Institute of Infrastructure, Technology Research And Management Ahmedabad

Syllabus for Ph.D. Entrance Exam 2017

Test Type: MCQs **Test Duration: 60 Minutes**

Number of Questions: 50

Civil Engineering

1. General Aptitude

Verbal ability, numerical ability, reasoning, engineering mathematics.

2. Structural Engineering

Engineering mechanics, solid mechanics, structural analysis, design of RCC structures, design of steel structures, structural dynamics, construction materials and management.

3. Geotechnical Engineering

Engineering properties of soils, shallow foundations, deep foundations, reinforced earth structures, subsurface exploration, ground improvement techniques.

4. Water Resources Engineering

Fluid mechanics, irrigation engineering, hydrology, hydraulic structures, open channel flow.

5. Environmental Engineering

Water and waste water, air pollution, municipal solid waste.

6. Transportation Engineering

Pavement material and design, Traffic engineering transportation planning, traffic flow theory and capacity analysis.

Electrical Engineering

Section 1 (compulsory, 30 Marks)

Electric Circuits

Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Passive filters, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits.

Electromagnetic Fields

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

Signals and Systems

Representation of continuous and discrete-time signals, Shifting and scaling operations, Linear Time Invariant and Causal systems, Fourier series representation of continuous periodic signals, Sampling theorem, Applications of Fourier Transform, Laplace Transform and z-Transform.

Analog and Digital Electronics

Characteristics of diodes, BJT, MOSFET; Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: Biasing, Equivalent circuit and Frequency response; Oscillators and Feedback amplifiers; Operational amplifiers: Characteristics and applications; Simple active filters, VCOs and Timers, Combinational and Sequential logic circuits, Multiplexer, Demultiplexer, Schmitt trigger, Sample and hold circuits, A/D and D/A converters, 8085Microprocessor: Architecture, Programming and Interfacing.

Section 2. (Any one section, 20 marks)

1. Control Systems

Mathematical modelling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State

space model, State transition matrix.

2. Power Systems

Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, GaussSeidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

3. Communications

Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems; Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem; Digital communications: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; Timing and frequency synchronization, inter-symbol interference and its mitigation; Basics of TDMA, FDMA and CDMA. Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; Basics of radar; Light propagation in optical fibers.

4. Signal Processing

Introduction to continuous and Discrete-time signal and Sequence, introduction to system and its properties: Linearity, time invariance and causality, Analysis of A LTI System:(a) impulse response, Convolution sum convolution integral(b) differential equation and Difference equation(c) transform domain considerations. Z-transform, Applications of transforms to discrete and continuous time system analysis, Transfer function, block diagram representation. Fourier Series and Fourier Transform (FT), Discrete-time FT (DTFT),Discrete FT (DFT), fast Fourier transform (FFT).Sampling theorem, Design of Digital filters:(a) FIR, and (b) IIR Introduction to spectral estimation

Mechanical Engineering

1. ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigenvalues, Eigenvectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series, Vector identities, Directional derivatives, Line integral, Surface integral, Volume integral, Stokes's theorem, Gauss's theorem, Green's theorem.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's equation, Euler's equation, Initial and boundary value problems, Partial Differential Equations, Method of separation of variables.

Numerical Methods: Solutions of nonlinear algebraic equations, Single and Multi step methods for differential equations.

Transform Theory: Fourier Transform, Laplace Transform.

2. APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion, including impulse and momentum (linear and angular) and energy formulations; impact.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; strain energy methods; thermal stresses.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of slider-crank mechanism; gear trains; flywheels.

Vibrations: Free and forced vibration of single degree of freedom systems; effect of damping; vibration isolation; resonance, critical speeds of shafts.

Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; *principles* of the design of machine elements such as bolted, riveted and welded joints, shafts, spur gears, rolling and sliding contact bearings, brakes and clutches.

3. FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced

convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; Carnot cycle.irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion.

Applications: *Power Engineering*: Steam Tables, Rankine, Brayton cycles with regeneration and reheat. *I.C. Engines*: air-standard Otto, Diesel cycles. *Refrigeration and air-conditioning*: Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; moist air: psychrometric chart, basic psychrometric processes. *Turbomachinery:* Pelton-wheel, Francis and Kaplan turbines — impulse and reaction principles, velocity diagrams.

