VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of the UGC Act, 1956)

VITREE

VIT Research Entrance Examination

December 2022

Syllabus for Research Programmes

Ph.D. / Integrated Ph.D.

VIT-A place to learn; A Chance to grow

COMMON SYLLABUS FOR ALL SUBJECTS FOR PHD
ENGLISH COMMUNICATION (15 QUESTIONS)

1. Grammar
    - Subject – Verb Agreement
    - Tense forms
    - Voices
    - Articles and Preposition

Use of Conjunctions
2. Writing Technical Instructions
3. Writing Memos & Writing Minutes
4. Transcoding
5. Preparing Questionnaire
6. Proof Reading

STATISTICS & PROBABILITY (15 QUESTIONS)

Unit 1: Statistics

Definitions, Scope and Limitations - Sampling methods - Collection of data-Classification and Tabulation - Frequency distribution - Diagrammatic and graphical representation - Measures of Central Tendency - Mean, median, mode Partition values (Median, quartile, Deciles and percentiles)- Measures of Dispersion- Coefficient of variation- Skewness and Kurtosis.

Unit 2: Correlation- and regressions

Scatter diagram-Coefficient of correlation – Rank correlation- Lines of linear regression – Partial correlation-multiple correlation - Multiple linear regressions.

Unit 3: Probability

Events - Addition Law of probabilities – Conditional Probabilities-Multiplication Law of probabilities - Baye's Theorem – random variable – Discrete-continuous-cumulative distribution function-probability mass function-probability density function - mathematical expectation. Binomial and Poisson's distributions. Tests of hypothesis- small and large samples tests- chi-square test- Analysis of variance (ANOVA).

SUBJECT SYLLABUS FOR ENTRANCE EXAMINATION FOR PHD ADMISSION

BBT—BIO SCIENCES AND BIO-TECHNOLOGY

Biophysics and Biochemistry

Structural elucidation of biological macromolecules (Carbohydrates and lipids). Forces that determine protein and nucleic acid structure, Prediction of proteins structure, nucleic acids, Properties of lipid bilayers, Biochemical Kinetics studies, unimolecular reactions, methods of determining macromolecular structures inclusive of the spectroscopic techniques like UV-vis absorption, lR absorption, circular dichroism fluoresence NMR and X-ray and neutron diffraction techniques.

Structure and properties Amino acids, peptides, proteins and conjugated proteins, protein hydration, coagulation, de- naturation - gelation, protein-protein interactions, cytosolic and membrane properties, purines, pyrimidines, nucleo- sides, nucleotides, polynucleotides, Ribonucleic acids and deoxyribonucleic acids, TCA cycle, glycolysis, pentose phos- phate pathway, urea cycle, metabolic regulation, respiratory chain, TP cycle, energy rich compounds, integrated metabolism, Carbohydrates - linear and branched carbohydrates, N containing

carbohydrates, cell wall carbohydrates, metabolism of carbohydrates, Fats and oils-structure, properties of saturated and unsaturated fatty acids, glycerolipids, phospholipids, sphingolipids, glycolipids, steroids, Vitamins and minerals types, structure and functional properties of vitamins, utility of essential minerals sources and trace elements.

Biotechnology

Industrial biotechnology – Isolation; preservation and strain improvement for the overproduction of primary and secondary metabolites. Medium formulation, optimization and sterilization; biological waste treatment processes. Bioprocess-Types of reactors; volumetric oxygen mass transfer coefficient and its estimation; models for ideal and non-ideal flow. Downstream processing-Unit operations in downstream processing, cell disruptions method, solid liquid separation methods, precipitation methods, extraction methods, membrane based separation methods, different types of purification and chromatographic techniques.

Culture of animal cells: Primary culture: Isolation of mouse and chick embryos, human biopsies, methods for primary culture, nomenclature of cell lines, sub culture and propagation and routine maintenance. Cell characterization: cytotoxicity assays, cell quantitation, cell culture contamination: monitoring and eradication, cryopreservation, confocal microscopy. Stem cell culture and its applications.

Molecular Biology and Cell Structure & Function of the Organelles

Eukaryotic and Prokaryotic cells, cell division, mitosis & meiosis cell cycle and molecules that control cell cycle, endocytosis and Exocytosis. Ultrastructure of cellular organelles, viz. Mitochondria, ER, Golgi, Chloroplast, plasma membrane, centriole, nuclear and membrane bound receptors, Signal Transduction, Techniques of propagation of prokaryotic and Eukaryotic cells, Autocrine, Paracrine and Endocrine models of action, Cell line, generation of cell lines.

Structure of DNA and histone molecules, Replication of eukaryotic chromosomes, nucleoid the complex replication apparatus, process of transcription and, Structure of tRNA, mRNA, rRNA, Deciphering of the genetic code, Translation, Mutation. Reverse transcription, Methods for analysis of gene expression at RNA and protein level, micro array, DNA chips. PCR, RFLP, Southern and Northern blotting, AFLP techniques, Real- time PCR. In situ localization, FISH and GISH.

Genetics and Recombinant DNA

Mendelian genetics. Types of genetic disorders- chromosomal disorders, single gene disorders, multifactorial disorders, mitochondrial disorders, Pedigree analysis, Human chromosomal syndromes- variation in chromosome number, Variation in chromosome structure, Molecular basis of inborn error of metabolism, Molecular basis of cancer. Prenatal diagnosis and genetic counseling. Eugenics. Population genetics.

General principles of cloning, Genetic elements that control gene expression, method of creating recombinant DNA molecules creating transgenic animals, plants microbes, safety guidelines of creating recombinant DNA research, restriction enzymes and mapping of DNA, plasmid and phage and other vectors. Construction of genomic and cDNA libraries, methods of nucleic acid extraction. Transformation, Patents and methods of application of patents.

Environmental Sciences

Ecosystems, energy flow, ecological succession, pollution. Bioremediation, Conventional and Non conventional sources of energy. Biogeo chemical cycles. Biodiversity and wild life conservation. Social issues and the environment.

Immunology

Innate Immunity, Adaptive Immunity, Cell mediated Immunity, Phagocyte, cells B and T cells - structure and function of Antibody molecules, Antigen processing and presentation, Monoclonal antibody, Autoimmunity and hypersensitivity.

Microbiology:

Basic concepts of Microbiology and classification, Bacteriology, Virology, Mycology, Parasitological, Recombination.

Bioinformatics:

Biological databases, File formats, sequence alignment, Database searches, phylogenetic tree construction and validation, Homology modeling, Drug discovery, DNA mapping and sequencing, sequence assembly and gene prediction, molecular predictions with DNA strings, Visualization tolls.

BME—BIOMEDICAL ENGINEERING

Unit 1: Basics of Circuits

Kirchoff 's laws, mesh and nodal Analysis. Circuit theorems. One port and two-port Network Functions. Static and dynamic characteristics of Measurement Systems. Error and uncertainty analysis. Statistical analysis of data and curve fitting.

Unit 2: Transducers and Measurement

Resistive, Capacitive, Inductive and piezoelectric transducers. Measurement of displacement, velocity and acceleration (translational and rotational), force, torque, vibration and shock.

Unit 3: Analog Electronics

Characteristics of diode, BJT, JFET and MOSFET. Diode circuits. Transistors at low and high frequencies, Amplifiers, single and multi-stage. Feedback amplifiers. Operational amplifiers, characteristics and circuit configurations. Instrumentation amplifier. Precision rectifier. V-to-I and I-to-V converter. Op-Amp based active filters. Oscillators and signal generators.

Unit 4: Digital Electronics

Combinational logic circuits, minimization of Boolean functions. IC families, TTL, MOS and CMOS. Arithmetic circuits. Comparators, Schmitt trigger, timers and mono-stable multi-vibrator. Sequential circuits, flip-flops, counters, shift registers. Multiplexer, S/H circuit. Analog-to-Digital and Digital-to-Analog converters. Basics of number system. Microprocessor applications, memory and input-output interfacing. Microcontrollers.

Unit 5: Signals, Systems and Communications

Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first- and second order systems. Convolution, correlation and characteristics of linear time invariant systems. Discrete time system, impulse and frequency response. Pulse transfer function. IIR and FIR filters. Amplitude and frequency modulation and demodulation. Sampling theorem, pulse code modulation. Frequency and time division multiplexing. Amplitude shift keying, frequency shift keying and pulse shift keying for digital modulation.

Unit 6: Electrical and Electronic Measurements

Bridges and potentiometers, measurement of R, L and C. Measurements of voltage, current, power, power factor and energy. A.C & D.C current probes. Extension of instrument ranges. Q-meter and waveform analyzer. Digital voltmeter and multimeter. Time, phase and frequency measurements. Cathode ray oscilloscope. Serial and parallel communication. Shielding and grounding.

Unit 7: Analytical, Optical and Biomedical Instrumentation

Mass spectrometry. UV, visible and IR spectrometry. X-ray and nuclear radiation measurements. Optical sources and detectors, LED, laser, photo-diode, photo-resistor and their characteristics. Interferometers, applications in metrology. Basics of fiber optics. EEG, ECG and EMG, Clinical measurements, Ultrasonic transducers and Ultrasonography. Principles of Computer Assisted Tomography.

Unit 8: Mathematics

Linear algebra, calculus, differential equations, numerical methods, probability .theory

CEE—CHEMICAL ENGINEERING

Unit 1: PROCESS CALCULATIONS AND THERMODYNAMICS

Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis. First and Second laws of thermodynamics. First law application to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: equation of state and departure function, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibria.

Unit 2: FLUID MECHANICS AND MECHANICAL OPERATIONS

Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids

Unit 3: HEAT TRANSFER

Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Unit 4: MASS TRANSFER

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, Theories of mass transfer; stage wise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

Unit 5: CHEMICAL REACTION ENGINEERING

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Unit 6: INSTRUMENTATION AND PROCESS CONTROL

Measurement of process variables; sensors, transducers and their dynamics, transfer functions and dynamic responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response and controller tuning, cascade, feed forward control.

Unit 7: PLANT DESIGN AND ECONOMICS

Process design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in design.

Unit 8: CHEMICAL TECHNOLOGY

Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers

CHY—CHEMISTRY

Unit 1: Physical Chemistry

Hydrogen atom, angular Momentum. Vibrational and perturbational methods. Basics of atomic structure, electronic configuration, shapes of orbitals, hydrogen atom spectra, Theoretical treatment of atomic structures and chemical bonding, Chemical applications of group theory, Basic principles and application of spectroscopy – rotational, vibrational, electronic, Raman, ESR, NMR. Chemical thermodynamics, Phase equilibria, Statistical thermodynamics, Chemical equilibria, Electrochemistry – Nernst equation, electrode kinetics, electrical double layer, Debye-Hückel theory, Chemical kinetics – empirical rate laws, Arrhenius equation, theories of reaction rates, determination of reaction mechanisms, experimental techniques for fast reactions, Concepts of catalysis, Polymer chemistry. Molecular weights and their determinations. Kinetics of chain polymerization, Solids - structural classification of binary and ternary compounds, diffraction techniques, bonding, thermal, electrical and magnetic properties, Colloids and surface phenomena, Data analysis.

Unit 2: Inorganic Chemistry

Chemical periodicity, Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules, Concepts of acids and bases, Chemistry of the main group elements and their compounds. Allotropy, synthesis, bonding and structure, Chemistry of transition elements and coordination compounds – bonding theories, spectral and magnetic properties, reaction mechanisms, Inner transition elements – spectral and magnetic properties, analytical applications, Organometallic compounds - synthesis, bonding and structure, and reactivity. Organometallics in homogenous catalysis, Cages and metal clusters, Analytical chemistry- separation techniques. Spectroscopic electro and thermoanalytical methods, Bioinorganic chemistry – photosystems, porphyrines, metalloenzymes, oxygen transport, electron- transfer reactions, nitrogen fixation, Physical characterisation of inorganic compounds by IR, Raman, NMR, EPR,Mössbauer, UV-Visible, NQR, MS, electron spectroscopy and microscopic techniques, Nuclear chemistry – nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

Unit 3: Organic Chemistry

IUPAC nomenclature of organic compounds, Principles of stereochemistry, conformational analysis, isomerism and chirality, Reactive intermediates and organic reaction mechanisms, Concepts of aromaticity, Pericyclic reactions, Named reactions, Transformations and rearrangements, Principles and applications of organic photochemistry. Free radical reactions, Reactions involving nucleophilic carbon intermediates, Oxidation and reduction of functional groups, Common reagents (organic, inorganic and organometallic) in organic synthesis, Chemistry of natural products such as steroids, alkaloids, terpenes, peptides, carbohydrates, nucleic acids and lipids, Selective organic transformations – chemoselectivity, regioselectivity, stereoselectivity, enantioselectivity. Protecting groups, Chemistry of aromatic and aliphatic heterocyclic compounds, Physical characterisation of organic compounds by IR, UV-Visible, Mass, and NMR.

