance, polymorphism and overloading.

Algorithms

Greedy algorithms, dynamic programming, divide-and-conquer, network flow, Notions of space and time complexity, Asymptotic analysis: Big Oh, Little oh, Theta, Worst case and average case analysis, Polynomial time algorithms, NP-algorithms, NP-hardness and NP-completeness.

Relational Database Design and SQL

E-R diagrams and their transformation to relational design, normalisation-1NF, 2NF, 3NF, BCNF and 4NF. Limitations of 4NF and BCNF. Good working knowledge in SQL.

Computer Networks

Network fundamentals: LAN, MAN, WAN, Wireless Networks. Reference Models: The OSI model, TCP/IP model. Data Communication: Channel capacity. Internet working: Switch/

Hub, Bridge, Router, Gateways, Tunnelling, Fragmentation, Routing algorithms, Sliding window protocols, Three-way handshake, Congestion control.

System Software and Compilers

Assemblers-2-pass and single-pass. Macros and macroprocessors. Loading, linking, relocation, program relocatability. Phases of compilation process. Lexical analysis. Context free grammars. Parsing and parse trees. Representation of parse (derivation) trees as rightmost and leftmost derivations. Bottom up parsers-shift- reduce, operator precedence, and LR.

Operating Systems (with Case Study of Unix)

Main functions of operating systems. Multiprogramming, multiprocessing, and multitasking. Memory Management: Virtual memory, paging, fragmentation. Concurrent Processing: Mutual exclusion.

Critical regions, lock and unlock. Scheduling

CPU scheduling, I/O scheduling, Resource scheduling. Deadlock and scheduling algorithms. Banker's algorithm for deadlock handling.

PH.D. IN ACTUARIAL SCIENCE

Numerical Analysis

Numerical solution of algebraic and transcendental equations; fixed point iteration; interpolation; numerical differentiation; numerical integration; numerical solution of systems of linear equations: direct methods; iterative methods; numerical solution of ordinary differential equations and initial value problems.

Partial Differential Equations

Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification;

Set Theory & Linear Algebra

Sets, Relations, Functions, Partial Orders, Groups, Boolean Algebra, Algebra of matrices, determinants, systems of linear equations, Linear Transforms, Eigenvalues and Eigenvectors.

Probability and Statistics

Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; Exploratory Data Analysis, Statistical Inference; confidence intervals; Hypothesis testing; Regression Theory and applications; ANOVA

Applied Statistics

Bayesian statistics, Loss Models, Poisson Process; Time Series, Stochastic Processes, Survival Models, Fundamentals Machine Learning

DEPARTMENT OF PHYSICS

FOR CANDIDATES WITH AN M.SC. IN PHYSICS, PHOTONICS AND NUCLEAR PHYSICS

Mathematical Methods of Physics

Vector algebra and vector calculus; Linear algebra, matrices, eigenvalues and eigenvectors; ordinary differential equations of first & second order; Fourier transforms; Elements of complex analysis.

Electromagnetism: Electrostatics

Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; Electromagnetic waves in free space.

Optics and Photonics

Geometrical optics, wave optics: Interference, diffraction, polarization, optical anisotropy, light microscopy, spatial and temporal coherence.

Quantum Mechanics

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Commutator and Heisenberg uncertainty principle; orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom

Thermodynamic and Statistical Physics

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions

Electronics

pn Junction diodes, transistors, Operational amplifiers and their applications. Digital Electronics: Logic Gates, Flip flops and applications.

Atomic & Molecular Physics

LS & JJ coupling schemes. Zeeman effect, Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules.

Lasers

Spontaneous and stimulated emission, population inversion; Laser characteristics; Classification of lasers- two-level, three-level and four-level laser systems, Laser systems – He-Ne laser, CO₂ lasers, Dye lasers, Solid state lasers - Ruby laser,

Nd-YAG laser, Nd-glass laser.

Solid State Physics

Bravais lattices. Reciprocal lattice. X-ray diffraction and the structure factor, bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power; band theory of solids: metals, insulators and semiconductors; magnetism- dia, para, ferro and ferri-magnetism; dielectric and ferroelectric properties.