4. MANUFACTURING SCIENCE AND ENGINEERING

Engineering Materials: Structure and properties of engineering materials, heat treatment, stress-strain diagrams for engineering materials.

Metal Casting: Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations.

Forming: Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy.

Joining: Physics of welding, brazing and soldering; adhesive bonding; design considerations in welding.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures

Metrology and Inspection: Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools.

Physics

1. Mathematical Methods of Physics

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem. Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques: root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods. Tensors. Introductory group theory: SU(2), O(3).

2. Classical Mechanics

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

3. Electromagnetic Theory

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; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields. Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.

4. Quantum Mechanics

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom. Stern-Gerlach experiment. Time-independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection. Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering: phase shifts, partial waves, Born approximation. Relativistic quantum mechanics: Klein-Gordon and Dirac equations. Semi-classical theory of radiation.

5. Thermodynamic and Statistical Physics

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro- and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Ideal Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law. First- and second-order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Brownian motion. Introduction to nonequilibrium processes.

6. Electronics and Experimental Methods

Semiconductor devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Digital techniques and applications (registers, counters, comparators and similar circuits). A/D and D/A converters. Microprocessor and microcontroller basics.

Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting, Linear and nonlinear curve fitting, chi-square test. Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control. Signal conditioning and recovery. Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding. Fourier transforms, lock-in detector, box-car integrator, modulation techniques. High frequency devices (including generators and detectors).

7. Atomic & Molecular Physics

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

8. Condensed Matter Physics

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

9. Nuclear and Particle Physics

Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Rotational spectra. Elementary ideas of alpha, beta and gamma decays and their selection rules.

Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.

Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

Applied Chemistry

Periodic table, periodic properties.
Chemical bonding, hybridization, Valence bond and molecular orbital theories.
Concepts of acids and bases.
Coordination compounds and organometallic compounds
Solid state chemistry: Crystal structures; Bragg's law and applications.
Nuclear chemistry, nuclear fission and fusion, nuclear reactor.

Chemical thermodynamics, laws of thermodynamics, energy, entropy, free energy, state and path functions, spontaneity and equilibria.
Phase transitions and phase rule. One and two components systems.
Electrochemistry: Nernst equation, redox systems, electrodes, electrochemical cells; ionic equilibria; pH and buffer solutions. Conductometric and potentiometric titrations.
Chemical kinetics, rate laws and temperature dependence of rate; complex reactions; steady state approximation; collision and transition state theories, unimolecular reactions.
Adsorption, adsorption isotherms, colloids.

Homogeneous and heterogeneous catalysis; Enzyme kinetics;
Photochemical reactions and quantum yield.

IUPAC nomenclature of organic molecules,
Aromaticity, heterocyclic compounds.
Basic reaction mechanisms, Named reactions. Natural products, Drugs and pharmaceuticals.
Isomerism, stereochemistry
Polymer chemistry, Polymerization reactions, MW of polymers and their determination, Nanomaterials,
Environmental impact of chemicals and green chemistry,

Chromatography, theory, classification, applications.
Basic molecular spectroscopy, microwave, IR and UV-Visible spectroscopy. NMR spectroscopy. Instrumentation. Applications.
Thermal methods of analysis: DTA, TG, DSC

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

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, Skew-Hermitian and unitary matrices, finite dimensional inner product spaces, Gram-Schmidt orthonormalization process.

Abstract Algebra: Groups, subgroups, normal subgroups and homomorphism theorems, automorphisms, cyclic groups, permutation groups, Cayley's theorem, Sylow's theorems and their applications, rings, ideals, prime and maximal ideals, quotient rings, Euclidean domains, principle ideal domains and unique factorization domains, fields, finite fields.