Unit 4: Interdisciplinary topics

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

CMA—COMMERCE & ACCOUNTANCY

Unit 1: Accounting for financial decisions

Managerial accounting – analysis of financial statements – ratio analysis – budgetary control – marginal costing – inventory valuation.

Unit 2: Business Research Methodology

Business research methods – development of research methodology – research plan – data collection – sampling techniques – qualitative research – quantitative analysis – report writing.

Unit 3: Banking and Insurance

Central banking – commercial banks – development banks – non-banking financial institutions – modern banking – development of insurance – risk management and role of insurance – legal aspects – types of insurance products – customers services – marketing and distribution.

Unit 4: Marketing Management

Foundations of marketing – selection of markets – product decisions – pricing decisions – distribution decisions – communication decisions – impact of competition on strategy – reaching consumers directly – analyzing markets.

Unit 5: Human Resource and Organizational Behaviour

Human resource planning – training development and career management – motivation perspectives – managing ethical issues in HRM – organizational behaviour – individual perspective – group dynamics – dynamics of organization.

CIE—COMPUTATION & INFORMATION ENGINEERING

Engineering Mathematics

Mathematical Logic: Syntax of First Order Logic, Semantics of First Order Logic, a Sequent Calculus, the Completeness Theorem, the Limitations of First Order Logic.

Differential and Integral Calculus : Limit, Continuity, Differentiability, Leibniz theorem, Mean Value Theorems, Taylor's theorem, Integrals, Improper integrals, Total Differentiation, Partial derivatives ,Maxima and Minima, vector calculus, Linear differential equations.

Probability and Statistics: Probability, conditional probability, Baye's theorem, means, median, mode, moments, standard deviation. Random variables, Uniform, Binomial, Poisson, normal distributions, Correlation and regression, Sampling and Tests of significance.

Numerical Methods: Solutions to algebraic and transcendental equations (Bisection and Newton Raphson's methods), simultaneous linear algebraic equations (Gauss elimination, Crout's, Gauss seidel and relaxation), Interpolation methods (forward, backward and central), numerical integration (Trapezoidal, Simpson's and Weddle's) eigenvalues and eigenvectors, Numerical solutions to ordinary (Euler, modified Euler, Runga Kutta 4th order) and partial differential (parabolic, elliptic and Hyperbolic) equations.

Linear Algebra and Transforms: linear vector space, determinants, matrices, eigen values, eigen vectors, elements of complex analysis, Laplace transforms, Fourier analysis.

Algebra and Complex Analysis: Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Canonical forms, diagonal forms, triangular forms, Quadratic forms, reduction and classification of quadratic forms Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations—Fourier series—harmonics.

Calculus and its Applications: Linear ordinary differential equations (ODEs), variation of parameters, Sturm-Liouville problem. Partial differential equations (PDEs) - Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations. Transformation techniques—Laplace transformation—Fourier transforms—z—transformation to solve differential and difference equations.

Numerical Methods: Numerical solutions of algebraic and transcendental equations iteration methods and Newton—Raphson method, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods-Numerical differentiation and integration, Numerical solutions of ODEs and PDEs.

Descriptive statistics, Exploratory Data Analysis: Sample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate) - expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Standard discrete and continuous univariate distributions. Correlation and simple and multiple linear regression. Test of

hypotheses—Large and small sample tests confidence intervals. Chi-square test goodness of fit. Simple non parametric tests for one and two sample problems, rank correlation and test for independence. ANOVA.

Discrete Mathematics: Sets, relations and functions, algebra of matrices and determinants, algebraic structures, Boolean algebra and applications, order relations and structures, graph theory, logic and combinatorics.

Theory of Computation: Regular languages and finite automata, context free languages and Push down automata, recursively enumerable sets and Turing machines, undecidability.

Programming Language Processors : Compiler, Interpreter, assembler, Linker, Loader, Macro processors, phases of compilers, Lexical analysis, parsing, Top-down parsing and bottom up parsing, syntax directed translation, runtime environment, Symbol table, type checking, intermediate Code generation, Code optimization, code generation.

Algorithmic Analysis and Data Structures

Analysis of Algorithms and Computational Complexity : Asymptotic analysis (best , worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness, code and query tuning techniques, numerical analysis, power analysis & resiliency, intractable problems.

Algorithms for Problem Solving: Tree and graph traversal, connected components, spanning trees, shortest paths, hashing, sorting, searching, design paradigms (Greedy, dynamic programming, divide and conquer).

Data Structures: Notion of abstract data types, stack, Queue, List, set, string, Tree, binary search trees, heap, graph.

Computer Architecture & Organization and Operating Systems

Electronics: Network analysis, semiconductor devices, bipolar transistors, FET's, Power supplies, amplifier, Oscillators, Operational amplifiers, elements of digital electronics, logic circuits.

Digital Logic : Number systems and codes, Gates, TTL circuits, Boolean algebra and Karnaugh maps, Arithmetic logic units, Flip flops, registers and counters, Memories, Combinational and sequential logic circuits .

Computer Architecture and Organization: Machine instructions and addressing modes, ALU and data path, Register Transfer Language , hardware and micro programmed control, memory interface, RAM, ROM I/O interface (Interrupt and DMA modes), serial communication interface, instruction pipe-lining, Cache , main and secondary memory storage, organization and structure of disk drives, RAID architectures Microprocessors: 8085, 8086, Interfacing and memory addressing.

Operating Systems: Memory management, page faults, overlay, processor management, device management, deadlocks, Process, thread and inter process communication, CPU scheduling, file systems, I/O systems, protection and security.

Software Engineering and Programming

System & Program Development Methodology: Software paradigms, principles of programming in any language, documentation, system analysis and design methodologies, User Interface Design (UID), software construction, software testing, software quality, Object Oriented Analysis and Design (OOAD) concepts.

Programming Methodology: Introduction to programming, pointers, arrays, control structures, Iterational control structures, functions, recursion, testing, debugging, code review, structures, files (C, C++, JAVA).

Computer Networks & Data Communications: Analog versus Digital communication, modems, multiplexers, and concentrators, serial versus parallel communication, simplex, duplex, and half duplex communication, synchronous and asynchronous communication, Error detection/correction methods, data link control protocols, balanced and unbalanced interfaces, communication media, ISO/OSI stack, Sliding window protocol, LAN Technologies (Ethernet, Token ring) , TCP/UDP, IP, switches, gateways, and routers.

Computing Technologies: Client server computing, Logical layers in client server architecture, Two-tier versus Three-tier, Distributed computing, Middle-ware, Mobile Computing, Cloud Computing.

Databases Management Systems: Data, database and DBMS, Data dictionary/directory, schema, description of database structure, forms of DBMS systems, Hierarchical, network and RDBMS, DDL, DML , stored data structure language and query language, Recent trends in database management systems, Memory management techniques used in computers, query languages (SQL), file structures (sequential files, indexing, B* trees)

Transactions and concurrency control, Basic concepts of transaction processing , ACID properties of transactions, serializability of transactions, concurrency control, recovery, OLAP.

CVL—CIVIL ENGINEERING

Unit 1: STRENGTH OF MATERIALS

Analysis of statically determinate trusses, arches, beams, cables and frames, displacements in statically determinate structures and analysis of statically indeterminate structures by force/ energy methods, analysis by displacement methods (slope deflection method), influence lines for determinate and indeterminate structures. Bending moment and shear force in statically determinate beams. Simple stress and strain relationship Stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle. Simple bending theory, flexural and shear stresses, unsymmetrical bending, shear centre.

Unit 2: REINFORCED CONCRETE STRUCTURES

Concrete Technology- properties of concrete, basics of mix design. Concrete design-basic working stress and limit state design concepts, analysis of ultimate load capacity and design of members subjected to flexure, shear, compression and torsion by limit state methods. Basic elements of pre-stressed concrete, analysis of beam sections at transfer and service loads.

Unit 3: STEEL STRUCTURES

Analysis and design of tension and compression members, beams and beam columns, column bases. Connections simple and eccentric, beam-column connections, plate girders and trusses. Plastic analysis of beams and frames.

Unit 4: GEOTECHNICAL ENGINEERING

Soil classification, three - phase system, fundamental definitions, relationship and interrelationships, permeability and seepage, effective stress principle, consolidation, compaction, shear strength. Sub-surface investigations- scope, drilling bore holes, sampling, penetration tests, plate load test. Earth pressure theories, effect of water table, layered soils. Foundation types foundation design requirements. Shallow foundations bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays. Deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays, negative skin friction.

Unit 5: WATER RESOURCES ENGINEERING

Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, flow in pipes, pipe networks. Concept of boundary layer and its growth. Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, flow measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modeling. Kinematics of flow, velocity triangles and specific speed of pumps and turbines. Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics. Duty, delta, estimation of evapo-transpiration. Crop water requirements. Types of irrigation system, irrigation methods.

Unit 6: ENVIRONMENTAL ENGINEERING

Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards. Air pollutants – Types, their sources and impacts. Air pollution meteorology, air pollution control, air quality standards and limits. Municipal Solid Wastes -Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management. Noise Pollution - impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Unit 7: TRANSPORTATION ENGINEERING

Highway Planning - Geometric design of highways, testing and specifications of paving materials, design of flexible and rigid pavements. Traffic Engineering - Traffic characteristics, theory of traffic flow, intersection design, traffic signs and signal design, highway capacity.

ECE—ELECTRONICS ENGINEERING

Unit 1: ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

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, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant co-efficient, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary Value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy 's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Numerical Methods: Numerical differentiation and integration using interpolation polynomials and Trapezoidal, single and multi-step methods for ordinary differential equations.

Probability and Statistics: Basic counting techniques, definitions of probability, conditional probability, Bayes' Theorem, random variables, special distributions, joint and sampling distributions, transformations, descriptive statistics, estimation and testing of hypothesis.

Unit 2: NETWORK THEORY

Network graphs: Matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods; nodal and mesh analysis. Network theorems; superposition, Thevenin and Nortan's, maximum power transfer, wye-delta transformation, steady state sinusoidal analysis using phasors, fourier series, linear constant coefficient differential and difference equations; time domain analysis of simple RLC circuits. Laplace and Z transforms: frequency domain analysis of RLC circuits, convolution, 2-port network parameters, driving point and transfer functions, state equation for networks.

Unit 3: ELECTRONIC DEVICES AND CIRCUITS

ELECTRONIC DEVICES:

Intrinsic and extrinsic Semiconductors, energy band diagram, direct and indirect semiconductors, carrier transport, semiconductor diodes, bipolar junction transistors (PNP and NPN), early effect, hybrid π and h parameter model, multi-emitter transistor, field effect transistors (JFET and MOSFET), channel length modulation, special semiconductor devices (FINFET, PINFET, CNTFET), power and display devices (UJT, SCR, Diac, Triac, LED, LCD, CCD).

ANALOG CIRCUITS: Characteristics and equivalent circuits (large and small signal) of diodes, BJT, JFETs and MOSFET simple diode circuits: clipping, clamping, rectifier, biasing and bias stability of transistor and FET amplifiers. Amplifiers: single and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators: criterion for oscillation; single-transistor and op-amp configurations. Function generators and waveshaping circuits, Power supplies.

DIGITAL CIRCUITS

Boolean algebra; minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift- registers. Comparators, timers, multivibrators. Sample and hold circuits, ADCs and DACs. Semiconductor memories. Microprocessor (8085): architecture, programming, memory and I/O interfacing

Unit 4: CONTROL SYSTEMS

Basic control system components; block diagrammatic description, reduction of block diagrams, properties of systems: linearity, time-invariance, stability, causality. Open loop and closed loop (feedback) systems. Special properties of linear time-invariance (LTI) systems- transfer function, impulse response, poles, zeros, their

significance and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI system and frequency response. Tools and techniques for LTI control system analysis: Root, loci, Routh_Hurwitz criterion, Bode and Nyquist plots;
Control system compensators: elements of lead and lag compensations, elements of proportional-integral-Derivative (PID) control. State variable representation and solution of state equation for LTI systems.

Unit 5: COMMUNICATION SYSTEMS

Signals and System's: Continuous-time and Discrete time classification of signals and systems, Laplace transform analysis of signals and systems, time-invariant systems (difference and differential equations, block diagrams, system functions, poles and zeros, convolution, impulse and step responses, frequency responses), Discrete time Fourier transform, Z- Transform analysis of recursive and non-recursive systems, Digital filter design techniques. Fourier analysis of signals - amplitude, phase and power spectrum, auto-correlation and cross-correlation and their Fourier trans-forms. Signal transmission through linear time-invariant (LTI) systems, impulse response and frequency response, group delay, phase delay. Analog modulation systems-amplitude and angle modulation and demodulation systems, spectral analysis of these operations, super-heterodyne receivers, elements of hardware's realizations of analog communication systems. Basic sampling theorems. Pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM). Digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK). Multiplexing - time division and frequency division. Additive Gaussian noise; characterization using correlation, probability density function (PDF), power spectral density (PSD). Signalto-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions.