Nuclear Physics

Basic nuclear properties size, shape and charge distribution, spin and parity. Binding energy, Evidence of shell structure, single-particle shell model, elementary ideas of alpha, beta and gamma decays and their selection rules.

FOR CANDIDATES WITH AN M.SC. IN PHYSICS, CHEMISTRY, MATERIALS SCIENCE, NANOSCIENCE & NANOTECHNOLOGY, OR AN M.TECH. IN MATERIALS SCIENCE & ENGINEERING, MATERIALS & METALLURGICAL ENGINEERING, NANOTECHNOLOGY, MATERIALS OR CERAMIC ENGINEERING

Crystal Structure & Defects

Crystal symmetry, indices of planes, close packing in solids, types of crystal structures, coordination, radius ratios concepts, Miller Indices, Defects in Solids: Point defects, dislocations (edge and screw) Burgers vector - grain boundaries.

Materials Fabrication

Synthesis of Materials: Fabrication of Nanomaterials - Top-down & Bottom-up approaches; Soft chemistry routes: solvothermal/hydrothermal method, sol-gel method; methods of preparing single crystals; physical and chemical vapor deposition.

Characterization & Spectroscopic Techniques

X-ray diffraction technique, indexing of diffraction patterns, Electron Microscopy - fundamentals of SEM and TEM; Scanning Probe Microscopy: STM & AFM; Spectroscopic tools - UV-Visible Spectroscopy, Vibrational spectroscopy: IR and Raman Spectroscopy.

Physical Properties of Materials

Mechanical properties: Elements of elastic and plastic behavior of materials, stress-strain relations
Thermal properties: specific heat, thermal conductivity,
Magnetic properties: dia, para, ferro and ferri-magnetism,
Electrical and insulating properties: Electrical conductivity,

Dielectric behavior – piezo and ferro-electric materials, elements of band theory, semiconductors, Hall effect, Optical properties: refractive index, absorption coefficient, frequency-dependent dielectric constant
 Quantum Mechanics: Wave-particle duality, Schrödinger equation (time-dependent and time-independent).
 Eigenvalue problems (particle in a box, harmonic oscillator, etc.).

Mathematical Methods

Differentiation, integration, differential equations, vectors, matrices and determinants, eigenvalues and eigenvectors, complex numbers.

Thermodynamics

Thermodynamic potentials, Maxwell relations, chemical potential, phase rule, phase diagrams, solid solutions, lever rule; iron-carbon phase diagram, solidification, phase transformation, recrystallization, diffusion, mechanisms of diffusion.

DEPARTMENT OF CHEMISTRY

PH.D. IN PHYSICAL CHEMISTRY

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, thermodynamics of ideal and non-ideal gases, and solutions.

Statistical Thermodynamics

Boltzmann distribution, partition functions and their relation to thermodynamic quantities.

Phase Equilibria

Phase rule and its application to one and two-component systems.

Quantum Chemistry

Postulates of quantum mechanics, application of Schrodinger's equation to the particle in a box, rigid rotator, harmonic oscillator and hydrogen atom, tunneling, variational principle, perturbation theory up to second order.

Group Theory

Symmetry elements and operations, point groups, selection rules and character tables.

Electrochemistry

Nernst equation, electrochemical cells, electrolytic

conductance – Kohlrausch's law and its applications, Debye-Huckel theory, conductometric and potentiometric titrations.

Chemical Kinetics

Empirical rate laws, theories of reactions - collision theory, transition state theory, applications of thermodynamic concepts to reactions, complex reactions - parallel, consecutive and reversible reactions, chain reactions and their kinetics, enzyme kinetics, salt effects, homogeneous catalysis, photochemical reactions.

Molecular Spectroscopy

Rotational and vibrational spectra of diatomic molecules, electronic spectra, IR and Raman activities – selection rules.

PH.D. IN INORGANIC & ANALYTICAL CHEMISTRY

Chemical Periodicity

Alkali and alkaline earth metals, transition metals, main group elements, noble gases, lanthanides and actinides.