Real Analysis: Real valued functions of a real variable, continuity and differentiability, sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, metric spaces, completeness, Weierstrass approximation theorem, compactness, Lebesgue measure, measurable functions, Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Complex Analysis: Algebra of complex numbers, complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions, analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Numerical Analysis: Numerical solution of algebraic and transcendental equations: bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: error of polynomial interpolation, Lagrange, Newton interpolations, numerical differentiation, numerical integration: Trapezoidal and Simpson rules, numerical solution of systems of linear equations: direct methods (Gaussian elimination, LU decomposition), iterative methods (Jacobi and Gauss-Seidel), numerical solution of ordinary differential equations: initial value problems: Euler's method, Runge-Kutta methods.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, 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, Legendre and Bessel functions and their orthogonality.

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 and di_usion equations in two variables, Fourier series and Fourier transform and Laplace transform methods of solutions for the above equations.

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma.

Probability and Statistics: Probability space, conditional probability, Bayes theorem, independence, random variables, joint and conditional distributions, standard probability

distributions and their properties, expectation, conditional expectation, weak and strong law of large numbers, central limit theorem, sampling distributions, maximum likelihood estimators, testing of hypotheses, standard parametric tests based on normal, X^2, t, F - distributions, linear regression, interval estimation.

Operation Research: Introduction to linear programming problems (LPP), solving LPP, graphical method, simplex method, artificial starting solution, duality of LPP, assignment problems, transportation problems, nonlinear programming.

English

1. The Age of Chaucer
2. The Elizabethan Age
3. The Jacobean Age to the Puritan Age
4. The Neo-classical Period
5. The Restoration Period and The Augustan Age
6. The Romantic Period
7. The Victorian Period and The Pre-Raphaelites
8. Modern Period
9. Modern British Literature
10. Literary Theory and Criticism: The Classical Period (Plato, Aristotle, Longinus)
11. British Literary Criticism from the Elizabeth Period to the Victorian Period
12. The New Criticism
13. American Literature
14. Indian Writing in English
15. Indian Literature in English Translation
16. National and International Literary Awards

Sociology

1. **Sociological theories**:

   Evolutionary, Functional, Marxian, Structural, Structural -Functional, Symbolic Interactionism, Phenomenology and post modern

2. **Classical Sociological Theory:**

   The socio-historical and intellectual background of sociology.

   Contributions of classical sociologists- Auguste Comte, Karl Marx, Emile Durkheim and Max Weber

3. **Sociology of Development:**

   Social, economic, human, sustainable and ecological notions of development

4. **Social change:**

   Theories of Social change, transformation, social movements

5. **Sociology of India:**

   Society in India: Caste structure and change, Rural Social structure, Family, Kinship and marriage in India, Religion in India

   Approaches to the study of Indian society-

6. **Economy and Society:**

   Types of society, Features of industrial and post- industrial society, industrial planning, industrialization and social change in India.

7. **Research Methods:**

   Objectivity and Subjectivity

   Quantitative and Qualitative research methods

   Mixed research methods, Research designs, sampling

   Techniques of data collection- Observation, Questionnaire and Interview

   Data collection, presentation and analysis, Statistical tools for social research

Economics

A) Microeconomics

1. Demand and Supply Analysis

2. Theory of Production and Cost

3. Welfare Economics

B) **Macroeconomics**

1. Measuring value of Economic Activity (National Income Accounting).

2. Theory of employment, Consumption, Output, Inflation, Money and Finance

3. Financial and Capital Market

4. Economic Growth and Development

5. International Economics

7. Balance of Payments

8. Global Institutions

C) Public Finance

1. Theories of taxation, Theories of public expenditure and Theory of public debt management.

2. Environmental Economics

4. State, Market and Planning

D) INDIAN ECONOMICS

1. History of development and planning.

2. Budgeting and Fiscal Policy

3. Poverty, Unemployment and Human Development

4. Agriculture and Rural Development Strategies.

5. Foreign trade and Foreign Investment

E) Research Methodology Basic Statistics and Econometrics, Logical Reasoning and Data Interpretation –

Primary and Secondary Research, Techniques of data collection-Qualitative and Quantitative, presentation and analysis, Econometric and Statistical tools for social research.