Unit 6: ELECTROMAGNETICS

Elements of vector calculus: gradient, divergence and curl; Gauss and strokes theorems, maxwells equation: differential and integral forms. Wave equation. Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth Transmission lines: Characteristic impedence; impedence transformation; smith chart; impedence matching pulse excitation. Wave guides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas; Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

ELE—ELECTRICAL ENGINEERING

Engineering Mathematics

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and 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, Surface and Volume integrals, Stokes, Gauss and Green's theorems. Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method. Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals. Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations. Transform Theory: Fourier transform, Laplace transform, Z-transform Electric Circuits Network graph, KCL, KVL, node and mesh analysis, transient response of dc and ac networks; sinusoidal steady-state analysis, resonance, basic filter concepts; ideal current and voltage sources, Thevenin's, Norton's and Superposition and Maximum Power Transfer theorems, two-port networks, three phase circuits.

Electrical Machines

Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; autotransformer; energy conversion principles; DC machines - types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors; three phase induction motors - principles, types, performance characteristics, starting and speed control; single phase induction motors; synchronous machines - performance, regulation and parallel operation of generators, motor starting, characteristics and applications; servo and stepper motors.

Control Systems and Instrumentation

Principles of feedback; transfer function; block diagrams; steady-state errors; Routh and Niquist techniques; Bode plots; root loci; lag, lead and lead-lag compensation; state space model; state transition matrix, controllability and observability. Classification of Instruments, Moving iron, Moving Coil, Permanent magnet, and Dynamometer types. Thermal, Electrostatic Rectifier Instruments, Instrument transformers, CT, PT, Power measuring instruments, power factor, frequency meters and synchroscope. Measurement of low, medium and high resistances, AC and DC measuring bridges, Magnetic measurement. General Transducers voltage, current, phase angle, optical, Hall effect and Industrial transducers.

Analog and Digital Electronics

Characteristics of diodes, BJT, FET; 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; Schmitt trigger; multivibrators; sample and hold circuits; A/D and D/A converters; 8-bit microprocessor basics, architecture, programming and interfacing.

Power Electronics and Drives

Characteristics and ratings of different thyristor family devices, their turn on and turn off methods with theirprotection, series and parallel connection of SCRs and their derating, Controlled single phase and three phase rectifiers for different types of load viz. R, R-L, R-L-E, single phase and three phase voltage source and current source inverter, cycloconverter, choppers, PWM techniques, Characteristics and principle of AC and DC machines, Methods of conventional controls and application of static controls and microprocessor based controls for AC and DC machines. Basic concepts of adjustable speed dc and ac drives.

Power System

Transmission line parameters; Representation of short, medium, and long transmission lines – ABCD parameters; Circle Diagram; Per Unit representation; 3-_ system; Short Circuit Studies; Sequence Networks; Load-flow Studies – Gauss Seidel method, Newton- Raphson Method; Automatic Generation Control; Load-Frequency Control; Automatic Voltage Regulator; Power System Stability – Equal area criteria; Swing Equation; Optimal Load dispatch in Power System. Protection Schemes for Transformer, Generators and Transmission Lines.

Microelectronics

MOSFET, Double and Multigate MOSFETs, Device/IC Fabrication processes, low power VLSI design, VLSI Interconnects, Lithography processes, ALD, CVD and Anodization techniques, optical processes, Ultrafast Lasers, noise, temperature, stress, delay and power calculations in device and circuits, photonics and optoelectronics.

ECO—ECONOMICS

UNIT – I: Micro Economic Analysis: Utility Analysis - Law of Diminishing Marginal Utility -Law of Equi-Marginal Utility - Theory of Demand – Law of Demand - Indifference Curve Analysis - Marginal Rate of Substitution - Consumers equilibrium – Income effect - Price effect and Substitution effect (Hicks Allen Eugene Slutsky method).

UNIT - II: Micro Economic Analysis: Theory of Production – Law of Variable Proportions and Returns to Scale; Producers equilibrium, Elasticity of substitution - Production function: Linear-Homogenous production function, Cobb – Douglas Production function; Theory of cost – Different concepts of costs – short run – long run behavior of cost; Revenue concepts: Average, Marginal and Total Revenue, revenue curves under different market conditions; Market structure and pricing – Different types of Market – characteristics - Pricing and output under different forms of markets.

UNIT - III: Macro Economic Analysis: National Income Analysis - Four sector model - Determination of output and employment - Classical approach and Keynesian approach - Theories of consumption – Multiplier – Accelerator.

UNIT – IV: Macro Economic Analysis: Theories Inflation – causes – consequences of inflation – Demand for money – Supply of money – Determinants of money supply - High-powered money, Money multiplier - Macroeconomic Equilibrium - Relative roles of monetary and fiscal policies.

UNIT – V: International Economic Analysis: Theories of International trade - Mercantilism - Absolute Advantage of trade, Comparative Advantage theory & Heckscher-Ohlin theory - Structure of India's Exports – Imports – Balance of payments – Tariff – Terms of Trade – Protection – Free trade – Foreign Exchange Rate Mechanism - Trade Policy and Reforms in India.

ENG—ENGLISH

Unit 1: Poetry

Keats, (Nightingale, Grecian Urn), Tennyson (Ulysses, Lotos Eaters), Eliot (Waste Land), Emily Dickinson (Because I Could Not Stop for Death, Success is Counted Sweetest), Kamala Das (My Grandmother's House).

Unit 2: Drama

Shakespeare's Tragedies, Theatre and political struggle: Trends in Apartheid South African Drama - Athol Fugard (The Blood Knot, Master Harold and the Boys)

Unit 3: Fiction

R.K.Narayan (The Guide), Amitav Ghosh - (The Shadow Lines), Science Fiction - H.G Wells (The Time Machine, The Invisible Man), Fantasy Fiction - J.K. Rowling (Harry Potter and the Sorceress' Stone).

Unit 4: Literary Criticism

Matthew Arnold (Study of Poetry), T.S.Eliot (Tradition and Individual Talent), Literary Forms, Literary Terms (A Glossary of Literary Terms - M.H. Abrams), Literary Forms and Literary Movements.

Unit 5: Language

Grammar, History of English Language (F.T.Wood), ELT - Approaches and Methods, Language Acquisition and Learning, Basic Concepts of Testing and Assessment, Computer Assisted Language Learning (CALL), Communicative Language Teaching (CLT).

HIN—HINDI

Unit 1: History of Hindi Literature (Hindi Sahitya ka Itihas)

Ancient and Medival Period (Aadikal aur Madyakaal)

i. Kaal vibhajan – seema Nirdharan – Namakaran, ii. Aadikaal- Sidh aur Nadh Sahitya – Raso Kavya, iii. Poorva Madyakaal (Bhaktikaal) –pramukh nirgun santh kavi aur, unka avadan – soofi kavi aur kavyagangh- Ram aur Krishna kavya – pramukh kavi aur unke rachana, iv. Uttarmadyakaal (Reethikaal) - Kaal vibhajan –Namakaran – reethikaleen sahitya ki vibinnu dharayemn (reethibadh, reethisisidh, aur reethimukth) – prathinidhi rachanakar aurrachanayemn.

B) Modern Period (Adhunik Kaal)

i. Bharathendu yug- pramuk sahityakar,rachanayemn, ii. Dwivedi yug - pramuk sahityakar,rachanayemn, iii. Hindi swachaanthadavadi chethana ka vikas – chayavadi kavya – pramuk sahityakar,rachanayemn, iv. Uttar chayavadi kavya – pragathivad – prayogvad- nayi kavitha, samakaleen kavitha, v. Hindi gadya ki pramukh vidhaomn – kahani, upanayas, natak, nibhandh, samamaran, rekhachitr, jeevani, aathmakatha, vi. Hindi alochana – pramuk alochak aur rachanayemn.

Unit 2: Origin and Development of Hindi language and grammatical structure of Hindi

i. Pracheen bharatheeya aryabhashayemn- vedic thatha loukik sanskriti- madyakaleen, bhaatheeya aryabhashayemn – pali, prakrit- sourseni- apabramsh, ii. Hindi ke upbhashayemn – pashchimi Hindi, Poorvi Hindi, Rajasthani, Bihari thatha, pahadi aur unki boliyamn- braj, avadhi aur khariboli, iii. Hindi ka bhashik swaroop – hindi sabdh rachna- upasarg, prathaya aur samasrooprachana-ling, vachan aur karak.

Unit 3: Theory of literature (Literary criticism) - Indian and Western

A) Bharatheeykavyasastra

i. Ras sidhanth – ras ka swaroop- ras nishpathi -ras ka angu, ii. Alankar sidhanth – reethi sidhanth- vakrokti sidhanth – dwani sidhanth – pramukh sthapaneyemn

B) Paschathaya Kavyasastra

i. Plato-Arastoo ka anukaran sidhanth- Lomjayins- Traiden – Wordsworth ke kavya bhasa aur sidhanth – Mathew Arnold-alochana ka swaroop – T.A.Elliot-I.A.Richards, ii. Sidhanth aur vaad-Abhijatyavad, swachandathavaad, Abhivyanjajavad, Marxvaad, Asthitwavad, iii. Adhunik Sameekska ki visistu pravarthiyamn-samrachanavad, sylivijnan, Uttar adhunikadavad.

Unit 4: Official language Hindi and Functional Hindi

i. Development of Hindi language as official language-Rajbhasa adhiniyam 1963-Rajbhasa Niyam 1976, ii. Functional Hindi – Hindi ke vibhinu roop- sarjanatmak Bhasha, Sanchar Bhasa, Raj Bhasa, Paribhashiksabdhavali

Unit 5: Journalism (Patrakarita)

Patrakarita –vibhinna prakar- Hindi patrakarita ka sankshipta Ithihas.

Unit 6: Linguistics

Phonology- phoneme and allophone, syntax – structure.

LAW—LAW

Unit 1: Legal Research Methodology

Legal research Methods - Sociological Research methods - Empirical research in Law Theory - Hypothesis-Null hypothesis - Research Plan-Research proposal- Research problem.

Unit 2: Constitutional Law

Important aspects of the Constitutional Law including leading cases on Constitutional Law.

Unit 3: Jurisprudence

Different Schools of Law - Critical analysis of law.

Unit 4: Criminal Law

General Principles of Criminal law.

Unit 5: Tort law

Remedies available under Tort law with leading cases.

Unit 6: Emerging issues in Law

IPR, Cyber Law, International Law, Contracts, Justice Education, Justice Administration, Labour and Industrial law, Personal and Administrative Law.

MAT—MATHEMATICS

Module – 1 Algebra: Permutations, combinations, pigeon-hole principle, inclusion exclusion principle, derangements. Fundamental theorem of arithmetic, divisibility in Z, congruence's, Chinese Remainder Theorem, Euler's □- function, primitive roots. Groups, subgroups, normal subgroups, quotient groups, homeomorphisms, cyclic groups, permutation groups.

Matrices, rank and determinant of matrices, linear equations. Eigen values and Eigen vectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Canonical forms, diagonal forms, triangular forms, Quadratic forms, reduction and classification of quadratic forms

Module – 2 Analysis: Sequences and series of functions, uniform convergence- Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral. Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation Metric spaces, compactness, connectedness

Analytic functions, Cauchy-Riemann equations-harmonic functions-Taylor series, Laurent series, Poles-Singularities-residues-Contour integral, Cauchy's theorem, Cauchy's Integral formula Evaluation of definite real integrals-Conformal mappings, Mobius transformations.