Coordination Chemistry

Structure, isomerism, bonding theories, spectral and magnetic properties, reaction mechanisms.

Organometallic Compounds

Synthesis, bonding, structure, and reactivity, organometallics in homogeneous catalysis.

Solid State Chemistry

Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, band theory of metals and semiconductors.

Data Analysis

Significant figures, mean and standard deviation, absolute and relative errors, linear regression, covariance and correlation coefficient.

Analytical Chemistry

Separation techniques, electro- and thermoanalytical techniques.

Spectroscopy

Physical characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-Visible, NQR, MS, electron spectroscopy and microscopic techniques.

PH.D. IN ORGANIC CHEMISTRY

Stereochemistry

Principles of stereochemistry, configurational and conformational isomerism in acyclic and cyclic compounds, chirality, stereoselectivity, enantioselectivity, diastereoselectivity.

Reactive Intermediates

Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzyne and nitrenes.

Aromaticity

Concepts of aromaticity, benzenoid and non-benzenoid compounds, reactions of aromatic compounds.

Reaction Mechanisms

Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species, molecular rearrangements involving electron deficient atoms, common named reactions and rearrangements – applications in organic synthesis.

Organic Reagents

Functional group interconversion including oxidations and reductions, common catalysts and reagents (organic, inorganic, organometallic and enzymatic), chemo, regio and stereoselective transformations.

Concepts in Organic Synthesis

Asymmetric synthesis, retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.

Pericyclic Reactions

Electrocyclic, cycloaddition, sigmatropic rearrangements.

Heterocyclic Compounds

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

Chemistry of Natural Products

Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.

Spectroscopy

Structural determination of organic compounds by IR, UV-Visible, Mass, and NMR techniques.

DEPARTMENT OF BIOSCIENCES**Molecular Cell Biology**

Organization of prokaryotic and eukaryotic cells, Cell wall and membrane, Major cell organelles, Membrane transport, Cell junctions, Cell adhesion and Extracellular matrix, Cellular communication and signaling pathways, Cell cycle and Cell division, Cell death.

Molecular Biology and Genetic Engineering

Genome organization in prokaryotes and eukaryotes, DNA replication, Transcription, Protein synthesis, Regulation

of gene expression in prokaryotes and eukaryotes, DNA repair and damage, Molecular cloning strategies, Molecular diagnostics, Transgenic plants and animals, Gene therapy.

Biological Chemistry

Structure, function and metabolism of carbohydrates, proteins, lipids and nucleic acids, Enzyme kinetics and regulation of enzyme activity, Electron transport chain and oxidative phosphorylation.

Immunology

Cells and organs of immune system, Antigens, Structure and function of immunoglobulins, Major Histocompatibility Complexes, Humoral immune response, Cell mediated immunity, Hypersensitive reactions, Autoimmunity.

Developmental Biology

Gametogenesis, Fertilization, Cleavage - Blastulation, Gastrulation and Neurulation, Proximate tissue interactions, Genetics of axis specification in *Drosophila*, Stem cells and their applications.

Microbiology

Bacterial structure and function, Bacterial growth and metabolism, Microbial Recombination, Conjugation, Transformation, Transduction and Transposition, Structure of viruses, Viral replication strategies.

Biotechnology

Applications of fungi in biotechnology, Plant tissue culture and micropropagation, Production of secondary metabolites from microbes and plants, Biomineralization, Biotechnological approaches for pollution control, Intellectual Property Rights and patenting of biological materials.