Statistics

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

Numerical analysis: Finite differences of different orders: Δ, E and D operators, factorial representation of a polynomial, separation of symbols, sub-division of intervals, differences of zero. Concept of interpolation and extrapolation: Newton Gregory's forward and backward interpolation formulae for equal intervals, divided differences and their properties, Newton's formula for divided difference, Lagrange's formula for unequal intervals, central difference formula due to Gauss, Sterling and Bessel, concept of error terms in interpolation formula. Inverse interpolation: Different methods of inverse interpolation. Numerical differentiation: Trapezoidal, Simpson's one-third and three-eight rule and WaPddles rule. Summation of Series: Whose general term (i) is the first difference of a function (ii) is in geometric progression. Numerical solutions of differential equations: Euler's Method, Milne's Method, Picard's Method and Runge-Kutta Method.

Probability and probability distributions: Classical and axiomatic definitions of Probability and consequences. Law of total probability, Conditional probability, Bayes' theorem and applications. Modes of convergences of sequences of random variables - in distribution, in probability, with probability one and in mean square.
Discrete and continuous random variables. Distribution functions and their properties. Mathematical expectation and conditional expectation. Characteristic function, moment and probability generating functions. Laws of large numbers and central limit theorems for independent variables.
Standard discrete and continuous probability distributions - Bernoulli, Uniform, Binomial, Poisson, Geometric, Rectangular, Exponential, Normal, Cauchy, Hyper geometric, Multinomial, Laplace, Negative binomial, Beta, Gamma, Lognormal. Joint and marginal distributions, conditional distributions, Distributions of functions of random variables.

Descriptive measures and regression: Collection, compilation and presentation of data, charts, diagrams and histogram. Frequency distribution. Measures of location, dispersion, skewness and kurtosis. Bivariate and multivariate data. Partial and multiple correlation, Intraclass correlation. Curve fitting and orthogonal polynomials. Simple and multiple linear regression. Polynomials. Fixed, random and mixed effects models. Elementary regression diagnostics. Logistic regression.

Statistical inference: Sampling distributions, standard errors and asymptotic distributions, distribution of order statistics and range. Methods of estimation, properties of estimators, confidence intervals. Tests of hypotheses: most powerful and uniformly most powerful tests, likelihood ratio tests. Analysis of discrete data and chi-square test of goodness of fit. Large sample tests. Simple nonparametric tests for one and two sample problems, Elementary Bayesian inference.

Multivariate analysis: Multivariate normal distribution, Wishart distribution and their properties. Hotelling's T^2 and its sampling distribution. Inference for parameters, partial and multiple correlation coefficients and related tests. Data reduction techniques: Principle component analysis, Discriminant analysis, Cluster analysis, Canonical correlation.

Experimental designs: Analysis of variance for one way and two way classifications, basic

principle of experimental design (randomization, replication and local control), complete analysis and layout of completely randomized design, randomized block design and Latin square design, Missing plot technique. Split Plot Design and Strip Plot Design. Factorial experiments and confounding in 2^n and 3^n experiments. Analysis of covariance. Analysis of non-orthogonal data. Analysis of missing data.

Reliability theory: Reliability concepts and measures, Life-distributions, reliability function, hazard rate, common univariate life distributions – exponential, Weibull, gamma, etc. Estimation of parameters in these models. Censoring and life testing, Reliability of series and parallel systems. Stress-strength reliability and its estimation.

Sampling theory: Simple random sampling, stratified sampling and systematic sampling. Ratio and regression methods.

Quality Control: Statistical process and product control. General theory of control charts, causes of variation in quality, charts for attributes and variables. Acceptance sampling plans for attributes inspection; single and double sampling plans and their properties; plans for inspection by variables for one-sided and two sided specification

Vital Statistics: Sources of demographic data. Complete life table and its main features. Abridged life tables. Stable and stationary populations. Measurements of Fertility and Mortality. Gross reproduction rate, Net reproduction rate.

Index Numbers: Price relatives and quantity or volume relatives, Link and chain relatives composition of index numbers. tests for index number, Construction of index numbers of wholesale and consumer prices, Demand Analysis

Time Series Analysis: Time series and its components. Determination of trend, seasonal and cyclical fluctuations. Auto covariance and autocorrelation functions and their properties. Detailed study of the stationary processes: moving average (MA), auto regressive (AR), ARMA and AR integrated MA (ARIMA) models. Box-Jenkins models, choice of AR and MA periods.