Module-3 Differential and Difference Equations:
Linear Ordinary Differential Equations (ODEs), variation of parameters, Sturm-Liouville problem. Partial Differential Equations (PDEs)-Classification of second order PDEs General solution of higher order PDEs with constant coefficients, Difference equations
Module-4 Transformation techniques – Laplace transformation – Fourier series – harmonics-Fourier transforms-z-transformation-
Module – 5 Numerical Methods: Numerical solutions of algebraic and transcendental equations iteration methods, Solution of systems of linear algebraic equations using Gauss elimination and Gauss – Seidel methods-Numerical differentiation and integration, Numerical solutions of ODEs and PDEs
Model-6 Descriptive statistics:
Sample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate)-expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic function. Standard discrete and continuous univariate distributions. Correlation and Simple and multiple linear regressions.
Module-7 Sampling Theory: Testing of hypotheses – Large and small sample tests- confidence intervals. Chi-square test -goodness of fit. Simple nonparametric tests for one and two sample problems, rank correlation and test for independence. ANOVA.
Module-8 Linear Programming: Formation of LPP – Simplex methods, duality. Elementary queuing and inventory models. Steady-state solutions of Markovian queuing models: M/M/1, M/M/1 with limited waiting space, M/M/C, M/M/C with limited waiting space, M/G/1.g

MEE—MECHANICAL ENGINEERING

Unit 1: Engineering Mathematics:
Geometry Equations of straight line, common normal between straight lines in space; Equations of circles, ellipse, etc.; parametric representation.
Unit 2: Linear Algebra:
Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.
Unit 3: Calculus:
Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives.
Unit 4: Differential equations:
First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.
Unit 5: Control Theory:
Open and closed loop systems; Laplace transforms; Transfer function; Block Diagram analysis; Concepts of stability; Input signals and system response; Nyquist stability criterion; Bode plot.
Unit 6: Probability and Statistics:
Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Permutations and combinations, Random variables, Poisson, Normal and Binomial distributions. Properties of normal curve; Statistical quality control
Unit 7: 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.

Unit 8: 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; thermal stresses.

Unit 9: Theory of Machines:

Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of slider-crank mechanism; flywheels.

Unit 10: Vibrations:

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

Unit 11: Technical drafting:

Engineering drawing practice; Indian standards for technical drawing. Machine Elements Basic concepts of machine elements and their design; Stress concentration factor; Fatigue Strength and S-N curve; failure theories.

Unit 12: Fluid Mechanics:

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

Unit 13: Heat-Transfer:

Modes of heat transfer; one dimensional heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, radiative heat transfer, black and grey surfaces, shape factors; heat exchanger performance, LMTD and NTU methods.

Unit 14: 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.

Unit 15: Applications Power Engineering:

Steam Tables, Rankine, Brayton cycles with regeneration and reheat. I.C. Engines air-standard Otto, Diesel cycles. Sterling cycle.

Unit 16: Refrigeration and air-conditioning:

Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; moist air psychrometric chart, basic psychrometric processes.

Unit 17: Turbo machinery:

Pelton-wheel, Francis and Kaplan turbines, impulse and reaction principles, velocity diagrams.

Unit 18: Engineering Materials:

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

Unit 19: Metal Casting:

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

Unit 20: Forming:

Load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy.

Unit 21: Joining:

Physics of welding, brazing and soldering; adhesive bonding.

Unit 22: 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.

Unit 23: 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.

Unit 24: Production Planning and Control:
Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Unit 25: Inventory Control:
Deterministic and probabilistic models; safety stock inventory control systems.

Unit 26: Operations Research:
Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

Unit 27: Mechatronics System Design:
Pneumatic and hydraulic systems; Eletro-pneumatic and electro-hydraulic systems; Pneumatic, hydraulic and electric motors and actutators; Concepts of microcontrollers, Feedback devices; Point-to-point, continuous-path and servo control; Types of CNC machines and robots. Programmable logic controllers; CNC and robot programming. Some current developments in modern machine tools, robotics, mechatronics; Basic topics related to micro-electro mechanical systems (MEMS).

Unit 28: Computer Integrated Manufacturing:
Basic concepts of CAD/CAM and their integration tools. Exchange of product design and manufacturing data; CNC and robot programming methods. CAD/CAM Software and Virtual Product Development; Rapid Manufacturing Technologies; Concepts of Machine vision and Jigless manufacturing;

Unit 29: Computer Aided Engineering:
Finite Element Methods; Computational Fluid Dynamics; Mechanical Systems Simulation; Tools for conventional mechanisms and MEMS design.

Unit 30: Automotive Engineering:
Development in Bio-fuels, other alternative fuels and hydrogen as future fuel; Emission standards; Electronic injection systems; Passenger comfort and safety devices; Indian auto industry and Automotive vehicles in Indian market.

MGT—MANAGEMENT

Unit 1: Economics
Demand and Supply – Production and Cost decisions – Pricing (policies and strategies in different market structure) – Measurement of National Income – Fiscal and Monetary Policy – Economic Reforms since 1991 – Inflation and Deflation – Money and Capital market, Indian Financial markets and Regulatory Bodies, Reforms in Indian Financial Markets - FDI - Business cycles.

Unit 2: Organizational Behavior and Human Resource Management
Personality - Learning Motivation- Emotions at workplace- Group Dynamics, Organizational Climate- Culture Change & Development – Leadership – Managing Conflicts – Organizational Development– Human Resource Development - HR Planning- Recruitment- Selection- Training and Development - Performance and Potential appraisals—Career and Succession Planning.

Unit 3: Information Technology
Foundations of Information Systems- IT Applications in Business- ERP- CRM- SCM and E-Commerce.

Unit 4: Accounting & Financial Management
Financial Accounts- Financial Statement Analysis and Ratio Analysis- Fund flow and cash flow Statements - Costing- Budgetary Control. Goals of Financial Management- Capital budgeting- Capital Structure- Leverage- Cost of Capital- Working Capital Policy.

Unit 5: Statistics, Production and Operation Research
Measures of Central tendency and Dispersion- Correlation & Regression Analysis—Linear Programming Problem- Transportation and Assignment Problem- Project Management - Production Planning- MRP- Inventory Management- Quality Concepts- Lean Management- Just in Time (JIT).

Unit 6: Business Research Methods

Types of Research- Research Design- Sampling Design: Sampling Methods and Determination of Sample size – Data Collection Design: Levels of Measurement and Scaling- Primary and Secondary data, Instrument Design - Data Analysis: Univariate, Bivariate and Multivariate Data Analysis – Report Preparation.

Unit 7: Marketing

Consumer Markets and Business Markets- Segmentation- targeting and Positioning- Marketing Mix 4P's- Product life cycle – Services Marketing: Additional Ps – Customer Relationship Management, Digital and Social Media Marketing – Brand Management – Retailing on the net.

Unit 8: Strategy

Strategic Management- Vision- Mission- Objectives- Environmental analysis- Strategy formulation- Corporate Level- SBU Level- Functional Strategies- Strategy implementation.

Corporate Governance: Procedures and Principles, Governance Reforms in India - Business Ethics: Ethics and Management System; Ethical issues and Analysis in Management; Value based organisations; Personal framework for ethical choices; Ethical pressure on individual in organisations; Gender issues; Ecological consciousness; – Corporate Social Responsibility.

Unit 9: International Business

Modes of International Business-Liberalization – Globalization - Privatization – Entry Strategies and FDI in International Business – Internationalization process of multination enterprises - Cross culture management - EXIM Policy – World Trade Organization.

Unit 10: Entrepreneurship

Entrepreneurship and the Entrepreneurial Mind-Set - Entrepreneurial Intentions and Corporate Entrepreneurship - Entrepreneurial Strategy: Generating and Exploiting New Entries - Creativity and the Business Idea - Identifying and Analyzing Domestic and International Opportunities - Intellectual Property and Other Legal Issues for the Entrepreneur - The Business Plan -The Marketing Plan - The Organizational Plan - The Financial Plan - Sources of Capital - Strategies for Growth and Managing the Implication of Growth - Qualities required for future Entrepreneurs.

HOT—HOSPITALITY MANAGEMENT

Unit 1: Global Scenario of the Hospitality Industry

Hospitality Industry of World and India, History & Origin of Hospitality Industry, Concepts of Hospitality Industry, Tenants of Hospitality Industry (Hotels, Food Service Outlets, Lodge, Inns, Airlines, Rail and Cruise Lines, Tour and Travel Operations, Events Managements, MICE Etc.), Current Trends in Hospitality Industry, Future of Hospitality Industry.

Unit 2: Hotel Operations Challenges and Aspects

Operations of Hotels (Front Office, Accommodation Management, Food Production and F& B Service), Concept of Control of Different Operations of the Hotel, Departments and their Roles and Responsibilities, Interdepartmental Coordination and Dependence, Importance and Objectives of Control in Hotel Operations Security and Engineering, Facility Planning, Laws Related to Hospitality

Unit 3: Hospitality Sales & Marketing Techniques

The New Concepts of Sales and Marketing, Types of Service Marketing, Strategic Marketing, Social Media Marketing, Segmentation, Targeting and Positioning of Hospitality Products, New Product Development in Hospitality Industry, Pricing Strategies in Hospitality, Product Marketing, Marketing Research in Hospitality Industry, Hospitality Products Advertising and Promotion, Quality Management, Innovation and Invention in Hospitality Marketing.

Unit 4: Hospitality Learning and Development

The Modern Concept of Human Resource Management, Role and Objectives of HRM In Hospitality, the Recent Human Resource Structure, Recruitment, Selection, Orientation, Placement, Training and Development, Retention in Hospitality Industry, Work Life Balance, Managing Productivity and Controlling Labor Costs, Discipline & Managing Conflict, Team Building, Motivation, Change Management.

Unit 5: Strategic Leadership in Hospitality Industry

Introduction to Supervision in Hospitality, Managing Productivity and Controlling Labor Costs, Discipline and Managing Conflict, Team Building, Motivation, Change Management, Time Management.

PHY—PHYSICS

Unit 1: Mathematical Methods of Physics

Dimensional analysis; Vector algebra and vector calculus; Linear algebra, matrices, Cayley Hamilton theorem, eigenvalue problems; Linear differential equations; Special functions (Hermite, Bessel, Laguerre and Legendre); Fourier series, Fourier and Laplace transforms; Elements of complex analysis: Laurent series-poles, residues and evaluation of integrals; Elementary ideas about tensors; Introductory group theory, SU(2), O(3); Elements of computational techniques: roots of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, solution of first order differential equations using Runge-Kutta method; Finite difference methods; Elementary probability theory, random variables, binomial, Poisson and normal distributions.

Unit 2: Classical Mechanics

Newton's laws; Phase space dynamics, stability analysis; Central-force motion; 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, Lagrangian and Hamiltonian formalisms and equations of motion; Poisson brackets and canonical transformations; Symmetry, invariance and conservation laws, cyclic coordinates; Periodic motion, small oscillations and normal modes; Special theory of relativity, Lorentz transformations, relativistic kinematics and mass–energy equivalence.

Unit 3: Electromagnetic Theory

Electrostatics: Gauss' 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 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; Dispersion relations in plasma; Loentz invariance of Maxwell's equations; Transmission lines and wave guides; Dynamics of charged particles in static and uniform electromagnetic fields; Radiation from moving charges, dipoles and retarded potentials.

Unit 4: Quantum Mechanics

Wave-particle duality; Wave functions in coordinate and momentum representations; Commutators and Heisenberg's uncertainty principle; Matrix representation; Dirac's bra and ket notation; Schroedinger equation (time-dependent and time-independent); Eigenvalue problems such as particle-in-a-box, harmonic oscillator, etc.; Tunneling through a barrier; Motion in a central potential; Orbital angular momentum, Angular momentum algebra, spin; Addition of angular momenta; Hydrogen atom, spin-orbit coupling, fine structure; Time-independent perturbation theory and applications; Variational method; WKB approximation; Time dependent perturbation theory and Fermi's Golden Rule; Selection rules; Semi-classical theory of radiation; Elementary theory of scattering, phase shifts, partial waves, Born approximation; Identical particles, Pauli's exclusion principle, spin-statistics connection; Relativistic quantum mechanics: Klein Gordon and Dirac equations.

Unit 5: Thermodynamic and Statistical Physics

Laws of thermodynamics and their consequences; Thermodynamic potentials, Maxwell relations; Chemical potential, phase equilibria; Phase space, micro- and macrostates; Microcanonical, canonical and grand-canonical ensembles and partition functions; Free Energy and connection with thermodynamic quantities; First- and second-order phase transitions; Classical and quantum statistics, ideal Fermi and Bose gases; Principle of detailed balance; Blackbody radiation and Planck's distribution law; Bose-Einstein condensation; Random walk and Brownian motion; Introduction to nonequilibrium processes; Diffusion equation.

Unit 6: Electronics

Semiconductor device physics, including diodes, junctions, transistors, field effect devices, homo and heterojunction devices, device structure, device characteristics, frequency dependence and applications;

Optoelectronic devices, including solar cells, photodetectors, and LEDs; High-frequency devices, including generators and detectors; 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.

Unit 7: Experimental Techniques and data analysis

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 field, 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. Applications of the above experimental and analytical techniques to typical undergraduate and graduate level laboratory experiments.

Unit 8: Atomic & Molecular Physics

Quantum states of an electron in an atom; Electron spin; Stern-Gerlach experiment; Spectrum of Hydrogen, helium and alkali atoms; Relativistic corrections for energy levels of hydrogen; Hyperfine structure and isotopic shift; width of spectral lines; LS & JJ coupling; Zeeman, Paschen Back & Stark effect; X-ray spectroscopy; Electron spin resonance, Nuclear magnetic resonance, chemical shift; Rotational, vibrational, electronic, and Raman spectra of diatomic molecules; Frank – Condon principle and selection rules; Spontaneous and stimulated emission, Einstein A & B coefficients; Lasers, optical pumping, population inversion, rate equation; Modes of resonators and coherence length.