Biostatistics

Measures of central tendency, Measures of dispersion, Statistical hypothesis testing, Analysis of variance, Chi-square analysis, Correlation and Regression analysis

Analytical Techniques

Principle and applications of microscopes (light microscope, phase contrast microscope, fluorescent microscope) pH meter, biosafety cabinets, centrifugation techniques, electrophoretic techniques, blotting techniques

DEPARTMENT OF FOOD AND NUTRITIONAL SCIENCES

STREAM 1 - FOOD SCIENCE & NUTRITION; NUTRITION & DIETETICS; CLINICAL NUTRITION & DIETETICS

Food Science and Food Chemistry

Basic concepts in food science. Food groups, water in foods– Water activity and shelf life of foods, moisture sorption isotherms, hysteresis. Properties and changes during processing of carbohydrates, proteins and fats. Enzymes in foods and their application in the food industry, Pigments in foods, their properties and stability, Food flavours, browning reactions –enzymatic and non-enzymatic, factors affecting their rate. Colloids and emulsions.

Nutritional Biochemistry and Physiology

Structure and functions of DNA & RNA, DNA replication and transcription, protein synthesis. Fatty acid metabolism, Cholesterol biosynthesis and its regulation. Energy metabolism – Concept and regulation, components of energy balance. Metabolism of carbohydrates and its regulation. Digestive system, composition, functions and secretion of digestive juices, Digestion and absorption of different nutrients. Role of liver, gallbladder, pancreas with reference to digestion and absorption, neuroendocrine control of hunger, appetite and obesity.

Advanced Nutrition

Homeostasis, body composition – determination methods and factors affecting; Energy balance regulation and factors affecting it; Components of energy expenditure and BMR determination; Metabolism - digestion, absorption, transport and storage of macro and micronutrients, interaction with other nutrients, and bioavailability; inborn errors of metabolism; Glycemic index and glycemic load of foods and CGM.

Nutrition in Health and Disease

Impact of good nutrition on the outcome of pregnancy. Meal pattern and nutritional requirements of different age groups in the life cycle. Diet during pregnancy and lactation. Breastfeeding vs. artificial feeding. Nutritional problems of pre-schoolers. Principles of diet therapy, Modifications of diets in febrile conditions, oral and dental conditions, Etiology, pathology, metabolic changes, clinical manifestations and dietary management of the following diseases, gastrointestinal and hepato-biliary disorders, disorders of energy metabolism- obesity, underweight & anaemia, Non-communicable diseases such as cardiovascular disorders, diabetes mellitus, hypertension and renal diseases, pulmonary disorders, Nutrition in critical

care, cancer, allergies and food intolerances.

Nutritional Epidemiology & Public Health Nutrition

Nutrition research methods- observational, case-control, cohort, randomized control trials, Nutrition surveys and surveillance in India, Nutritional assessment anthropometric, biochemical, clinical and dietary surveys, Monitoring and evaluation of nutrition programmes, and nutrition education. Nutrition, immunity and infection – mechanism of interaction, agent, host environment in disease occurrence, the meaning of epidemiology. Meaning of community, community nutrition, Assessment of nutritional status. Malnutrition – causes, measures to combat malnutrition: different intervention programs. General idea of nutrition education, program planning, nutrition surveillance and monitoring.

Research Methodology & Applied Statistics

Types of research, Types of research designs, Qualitative and quantitative research, applied research, Sampling methods, and Preparation of research proposal. Descriptive statistics, Probability and Decision Theory, Probability Distributions, Inferential statistics, Analysis of Variance, Non-Parametric Methods, Simple Correlation and Regression.

Recent concepts in Nutrition and Food Science

Nutrigenomics; nutraceuticals; functional foods; probiotics & prebiotics; genetically modified foods; organic foods; biopolymers for packaging; bio based preservation methods; emerging food processing technologies

STREAM 2 - FOOD SCIENCE & NUTRITION; FOOD TECHNOLOGY, FOOD SCIENCE & TECHNOLOGY, FOOD PROCESSING

Food Science and Food Chemistry

Basic concepts in food science. Food groups, water in foods– Water activity and shelf life of foods, moisture sorption isotherms, hysteresis. Properties and changes during processing of carbohydrates, proteins and fats. Enzymes in foods and their application in the food industry, Pigments in foods, their properties and stability, Food flavours, browning reactions –Enzymatic and non-enzymatic, factors affecting their rate. Colloids and emulsions.