Unit 9: 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; Diamagnetism, paramagnetism, and ferromagnetism; Electron motion in a periodic potential, band theory of metals, insulators and semiconductors; Superconductivity, type – I and type - II superconductors, Josephson junctions; Defects and dislocations; Ordered phases of matter, translational and orientational order, kinds of liquid crystalline order; Conducting polymers; Quasicrystals.

Unit 10: Nuclear and Particle Physics

Basic nuclear properties: size, shape, charge distribution, spin and parity; Binding energy, semiempirical mass formula; Liquid drop model; Fission and fusion; Nature of the nuclear force, form of nucleon-nucleon potential; Charge-independence and charge-symmetry of nuclear forces; Isospin; 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; Nuclear reactions, reaction mechanisms, compound nuclei and direct reactions; Classification of fundamental forces; Elementary particles (quarks, baryons, mesons, leptons); Spin and parity assignments, isospin, strangeness; Gell-Mann-Nishijima formula; C, P, and T invariance and applications of symmetry arguments to particle reactions, parity non-conservation in weak interaction; Relativistic kinematics.

PSY—PSYCHOLOGY

UNIT-I: Introduction to Psychology- Definition, Nature and Scope of psychology; Historical perspective; sub-fields and applications, methods of psychology; Schools of Psychology.

UNIT-II: Sensation and Perception, Learning, Memory Building, Cognition Process, Intelligence, Motivation and Emotion, Personality and its Types, Individual Differences and the impact of the process of Socialization, Environmental influences and Counseling therapy.

UNIT-III: Psychological theories - Learning theories, Models of Memory, Cognitive Strategies, Motivation theories, Current theories of emotion, Existential and humanistic theories of personality, Stress and coping Strategies.

UNIT IV: Research Methodology – Meaning, Aims, characteristics and types, Research Process, types of Research Design, Sampling, types and uses, Research Hypothesis, Methods of Data Collection, Tools and Techniques of data collection, Psychological Scaling, Sources of bias in Psychological testing , Data Analysis and Report writing.
UNIT V: Statistics: Introduction, Importance, Scope, Function and Limitations. Research Designs: Correlational, factorial, randomized block, matched group, quasi experimental, time series design, ANOVA: Randomized and repeated, Measures of Central tendency, Measures of Dispersion, Correlational analysis:, Partial, multiple and regression analysis, Factor analysis and Chi Square Analysis.

SOY—SOCIAL SCIENCES

UNIT I: Introduction to Sociology - Origin and Development of Sociology, Meaning of Sociology, Nature and Scope, Sociology as a Science, Relationship with other Social Sciences.
UNIT II: Basic Concepts – Group, Association, Organization, Community, Society, Institution, Socialization, Social Processes, Social Structure, Social Control, Social Stratification, Social Mobility, and Social Change.
UNIT III: Sociological Perspectives – Evolutionalism, Structuralism, Functionalism, Marxism, Interactionism, Phenomenology and Ethinomethodology, Post Modernism, Neo Marxism, Neo structuralism.
UNIT IV: Research Methodology – Social Research and its types, Research Process, types of Research Design, Sampling – types and uses, Research Hypothesis, Methods of data collection, Tools and Techniques of data collection, Data analysis and Report writing.
UNIT V: Social Statistics: Importance, Function and Limitations, Measures of Central tendency: Mean, Median, Mode. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation and Standard Deviation. Correlation: Karl Pearson's Coefficient of Correlation and Rank Correlation. Association of Attributes, Regression and Chi-Square.

SLW—SOCIAL WORK

Students who pursue a doctorate in social work are prepared to work in the fields of social work research, education, social policy, planning, and administration. Through practice-based research and field action projects, it identifies new areas for social work practise and develops creative solutions. A mixed methods foundation, grounding in social work ideals and a social justice lens, and training in teaching excellence are all required in the core curriculum.

Thematic Areas

- Social work education and practices
- Child rights and Child welfare
- Education and social welfare
- Mental health and wellbeing
- Gender and Sexuality studies
- Violence against women, children, elderly, migrants, refuges, differently abled, Scheduled Caste and Scheduled Tribes
- Issues of adolescent and youth
- Gerontology
- Rural and urban development
- Livelihood and social innovations
- Community and Sustainable development
- Human rights and social justice

PSC—POLITICAL SCIENCE

1. Political Theory and Thought

Concepts of Political Theory: Liberty, Equality, Justice, Rights, Democracy, Power, Citizenship
Political Traditions: Liberalism, Socialism, Marxism, Feminism, Multiculturalism, Postmodernism
Western Political Thought: Plato, Aristotle, Machiavelli, Hobbes, Locke, Rousseau, Hegel, John Stuart Mill, Karl Marx
Indian Political Thought: Manu, Kautilya, Swami Vivekanand, M.K Gandhi, Sri Aurobindo, M.N.Roy, Dr. B.R.Ambedkar, Ram Manohar Lohia, Jaya Prakash Narayan

2. Comparative Politics and Political Analysis

Evolution of Comparative Politics as a discipline; nature and scope.
Approaches to the study of comparative politics: Traditional, Structural – Functional, Systems and Marxist.
Constitutionalism: Concepts, Problems and Limitations.
Forms of Government: Unitary – Federal, Parliamentary – Presidential.
Organs of Government: Executive, Legislature, Judiciary – their interrelationship in comparative perspective.
Party Systems and Pressure Groups; Electoral Systems.
Bureaucracy – types and roles.
Political Development and Political Modernization.
Political Culture, Political Socialization and Political Communication.
Political Elite; Elitist theory of Democracy.
Power, Authority and Legitimacy.
Revolution: Theories and Types.
Dependency: Development and Under Development.

3. Indian Government and Politics

National Movement, Constitutional Developments and the Making of Indian Constitution.
Ideological Bases of the Indian Constitution, Preamble, Fundamental Rights and Duties and Directive Principles.
Constitution as Instrument of Socio – Economic Change, Constitutional Amendments and Review.
Union Government: President, Prime Minister, Council of Ministers, Working of the Parliamentary System.
State Government: Governor, Chief Minister, Council of Ministers, State Legislature.
Local-self Government: Panchayati Raj Institutions : Rural and Urban, their working.
Federalism: Theory and Practice in India; Demands of Autonomy and Separatist Movements; Emerging trends in Centre – State Relations.
Judiciary: Supreme Court, High Courts, Judicial Review, Judicial Activism including Public Interest Litigation cases, Judicial Reforms.
Political Parties, Pressure Groups, Public Opinion, Media; Subaltern and Peasant Movements.
Elections, Electoral Behaviour, Election Commission and Electoral Reforms.

4. Public Policy and Administration

Meaning and Development of Public Administration: Meaning, nature and scope of public administration, Development of Public Administration as a discipline
Theories of Public Administration: Scientific, classical, bureaucratic theory, human relation theory
Principles of Organization: Line and staff, unity of command, hierarchy, span of control, centralization and decentralization, Types of organization – formal and informal; Forms of organization; department, public corporation and board.
Personnel Administration: Recruitment, Training, Promotion, Discipline, Morale; Employee – Employer Relations.
Civil service and Bureaucracy: Theories, Types and Roles; Max Weber and his critics. Civil servant – Minister relationship, Civil service in India.
Financial Administration: Budget, Audit, Control over Finance with special reference to India and UK.

Good Governance: Problems of Administrative Corruption; Transparency and Accountability; Right to Information.
Grievance Redressal Institutions: Ombudsman, Lokpal and Lokayukta.

5. International Relations

Theories of International Relations; Idealist, Realist, Systems, Game, and Decision Making theory, English school of thought.
Power, Interest and Ideology in International Relations: Acquisition, use and limitations of power, Perception, Formulation and Promotion of National Interest, Meaning, Role and Relevance of Ideology in International Relations.
Arms and Wars: Nature, causes and types of wars / conflicts including ethnic disputes; conventional, Nuclear / bio – chemical wars; deterrence, Arms Race, Arms Control and Disarmament.
International Peace: Peaceful Settlement of Disputes, Conflict Resolution, Diplomacy, World – order and Peace studies.
Cold war and International Politics: Cold War, Alliances, Non – Alignment, End of Cold war, Globalisation. Rights and Duties of states in international law, intervention, Treaty law, prevention and abolition of war.
Political Economy of International Relations: New International Economic Order, North – South Dialogue, South – South Cooperation, WTO, Neo – colonialism and Dependency.
Regional and sub – regional organisations: SAARC, ASEAN, OPEC, OAS.
United Nations : Aims, Objectives, Structure and Evaluation of the working of UN; Peace and Development perspectives; Charter Revision; Power – struggle and Diplomacy within UN, Financing and Peace – keeping operations.
India's Role in International Affairs: India's relations with its neighbours, Wars, Security Concerns and Pacts, Mediatory Role, distinguishing features of Indian Foreign Policy and Diplomacy.

FTY—FASHION TECHNOLOGY

Module 1: Textile fibres - fibres and filament, classification - natural and manmade, fibres and filament manufacturing, characteristics and properties of textile fibres, testing of fibres, applications of fibres; Yarn Manufacturing – ginning to spinning, spinning systems, doubling, fancy yarn, yarn numbering system, characteristics and properties of yarn, testing of yarn; Fabric manufacturing – classification, process and mechanism - woven, knit, nonwoven and braided fabrics, multilayer fabrics, 2D to 3D fabrics, fabric structures – woven and knitted characteristics and properties fabrics, fabric testing, comfort and application; Wet processing – singeing to finishing - singeing, scouring, bleaching, dyeing, printing, other finishes; Advance textile machineries – spinning, weaving, knitting and wet processing.

Module 2: Origin of fashion**,** Evolution of fashion, fashion in different eras, concepts of fashion design, fashion forecasting, analysis, trend setting, fashion terminologies, fashion theories, fashion promotion, colour science, elements and principles of fashion design, fashion psychology, embellishments - embroidery, surface ornamentation, trims and accessories.

Module 3: Anthropometrics, sizing systems, body measurements, pattern making principles, drafting and draping methods, spreading, cutting, seams and stitches, machine elements for sewing, special attachments and machines for functional purpose, functional purpose - dart and dart manipulation, pleats, flares, gather, bias, pattern alteration; Garment components and construction - children's, women's and men's wear; Garment inspection - system and quality standards; CAD in apparel industry - pattern making, sewing, embroidery and robotic systems.

Module 4: Business concepts and pattern in apparel - export house, buyer, trading, buying agencies, sourcing, concepts of merchandising - time and action plan, merchandise plans, plant layout, specification and cost control; Production systems, work station, work measurement and operational breakdown; Apparel costing, export

documentation and policies, statistical process control; Merchandising and marketing – classification, marketing mix, market research and market strategy.

Module 5: Specialty Textile - fibres, yarns, fabrics and garments; Smart textile - smart clothes, wearable electronics; Textile and apparel waste management, sustainable practices in fashion and apparel industries, recycling textile and apparel products, recycling textile waste water, energy conservation management; standards and certification for textile and apparel industry, quality control and assurance.

GEO - GEOLOGY

EARTH, ATMOSPHERIC, OCEAN AND PLANETARY SCIENCES

The Earth and the Solar System: Milky Way and the solar system. Modern theories on the origin of the Earth and other planetary bodies. Earth's orbital parameters, Kepler's laws of planetary motion, Geological Time Scale; Space and time scales of processes in the solid Earth, atmosphere and oceans. Radioactive isotopes and their applications. Meteorites Chemical composition and the Primary differentiation of the earth. Basic principles of stratigraphy. Theories about the origin of life and the nature of fossil record. Earth's gravity and magnetic fields and its thermal structure: Concept of Geoid and, spheroid; Isostasy.

Interior of the Earth, Deformation and Tectonics: Basic concepts of seismology and internal structure of the Earth. Physico-chemical and seismic properties of Earth's interior. Concepts of stress and strain. Behaviour of rocks under stress; Folds, joints and faults. Earthquakes – their causes and measurement. Interplate and intraplate seismicity. Paleomagnetism, sea floor spreading and plate tectonics.