Principles of Food Processing and Preservation

Preservation techniques- Thermal and non-thermal methods. Thermal Processing–Canning, sterilization, Pasteurization, aseptic processing. Dehydration–Water activity, types of dryers, effect of dehydration on food quality. Freeze drying. Intermediate moisture foods. Fermentation–Types, nutritional importance of fermented foods. Preservation by chemicals, Hurdle Technology,

Irradiation–Mechanism, dosimetry, equipment, effect of irradiation on microorganisms. Membrane processing, minimally processed foods–Preservation and packaging of minimally processed foods. Microwave processing– Electromagnetic spectrum, difference between microwave and infrared energy, dielectric constant, relaxation time, equipment and applications, Refrigeration and frozen storage- freezing curves, equipment, freezing and chilling injuries. Controlled atmospheric storage (CAS)-Principle, design considerations, Modified atmospheric storage- gas storage, hypobaric storage. Food Packaging- types and properties of packaging materials and methods of packaging of foods.

Food Safety and Quality Assurance

Principles of food safety and hygiene. Importance and functions of quality control, Food spoilage and its control. Food adulteration, food contamination and food borne diseases. International and national food standards & laws. Quality control & assurance systems. Sensory evaluation and product development. Techniques of food analysis.

Research Methodology & Applied Statistics

Types of research, Types of research designs, Qualitative and quantitative research, applied research, Sampling methods, and Preparation of research proposal. Descriptive statistics, Probability and Decision Theory, Probability Distributions, Inferential statistics, Analysis of Variance, Non-Parametric Methods, Simple Correlation and Regression.

Recent Concepts in Nutrition and Food Science

Nutrigenomics; nutraceuticals; functional foods; probiotics & prebiotics; genetically modified foods; organic foods; biopolymers for packaging; bio based preservation methods; emerging food processing technologies

DEPARTMENT OF MANAGEMENT AND COMMERCE

Entrepreneurship

Traits of an innovative Entrepreneur, Entrepreneurial Decision-Making, Process, Opportunity identification, Types of entrepreneurship, Creativity and Innovation, Source of capital for entrepreneurship, Types of startups, Definition of Micro, Small and Medium Enterprises, Institutional Support and Legality, Formulating a business plan, Business plan pitch, and Business Incubators.

Marketing Management

Core marketing concepts, Consumer Buying Behaviour, Market Segmentation, Digital Marketing, Product Life Cycle Strategies, Innovation and New Product development, Marketing Services, Pricing, Marketing Channels, Marketing Communication process.

Financial Management

The goal of financial management, Decisions in financial management, Time value of money and Valuation of securities, Investment decisions – Capital Budgeting, Calculating average return and risk, Efficient market hypothesis and its forms, Capital structure and cost of capital, and short-term financing decisions.

Statistics for Business Management

Descriptive statistics, Probability and Decision Theory, Probability Distributions, Inferential statistics, Analysis of Variance, Non-Parametric Methods, Simple Correlation and Regression.

Human Resource Management

Changing nature of Human Resource Management, Human Resource Planning, Job Analysis and Job Design, Selection and Recruitment, Training and Development, Performance Appraisal, Compensation Management, Quality of Work Life.

Management Accounting

Analysis of financial statements, Cash flow statement, Cost Volume Profit analysis and decision making, Budgets and Budgetary control, Standard costing.

Services Operations Management

Operations strategy and Competitiveness, Service Quality, Demand forecasting, Managing Capacity and Demand, Managing Waiting Lines, Inventory Management, Supply Chain Management.

Management Science

Linear Programming Problems – Formulation of Linear Programming Problems, Graphical solutions, Simplex Algorithm, Industrial Applications of LPP, Transportation and Assignment models, Network Analysis using PERT and CPM.

DEPARTMENT OF HUMANITIES & SOCIAL SCIENCES

PH.D. IN ECONOMICS

Microeconomics

Consumer theory and Behaviour, Theory of Production and Cost, Market Structures, perfect and imperfect markets, Elements of Welfare Economics, General equilibrium.