Earth Materials, Surface Features and Processes: Gross composition and physical properties of important minerals and rocks; properties and processes responsible for mineral concentrations; nature and distribution of rocks and minerals in different units of the earth and different parts of India. Physiography of the Earth; weathering, erosion, transportation and deposition of Earth's material; formation of soil, sediments and sedimentary rocks; energy balance of the Earth's surface processes; physiographic features and river basins in India

Oceans and Atmosphere: Hypsography of the continents and ocean floor –continental shelf, slope, rise and abyssal plains. Physical and chemical properties of sea water and their spatial variations. Residence times of elements in sea water. Ocean currents, waves and tides, important current systems, thermohaline circulation and the oceanic conveyor belt. Major water masses of the world's oceans. Biological productivity in the oceans. Motion of fluids, waves in atmospheric and oceanic systems. Atmospheric turbulence and boundary layer. Structure and chemical composition of the atmosphere, lapse rate and stability, scale height, geopotential, greenhouse gases and global warming. Cloud formation and precipitation processes, air- sea interactions on different space and time scales. Insolation and heat budget, radiation balance, general circulation of the atmosphere and ocean. Climatic and sea level changes on different time scales. Coupled ocean-atmosphere system, El Nino Southern Oscillation (ENSO). General weather systems of India, - Monsoon system, cyclone and jet stream, Western disturbances and severe local convective systems, distribution of precipitation over India. Marine and atmospheric pollution, ozone depletion.

Environmental Earth Sciences: Properties of water; hydrological cycle; water resources and management. Energy resources, uses, degradation, alternatives and management; Ecology and biodiversity. Impact of use of energy and land on the environment. Exploitation and conservation of mineral and other natural resources. Natural hazards. Elements of Remote Sensing.

Paleontology and its applications: Theories on origin of life. Organic evolution – Punctuated Equilibrium and Phyletic Gradualism models. Mass extinctions and their causes. Application of fossils in age determination and correlation. Paleoecology, Life habitats and various ecosystems, Paleobiogeography. Modes of preservation of fossils and taphonomic considerations. Types of microfossils. Environmental significance of fossils and trace fossils. Use of microfossils in interpretation of sea floor tectonism. Application of micropaleontology in hydrocarbon exploration.

Oxygen and Carbon isotope studies of microfossils and their use in paleoceanographic and paleoclimatic interpretation. Important invertebrate fossils, vertebrate fossils, plant fossils and microfossils in Indian stratigraphy.

Sedimentology and stratigraphy: Classification of sediments and sedimentary rocks ; elastic, volcanoclastic and chemical. Classification of elastic rocks. Flow regimes and processes of sediment transport. Sedimentary textures and structures. Sedimentary facies and environments, reconstruction of paleoenvironments. Formation and evolution of sedimentary basins. Lithostratigraphic, chronostratigraphic and biostratigraphic subdivisions. Methods of startigraphic correlation including Shaw's Graphic correlation. Concept of sequence stratigraphy. Rates of sediment accumulation, unconformities. Facies concept in Stratigraphy – Walther's law. Methods for paleogeographic reconstruction. Earth's Climatic History. Phanerozoic stratigraphy of India with reference to the type areas– their correlation with equivalent formations in other regions. Boundary problems in Indian Phanerozoic stratigraphy.

Remote Sensing and GIS: Elements of photogrammetry, elements of photo-interpretation, electromagnetic spectrum, emission range, film and imagery, sensors, geological interpretations of air photos and imageries. Global positioning systems. GIS- data structure, attribute data, thematic layers and query analysis.

Engineering Geology: Engineering properties of rocks and physical characteristics of building stones, concretes and other aggregates. Geological investigations for construction of dams, bridges, highways and tunnels. Remedial measures. Mass movements with special emphasis on landslides and causes of hillslope instability. Seismic design of buildings.

Hydrogeology: Groundwater, Darcy's law, hydrological characteristics of aquifers, hydrological cycle. Precipitation, evapotranspiration and infiltration processes. Hydrological classification of water-bearing formations. Fresh and salt-water relationships in coastal and inland areas. Groundwater exploration and water pollution. Groundwater regimes in India.

Geomorphology: Concepts in geomorphology. Historical and process Geomorphology. Landforms in relation to climate, rock type, structure and tectonics. Processes – weathering, pedogenesis, mass movement, erosion, transportation and deposition. Geomorphic processes and landforms – fluvial, glacial, eolian, coastal and karst. River forms and processes – stream flow, stagedischarge relationship; hydrographs and flood frequency analysis. Submarine relief. Geomorphology and topographic analysis including DEM, Environmental change– causes, effects on processes and landforms. Extra-terrestrial geomorphology.

Geography of India: Physiography, drainage, climate, soils and natural resources – the Himalaya, Ganga-Brahmaputra Plains, and peninsular India Precambrian shield, the Gondwana rift basins, Deccan Plateau. Indian climatology with special reference to seasonal distribution and variation of temperature, humidity, wind and precipitation; Climate zones of India. Agricultural geography of India. Population – its distribution and characteristics. Urbanization and migration. Environmental problems and issues.

TAM—TAMIL

அலகு–1: இலக்கணங்கள்

தொல்காப்பியம் - நன்னூல் - நம்பியகப்பொருள் - (எழுத்து – சொல் - பொருள் - யாப்பு - அணி).

அலகு–2: சங்க இலக்கியங்கள் (ம) காப்பியங்கள்.

சங்க இலக்கியங்களின் சிறப்புகள் - முச்சங்கள் - பதினெண் மேல்கணக்கு (எட்டுத்தொகை – பத்துப்பாட்டு) – பதினெண் கீழ்க்கணக்கு நூல்கள் - ஐம்பெரும்காப்பியங்கள் - ஐஞ்சிறுகாப்பியங்கள்.

அலகு–3: சமயம் (ம) சிற்றிலக்கியங்கள்

சைவம்(பன்னிரு திருமுறைகள்) - வைணவம் (நாலாயிர திவ்வியப் பிரபந்தங்கள், பன்னிரு ஆழ்வார்கள்) - மணம் : பரணி – கலிங்கத்துப்பரணி: கோவை – திருக்கோவையார்: தூது – தமிழ்விடுத்தூது: பள்ளு – முக்கூடற்பள்ளு: குறவஞ்சி – திருக்குற்றாலக்குறவஞ்சி: பிள்ளைத்தமிழ் - மீனாட்சியம்மைப் பிள்ளைத்தமிழ்.

அலகு–4: இக்கால இலக்கியங்கள்

நாடகம் : தோற்றம் வளர்ச்சி, சமூக, சரித்திர, புராண, நகைச்சுவை நாடகங்கள்.

சிறுகதை : தோற்றம் வளர்ச்சி, புதுமைப்பித்தன், கு.பா.ரா., தி.ஜா, ஜெயகாந்தன்

புதினம் : தோற்றம் வளர்ச்சி, பிரதாப முதலியார் சரித்திரம், கமலாம்பாள் சரித்திரம், பத்மாவதி சரித்திரம், சமூக புதினங்கள், மு.வ.

மரபுக்கவிதை : தோற்றம் வளர்ச்சி, பாரதியார், பாரதிதாசன், கவிமணி, நாமக்கல் கவிஞர், கண்ணதாசன்.

புதுக்கவிதை : தோற்றம் வளர்ச்சி, ந.பிச்சமூர்த்தி, நா. காமராசன், மீரா , மு. மேத்தா, சௌந்தரா கைலாசம்.

ஐக்கூ : தமிழன்பன், அப்துல் ரகுமான்.

அலகு–5: நாட்டுப்புற இலக்கியங்கள்

தோற்றம், வளர்ச்சி, தாலாட்டு, ஒப்பாரி, தொழில், கதை, பழமொழி, விடுகதைகள் போன்றன.

அலகு–6: செம்மொழித் தமிழ்

செம்மொழி வரலாறு – காரணங்கள் - உயர்தனிச்செம்மொழி – தொன்மைச்சிறப்பு – தலைமைச் சிறப்பு – செவ்வியல் சிறப்பு – வாழும்மொழி – பன்னாட்டு மொழி – கணினி மொழி.

அலகு–7: மொழிபெயர்ப்பு, கணினி, இணையம்

மொழிபெயர்ப்பின் தோற்றம், வளர்ச்சி, அவசியம், பயன்பாடுகள், வகைகள், கணினி – தமிழ் எழுத்துருக்களின் தோற்றமும் வளர்ச்சியும் - பயன்பாடு, இணையம் - இணையத் தமிழின் தோற்றமும் வளர்ச்சியும், இதழ்கள், வலைப்பூக்கள் - மாநாடு – பல்கலைக்கழகம்.

FRC-FRENCH

Unité-1 - Littérature : Histoire de la littérature française :

Littérature française du Moyen Age au 20ème siècle . Les principaux mouvements littéraires : littérature médiévale, Renaissance, Classicisme, Baroque, Siècle des Lumières, réalisme, romantisme, symbolisme, surréalisme, nouveau roman, nouveau théâtre, existentialisme, postmodernisme, écriture des femmes, de migration

Unité--2 -Littératures francophones :

1. **Asie et Pacifique :** Extraits recommendés de : J.L.Joubert (sous la dir. de), Littératures francophones d'Asie et du Pacifque, Nathan :

*Makhali-Phal (Cambodge), Narayana ou celui qui se meut sur les eaux.
*Phan Van Ky (Vietnam), Celui qui règnera.
*Lokenath Bhattacharya (Inde), Poussières et royaumes.
*K.Madavane (Inde), Mourir à Bénarès.
*Kikou Yamata (Japon), Masako.

2. **Afrique Noire :** Extraits recommendés de : J.L.Joubert (sous la dir. de), Littératures francophones: Anthologie, Nathan.

*Léopold Sédar Senghor (Sénégal), Chants d'Ombre.
*Camara Laye (Guinée), L'Enfant noir.

*Cheikh Hamidou Kane(Sénégal), L'Aventure ambigue.
*Ahmadou Kourouma (Côte d'Ivoire), Les Soleils des Indépendances.

3. Canada : * Gabrielle Roy, Bonheur d'occasion.
* Hubert Aquin, Prochain Épisode.
* Marie-Claire Blais, Une Saison dans la vie d'Emmanuelle.
* Réjean Ducharme, L'Avalée des avalés
* Michel Tremblay, Belles soeurs.
* Anne Hébert, Kamarouska.
*Michèle Lalonde, Speak White.
*Antonine Maillet, L'Emmitouflé.

4. Maghreb : * Mohamemed Dib (Algérie), Habel.
* Helé Beji (Tunisie), L'Oeil du jour.
* Tahar Ben Jelloun (Maroc), La nuit sacrée.

5. Océan indien : *Ananda Devi (Maurice), Le voile de Draupadi.
*Jean-Marie Le Clézio, Le chercheur d'or
*Michèle Rokotoson (Madagascar), Le Bain des réliques.
*Axel Gauvin (La Réunion), L'Aimée.

6. Europe francophone : *Corinna S. Bille (Suisse), La demoiselle sauvage.
*Marie Gevers (Belgique), Vie et mort d'un étang.

Étude des Genres : Poésie, Théâtre, Roman, Contes et nouvelles

Unité--3- Civilisation de la Révolution française

Civilisation de la Révolution française jusqu'à la France contemporaine, y compris les tendances majeures de la vie politique, sociale et artistique en France.

• Connaissance générale de l'histoire de la France avec ses implications politique, économique et sociale.
• Connaissance générale de la géographie physique, politique et économique de la France
• Connaissance générale : - Cinéma - Peinture - Sculpture – Musique

Unité--4- Traductologie

-La traduction est un champ d'étude interdisciplinaire situé à l'interface entre la linguistique et les études culturelles.
-Définitions de traduction: traduction interlinguale, intralinguale et intersémiotique -Approches linguistiques à la traduction
-Théories interprétatives de traduction
- Concepts en traduction par exemple adaptation, cohérence, cohésion, contexte, emprunt, équivalence, faux amis, fidélité, procédés de traduction, processus de la traduction, sur traduction, sourcier, texte pragmatique, unités de traduction etc.
-Traduction pédagogique/ traduction professionnelle
-Terminologie de la traduction relative à divers domaines de la science et de la technologie.
-Enseignement de la traduction
-Traduction et idéologie / politique de la traduction

Unité- 5- Linguistique

-Compréhension des concepts linguistiques de base, notamment langue/parole, code / message, relation syntagmatique/paradigmatique, compétence linguistique/performance
-Traits essentiels du langage humain -Description de la langue selon une perspective synchronique et/ou diachronique
-Nature du signe linguistique
-Différence entre Phonétique et Phonologie.
-Classification de consonnes, voyelles et semi-voyelles
- Syllabes and Rythmes -Morphologie et syntaxe de la langue française
-Registres de langue
- Analyse de constituants immédiats
-Théories de l'énonciation
-Identification de différentes fonctions du langage d'après Jakobson)
- Concepts essentiels de la pragmatique: actes de parole, des performatifs etc.
- Concepts essentiels de l'analyse de discours : cohérence and cohesion

Unité -6- Didactique des Langues – Cultures

-Evolution des méthodologies de l'enseignement du Français langue étrangère : des méthodes traditionnelles aux approches centrées sur l'apprenant
-Didactique en tant qu'un champ d'étude interdisciplinaire située à la croise de la linguistique, psychologie, sociologie, technologie, études culturelles.
-Définitions de concepts de base : méthode, méthodologie, manuel, didactique.
- Approche communicative et Approche actionnelle
-Usage des documents authentiques
-Problèmes et perspectives dans l'enseignement/apprentissage du Français dans le contexte indien
-Principes de production pédagogiques
-Interculture dans l'enseignement et l'apprentissage du Français
- CECR et Niveaux communs de référence
- French for specific purposes (FOS)
-Technologies de l'information et de la communication pour l'enseignement (TICE)
- Analyse des manuels de FLE : Dondo, Cours de langue et Civisation française, (Mauger Bleu) Mauger Rouge, De vive Voix, Cartes sur Table, Nouveau Sans Frontières, Archipel, Connexions, Alter Ego, Echo , Version Originale etc

Areas of interest:

Translation studies, Comparative Literature, Didactics of French Language Teaching, Foreign Language Teaching, French Literature & Francophone studies

EIE - Instrumentation Engineering

Sensors & signal conditioning: Resistive, Capacitive, inductive, Hall Effect, Magnetostrictive, MEMS sensors, self-generating, Electromagnetic, Optical, Digital Biosensors, and Intelligent sensors associated with signal conditioning units.

Transducers for industrial instrumentation: Low & High pressure, Flow, Level, Temperature, pH, Viscosity, Velocity, Acceleration, Force and Torque measurements

Control system: Feedback principles, Transient and steady state, Bode plot, Routh and Nyquist criteria, state space representation, P, PI, PID, Cascade Feed forward and Ratio controllers, DCS, PLC & SCADA. Linear and Non-linear process control, Model predictive controls and intelligent controllers.

Circuits and VLSI: Circuit analysis, Fundamental of Logic designs, MOS Transistor Principles and CMOS Inverter, Basic analog & digital CMOS Circuits, Sequential logic circuits, Arithmetic Building Blocks and Memory Architectures, Interconnect and Clocking Strategies.

Devices: Crystal structure basis, basic quantum mechanics, electrons in solids, energy band theory, charge carriers in semiconductors, drift-diffusion theory, p-n junctions, MOS capacitors, field-effect transistors, bipolar junction transistors, LEDs and solar cells.

Communication and Signal Processing: Analog and Digital Communications-Modulation techniques, Signal representation, Quantization, Power and bandwidth considerations, Data compression techniques - Probability of error in digital communications. Signal Processing-Representation of signals on orthogonal basis - Discrete systems- attributes, Z-Transform - Analysis of LSI systems, Frequency analysis, Inverse Systems, - Discrete Fourier Transform (DFT) - Fast Fourier Transform algorithm -Design of FIR Digital filters, Design of IIR Digital filters.

VSD-DESIGN

VITREE (VSIGN) 2022 will be in two parts (A & B).

Part-A

Part-A will have 30-40 questions (numerical answer/multiple choice) related to these topics:

- **Visualization and spatial ability:** Pictorial and diagrammatic questions to test the understanding of transformation and/or manipulation of 2D shapes and 3D objects and their spatial relationships.
- **Environmental and social awareness:** General awareness of environmental factors (such as climate, population, water, vegetation, pollution, weather, natural resources) and their implications on the design of products, images, infrastructure and environment. Awareness of design terminologies, social and cultural connection with design, history of the designed artefact, and socially responsible and environmentally sustainable design responses. History of art, sculpture and literature.
- **Analytical and logical reasoning:** Ability to analyse given information logically and select the most appropriate solutions; ability to weigh opinions, arguments or solutions against appropriate criteria; ability to use logic and structured thinking to deduce from a short passage, which of a number of statements is the most accurate response to a posed question.
- **Language and creativity:** Ability to understand passages in commonly used English language; ability to think creatively in terms of alternatives; ability to distinguish innovative options and think out-of-the-box.
- **Design thinking and problem solving:** Ability to understand the context, the users and the constraints and select the most appropriate solution for a given design problem.
- **Observation and design sensitivity:** Ability to detect concealed properties in day-to-day life and think critically about them. Ability to discern subtle differences in visual properties and aesthetic outcomes.

Note: The suggested topics are exhaustive and indicative of the nature of questions. However, the VITREE (VSIGN) 2022 may not cover all the topics.

Part-B

Part-B of VITREE (VSIGN) 2022 will have 5 questions related to these topics:

- **Drawing:** Ability to draw products, people or scenes in proportion with good line quality, composition, proportion, perspective, and shading.
- **Creativity:** Ability to think out-of-the-box and come-up with unique as well as diverse solutions.
- **Communication skills:** Ability to communicate concepts and ideas clearly with the help of text and visuals.
- **Problem identification skills:** Ability to understand the user and the context, knowledge of properties of materials and their appropriate use in design.

VITREE (VSIGN) 2022 is an aptitude test and hence, no specific text book or guide is recommended for its preparation. Candidates may however practise their drawing, rendering and visualization skills. For your preparation, you may solve question papers of some of the previous years which are available on the official CEED website.

Stationery: Candidates must bring their own drawing material like pens, pencils, sketch pens and colours for the examination. Candidates should NOT bring drawing sheets to the examination hall.

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COMMON SYLLABUS FOR ALL SUBJECTS FOR INTEGRATED PH.D.

ENGLISH COMMUNICATION (20 QUESTIONS)

1. Grammar
    - Subject – Verb Agreement
    - Tense forms
    - Voices
    - Articles and Preposition

Use of Conjunctions
2. Writing Technical Instructions
3. Writing Memos & Writing Minutes
4. Transcoding
5. Preparing Questionnaire
6. Proof Reading

SUBJECT SYLLABUS FOR ENTRANCE EXAMINATION FOR INTEGRATED PH.D.

CH – CHEMISTRY

Atomic Structure: Planck's quantum theory - wave particle duality - Heisenberg's principle - Schrodinger wave equation – particle in a box and hydrogen atom - VB and MO theories.
Spectroscopy: Rotational and vibrational spectra - harmonic anharmonic oscillator and Rigid Rotor - selection rules - fundamentals, overtones and combinational bands - calculation of force constants (diatomic molecules) - Group frequencies - electronic spectroscopy - potential energy diagram – term symbols - selection rules – L-S and J-J coupling – Frank Condon principle - oscillator's strength - effect of solvents on spectra.
Thermodynamics: Laws of thermodynamics – First law - second law - third law (terms and their relations). Chemical kinetics and equilibrium. Rate constant of chemical reactions, temperature dependence, collision and transition state theories - consecutive and parallel reactions - chemical equilibrium and response of chemical equilibrium to temperature and pressure.

d and f block elements: General characteristics of d and f block elements; Coordination chemistry; structure and isomerism; stability; theories of metal-ligand bonding (CFT and LFT); mechanisms of substitution and electron transfer reactions of coordination complexes. Electronic spectra and magnetic properties of transition metal complexes, lanthanides and actinides. Metal carbonyls, metal- metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis. Bioinorganic chemistry of Na, K, Mg, Ca, Fe, Co, Zn, Cu and Mo.
Solid State: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's law, ionic crystals, band theory, metals and semiconductors, different structures of AX, AX2, AX3 compounds, spinels.
Instrumental methods of analysis: Atomic absorption and emission spectroscopy including ICP-AES, UV-Visible spectrophotometry, NMR, Mass, Mossbauer spectroscopy (Fe and Sn), ESR spectroscopy, chromatography including GC and HPLC, electroanalytical methods (coulometry, cyclic voltammetry, polarography - amperometry, and ion selective electrodes). Structural determination of organic and inorganic compounds using UV-Visible, IR, NMR and mass spectroscopy.

Stereochemistry: Chirality of organic molecules with or without chiral centres. Specification of configuration in compounds having one or more stereogenic centres. Enantiotopic and dias tereotopic at oms, groups and faces . Stereospecific synthesis. Conformational analysis of acyclic and cyclic compounds. Geometrical isomerism. Configurational and co nformational effects on reactivity and selectivity / specificity.

Reaction Mechanism: Electrophilic and Nucleophilic substitution reactions in aliphatic and aromatic compounds and their mechanisms - Addition and Elimination reactions and their mechanisms - Reaction intermediates carbocations, carbanions, carbenes, nitrenes and free radicals.

Organic synthesis: Synthesis, reactions, mechanisms and selectivity involving the following - alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives, halides, nitro compounds and amines. Use of compounds of Mg, Li, Cu, B and Si in organic synthesis. Concepts in multistep synthesis - retrosynthetic analysis, disconnections, synthons, sy nthetic equivalents, umpolung in chemis tr y, selectivity, protection and deprotection of functional groups.

Heterocyclic compounds: Structure and reactions of furan, pyrrole, thiophene, pyridine, indole and their derivatives.

Biomolecules Structure, properties and reactions of mono- and disaccharides, physicochemical properties of amino acids, chemical synthesis of peptides, structural features of proteins, nucleic acids, steroids, terpenoids, carotenoids, and alkaloids.

CI – CIVIL ENGINEERING

STRENGTH OF MATERIALS & STRUCTURAL ANALYSIS

Strength of Materials: Bending moment and shear fo rce in s tatic ally determinate beams. Simple s t ress and s t rain relationship Stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle. Simple bending theory, flexural and shear stresses, unsymmetrical bending, shear centre. Thin walled pressure vessels, uniform torsion, buckling of column, combined and direct bending stresses.

Structural Analysis: Analysis of statically determinate trusses, arches, beams, cables and frames, displacements in statically determinate structures and analysis of statically indeterminate structures by force / energy methods, analysis by displacement methods (slope deflection method), influence lines for determinate and indeterminate structures. Basic concepts of matrix methods of structural analysis.

Reinforced Concrete Structures: Concrete Technology- properties of concrete, basics of mix design. Concrete design-basic working stress and limit state design concepts, analysis of ultimate load capacity and design of members subjected to flexure, shear, compression and torsion by limit state methods. Basic elements of pre-stressed concrete, analysis of beam sections at transfer and service loads.

Steel Structures

Analysis and design of tension and compression members, beams and beam columns, column bases. Connections simple and eccentric, beam-column connections, plate girders and trusses. Plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics

Origin of soils, soil classification, three - phase system, fundamental definitions, relationship and interrelationships, permeability and seepage, effective stress principle, consolidation, compaction, shear strength.

Foundation Engineering

Sub-surface investigations- scope, drilling bore holes, sampling, penetration tests, plate load test. Earth pressure theories, effect of water table, layered soils. Stability of slopes-infinite slopes, finite slopes. Foundation types foundation design requirements. Shallow foundations bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays. Deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays, negative skin friction.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics

Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations, pote ntial flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, flow in pipes, pipe networks. Concept of boundary layer and its growth. Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, flow measurements in channels, tanks and pipes . Dimensional analysis and hydraulic modeling. Kinematics of flow, velocity triangles and specific speed of pumps and turbines.

Hydrology

Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration. Crop water requirements. Design of lined and unlined canals, waterways, head works, gravity dams and spillways. Design of weirs on permeable foundation. Types of irrigation system, irrigation methods. Water logging and drainage, sodic soils.

ENVIRONMENTAL ENGINEERING

Water requirements: Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewe rage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment Unit operations and unit processes of domestic wastewater, sludge disposal.

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Municipal Solid Wastes: Characteris tics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

Noise Pollution: Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

TRANSPORTATION ENGINEERING

Highway Planning: Geometric design of highways, tes ting and specifications of paving materials, design of flexible and rigid pavements.

Traffic Engineering: Traffic characteristics, theory of traffic flow, intersection design, traffic signs and signal design, highway capacity.

LS – LIFE SCIENCES

Biophysics: Levels of structures in Biological macromolecules. Basic strategies in biophysics. Forces that determine protein and nucleic acid structure, Prediction of proteins structure nucleic acids, Properties of lipid bilayers, Biochemical Kinetics studies, unimolecular reactions, methods of determining macromolecular structures inclusive of the spectroscopic techniques like UV-vis absorption, IR absorption, circular dichroism fluoresence NMR and X-ray and neutron diffraction techniques.

Biochemistry: Structure and properties, Amino acids, peptides, proteins and conjugated proteins, protein hydration, coagulation, denaturation - gelation, protein-protein interactions, cytosolic and membrane properties, purines, pyrimidines, nucleosides, nucleotides, polynucleotides, Ri bonucleic acids and deoxyribonucleic acids, TCA cycle, glycolysis, pentose phosphate pathway, urea cycle, metabolic regulation, respiratory chain, TP cycle, energy rich compounds, integrated metabolism, Carbohydrates - linear and branched carbohydrates, N containing carbohydrates, cell wall carbohydrates, metabolism of carbohydrates, Fats and oils-structure and properties of saturated and unsaturated fatty acids, glycerolipids, phospholipids, sphingolipids, glycolipids, steroids, Vitamins and mineral-types, structure and functional properties of vitamins, utility of essential minerals sources and trace elements.