Macroeconomics

Measurement of National Income, Classical theory of Employment, Income, Expenditure Model -Money and Goods market, Consumption and Investment, Business cycles, Macroeconomic Dynamics, Policy Implications.

Quantitative Methods

Sets and Functions, Differential Calculus of one variable and several variables, Economic applications of derivatives, Optimization, with and without constraints, Difference and differential equations of first order, Matrices, Operations on matrices, inverse of a matrix- probability, expectation and variance, Probability distributions, Binomial, Poisson, Normal.

Development Economics

Economic Growth and Economic Development, Theories of Economic Growth and Development Neoclassical and endogenous growth models, Inclusive Growth, Human Development, Rural Development.

Public Economics and Fiscal Policy

Public Finance, Principles of Taxation and Resource Allocation, Public Expenditure -Fiscal Functions and Theory of Public goods Fiscal Policy and the Budget, Federal Finance in India, Cost, Benefit Analysis

Indian Economy

Structure of the Indian Economy, Agriculture, Industrial and Tertiary Sectors, Role of government, Services and Trade, New Economic Policy, Contemporary Issues, Future Scenario.

Econometrics

Elements of statistical Inference, Theory of Estimation (OLS and MLE), Testing of Hypothesis (t, Chi square and F tests) - Multiple regression models, Multicollinearity, Heteroscedasticity, Autocorrelation, Dummy variables.

Financial Economics

Introduction to Financial system, Financial Markets and Institutions, Finance and Economic Development, Financial Reforms in India, Investment Environment, Risk Management.

International Economics and Finance

International trade theory, Economic integration, Balance of Payments, Exchange rates and Foreign exchange markets, International monetary system.

DEPARTMENT OF EDUCATION

Unit-1: Meaning and Function of Educational Philosophy, Relationship of Education and Philosophy, Indian Schools of Philosophy – Vedanta, Sankhya, Buddhism and with special reference to the concepts of reality, knowledge and values

and their educational implications, contributions of Indian and Western Thinkers. Major philosophical Systems: Their salient features and its impact on Education.

Unit-2: Developmental psychology and Positive psychology- Behaviouristic, Cognitivist, Social constructivist perspectives, Positive psychology, well-being, life skill education-need and importance

Unit-3: Methods & Techniques of teaching- Principles and maxims of teaching - NCF-2005, NEF 2020 - Bloom's Taxonomy of Educational Objectives (revised), Models of Teaching- Principles and Maxims of teaching and learning, Assessment of cognitive, affective and psychomotor domains of learning, feedback devices – types- criteria – guidance as feedback - qualitative and quantitative tools. Standardisation of a tool- characteristics of a good measuring instrument- Online and offline assessment tools – rubrics, survey tools, puzzle makers, test generators, reflective journal, question bank

Unit-4: Educational Technology as a discipline: Technology of Education and Technology in Education, the Concept of IT and ICT, and Applications of Educational Technology in Formal, ODL, and Inclusive Education, constructivism- 5 E's of constructivism, ICT in Evaluation, Approaches and strategies to integrating ICT in teaching and learning.

Unit-5: Inferential Statistics-Parametric Normal Probability Distribution-Concept, Characteristics and Applications; Standard Scores; Derived scores Parametric testing of Hypothesis: Concepts of One-tailed and Two-tailed Test; Type 1 and Type 2 Error; Testing the Significance of the Difference between Means, Variances, Correlations and Proportions. Analysis of Variance and Co-variance: Concept, Principle, Assumptions and Uses. Non-parametric statistics in education; Use of non-parametric tests and its rationale for distribution free data; Chi-Square Test; Median Test; Sign Test, Mann Whitney U-test and Wilcoxon test, Kruskal-Wallis test and Friedman's test.

DEPARTMENT OF ENGLISH LANGUAGE & LITERATURE

British Literature: Chaucer until the Twentieth Century: Prose, Poetry, Drama, Novel

Indian Writing in English, American Literature, Post-Colonial Literature, Women's Writings, Literary Criticism and Theory, Advanced Linguistics, Modern English Grammar, Teaching of English as a Second Language.