Biotechnology: Industrial biotechnology – Isolation; preservation and strain improvement for the overproduction of primary and secondary metabolites. Medium formulation, optimization and sterilization; biological waste treatment processes. Bioprocess- Types of reactors; volumetric oxygen mass transfer coefficient and its estimation; models for ideal and non-ideal flow. Downstream processing-Unit operations in downstream processing, cell disruptions method, solid liquid separation methods, precipitation methods, extraction methods, membrane based separation methods, different types of purification and chromatographic techniques.

Bioinformatics : Biological databases, File formats, sequence alignment, Database searches, phylogenetic tree construction and validation, Homology modeling, Drug discovery, DNA mapping and sequencing, sequence assembly and gene prediction, molecular predictions with DNA strings, Visualization tolls.

Cell Structure and Function of the Organelles: Eukaryotic and Prokaryotic cells, cell division, mitosis & meiosis cell cycle and molecules that control cell cycle, endocytosis and Exocytosis. Ultrastructure of cellular organelles, viz. Mitochondria, ER, Golgi, Chloroplast, plasma membrane, centriole, nuclear and membrane bound receptors, Signal Transduction, Signal Amplification Techniques of propagation of prokaryotic and Eukayotic cells, Autocrine, Paracrine and Endocrine models of action, Cell line, generation of cell lines.

Molecular Biology: Structure of DNA and histone molecules, Replication of eukaryotic chromosomes, nucleoid the complex replication apparatus, process of transcription and, Structure of tRNA, mRNA, rRNA, Deciphering of the genetic code, Translation, Mutation. General principles of cloning.

Recombinant DNA: Genetic elements that control gene expression, method of creating recombinant DNA molecules creating transgenic animals, plants microbes, safety guidelines of creating recombinant DNA research, restriction enzymes and mapping of DNA, plasmid and phage and other vectors. Construction of genomic and cDNA libraries, methods of nucleic acid. Patents and methods of application of patents, legal implications bioremediation.

Ecosystems, energy flow, ecological succession, pollution. Conventional and Non conventional sources of energy. Bio-geo chemical cycles. Biodiversity and wild life conservation. Social issues and the environment.

Genetics: Classical genetics, Mendel's genetics, crossing over, linkage, Chromosome maps, chromosomal theory of heredity, cytoplasmic inheritance, Sex determination, sex linked inheritance, microbial genetics, population genetics, polyploidy, pedigree analysis, eugenics, mutation.

Microbiology: Basic concepts of Microbiology, classification, morphology, anatomy, physiology of bacteria, viruses, fungi, parasite. Microbes of various plant and animal diseases. Industrial microbiology, Microbial biotechnology, Microbial diversity and ecology.

Immunology: Basic concepts of immunology, types of immunity, biotechnological applications; organs of immune, res ponse Innate and adaptive immunity, clonal selection theory, hypersensitivity, hybridoma technology, vaccine development, epitope mapping and immunomics, immunological tolerance and transplantation biotechnology.

Plant Sciences: Taxonomy and systematic botany, Plant structure and development, morphology and anatomy, embryogenesis of mono and dicots. Phytohormones, respiration, nutrition, transpiration. Photosynthesis, C3 and C4, & CAM plants, photoperiodism, concepts of ecosystems and energy flow in biosphere.

ME – MECHANICAL ENGINEERING

MATHEMATICAL FUNDAMENTALS

Algebra and Complex Analysis: Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Canonical forms, diagonal forms, triangular forms, Quadratic forms, reduction and classification of quadratic forms Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations—Fourier series—harmonics.

Calculus and its Applications: Linear ordinary differential equations (ODEs), variation of parameters, Sturm-Liouville problem. Partial differential equations (PDEs) - Classification of second order PDEs, General solution of

higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations. Transformation techniques—Laplace transformation—Fourier transforms—z—transformation to solve differential and difference equations.

Numerical Methods: Numerical solutions of algebraic and transcendental equations iteration methods and Newton—Raphson method, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods-Numerical differentiation and integration, Numerical solutions of ODEs and PDEs.

Descriptive statistics, Exploratory Data Analysis: Sample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate) - expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Standard discrete and continuous univariate distributions. Correlation and simple and multiple linear regression. Test of hypotheses—Large and small sample tests confidence intervals. Chi-square test goodness of fit. Simple non parametric tests for one and two sample problems, rank correlation and test for independence. ANOVA.

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; thermal stresses; Stress concentration factor; Fatigue Strength and S-N curve; failure theories.

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

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

Technical drafting: Engineering drawing practice; Indian standards for technical drawing. Machine Elements Basic concepts of machine elements and their design;

FLUID MECHANICS AND THERMAL SCIENCES

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

Heat-Transfer Modes of heat transfer; one dimensional heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, radiative heat transfer, black and grey surfaces, shape factors; 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.

Power Engineering: Steam Tables, Rankine, Bray ton cycles with regeneration and reheat. I.C. Engines, air-standard Otto, Diesel cycles. Stirling cycle.

Refrigeration and air-conditioning: Vapour refrigeration cycle, heat pumps, gas refrigeration, Re ve rse Bray ton cycle; moist air, psychrometric chart, basic psychrometric processes.

Turbo machinery: Pelton-wheel, Francis and Kaplan turbines, impulse and reaction principles, velocity diagrams.

MANUFACTURING AND INDUSTRIAL 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: 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;

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.

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning.

Inventory Control: Deterministic and probabilistic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

SOMECURRENT TRENDS IN DESIGN AND MANUFACTURING

Mechatronics System Design: Pneumatic and hydraulic systems; Eletro-pneumatic and electro-hydraulic systems; Pneumatic, hydraulic and electric motors and actutators; Concepts of microcontrollers, Feedback devices; Point-to-point, continuous-path and servo control; Types of CNC machines and robots. Programmable logic controllers; CNC and robot programming. Some current developments in modern machine tools, robotics, mechatronics; Basic topics related to micro-electro mechanical systems (MEMS).

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools. Exchange of product design and manufacturing data; CNC and robot programming methods. CAD/CAM Software and Virtual Product Development; Rapid Manufacturing Technologies; Concepts of Machine vision and Jigless manufacturing;

Computer Aided Engineering: Finite Element Methods; Computational Fluid Dynamics; Mechanical Systems Simulation; Tools for conventional mechanisms and MEMS design.

Automotive Engineering: Development in Bio-fuels, other alternative fuels and hydrogen as future fuel; Emission standards; Electronic injection systems; Passenger comfort and safety devices; Indian auto industry and Automotive vehicles in Indian market.

EE – ELECTRICAL AND ELECTRONICS ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

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, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

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

Analysis of complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution of integrals.

Probabi lity and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distributions, Correlation and regression analysis.

Numerical Methods: Matrix inversion, solutions of non-linear algebraic equations, iterative methods for solving differential equations, numerical integration, regression and correlation analysis.

Transform Theory: Fourier transform, Laplacetransform, Z-transform.

ELECTRICAL ENGINEERING

Electric Circuits: Voltage and current sources: independent, dependent, ideal and practical; v-I relationships of resistor, inductor, mutual inductor and capacitor; transient analysis of RLC circuits with dc excitation. Kirchoff's laws, mesh and nodal analysis, superposition, Thevenin, Norton, maximum power transfer and reciprocity theorems. Peak-, average– and rms values of ac quantities; apparent-, active– and reactive powers; phasor analysis, impedance and admittance; series and parallel resonance, locus diagrams, realization of basic filters with R, L and C elements. One-port and two-port networks, driving point impedance and admittance, open-, and short circuit parameters, Three phase circuits, Power and power factor in ac circuits.

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.

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.

Electrical Machines: Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Auto-transformer, Electromechanical energy conversion principles, DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Operating principle of single phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance, regulation and parallel operation of generators, starting of synchronous motor, characteristics; Types of losses and efficiency calculations of electric machines.

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, Gauss-Seidel 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.

Control Systems: Mathematical modeling and representation of systems, Feedback principles, transfer function, Block diagrams and signal flow graphs, transient response, steady-state-errors, Bode plot, phase and gain margins, Routh and Nyquist criteria, root loci, design of lead, lag and lead-lag compensators, state-space representation of systems; time-delay systems; mechanical, hydraulic and pneumatic system components, synchro pair, servo and stepper motors, servo valves; on-off, P, P-I, P-I-D, cascade, feed forward, and ratio controllers.

Electrical and Electronic Measurements: Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multimeters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

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.

Power Electronics and Drives: Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Issues of line current harmonics, Power factor, Distortion factor of ac to dc converters, Single phase and three phase inverters, Sinusoidal pulse width modulation.

EI – INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

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, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

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

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems,Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplacetransform, Z-transform.

INSTRUMENTATION ENGINEERING

Basics of Circuits and Measurement Systems: Kirchoff's laws, mesh and nodal Analysis. Circuit theorems. Oneport and two-port Network Functions. Static and dynamic characteristics of Measurement Systems. Error and uncertainty analysis. Statistical analysis of data and curve fitting.

Transducers, Mechanical Measurement and Industrial Instrumentation: Resistive, Capacitive, Inductive and piezoelectric transducers and their signal conditioning. Measurement of displacement, velocity and acceleration (translational and rotational), force, torque, vibration and shock. Measurement of pressure, flow, temperature and liquid level. Measurement of pH, conductivity, viscosity and humidity.

Analog Electronics: Characteristics of diode, BJT, JFET and MOSFET. Diode circuits. Transistors at low and high frequencies, Amplifiers, single and multi-stage. Feedback amplifiers. Operational amplifiers, characteristics and circuit configurations. Instrumentation amplifier. Precision rectifier. V-to-I and I-to-V co nverter. Op-Amp based active filters. Oscillators and signal generators.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions. IC families, TTL, MOS and CMOS. Arithmetic circuits. Comparators, Schmitt trigger, timers and mono-stable multi-vibrator. Sequential circuits, flip-flops, counters, shift registers. Multiplexer, S/H circuit. Analog-to-Digital and Digitalto- Analog co nverters. Basics of number system. Microprocessor applications, memory and input-output interfacing. Microcontrollers.

Signals, Systems and Communications: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first- and second order systems. Convolution, correlation and characteristics of linear time invariant systems. Discrete time system, impulse and frequency response. Pulse transfer function. IIR and FIR filters. Amplitude and frequency modulation and demodulation. Sampling theorem, pulse code modulation. Frequency and time division multiplexing. Amplitude shift keying, frequency shift keying and pulse shift keying for digital modulation.

Electrical and Electronic Measurements: Bridges and potentiometers, measurement of R, L and C. Measurements of voltage, current, power, power factor and energy. A.C & D.C current probes. Extension of instrument ranges. Q-meter and waveform analyzer. Digital voltmeter and multimeter. Time, phase and frequency measurements. Cathode ray oscilloscope. Serial and parallel communication. Shielding and grounding.

Control Systems and Process Control: Feedback principles. Signal flow graphs. Transient Response, steadystate- errors. Routh and Nyquist critera. Bode plot, root loci. Time delay systems. Phase and gain margin. State space representation of systems. Mechanical, hydraulic and pneumatic system components. Synchro pair, servo and step motors. On- off, cascade, P, P-I, P-I-D, feed forward and derivative controller, Fuzzy controllers.

Analytical, Optical and Biomedical Instrumentation: Mass spectrometry. UV, visible and IR spectrometry. X-ray and nuclear radiation measurements. Optical sources and detectors, LED, laser, photo-diode, photo-resistor and their characteristics. Interferometers, applications in metrology. Basics of fiber optics.

Biomedical instruments, EEG, ECG and EMG. Clinical measurements. Ultrasonictransducers and Ultrasonography. Principles of Computer Assisted Tomography.

EC – ELECTRONICS ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

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, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary Value problems, Partial DifferentialEquations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theor y: Fourier transform, Laplacetransform, Z-transform.

NETWORK

Network graphs: Matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods; nodal and mesh analysis. Network theorems; superposition, Thevenin and Nortan's, maximum power transfer, wye-delta transformation, steady state sinusoidal analysis using phasors, fourier series, linear constant coefficient differential and difference equations; time domain analysis of simple RLC circuits. Laplace and Z transforms: frequency domain analysis of RLC circuits, convolution,

2-port network parameters, driving point and transfer functions, state equation for networks.

ANALOG CIRCUITS: Characteristics and equivalent circuits (large and small signal) of diodes, BJT, JFETs and MOSFET simple diode circuits: clipping, clamping, rectifier, biasing and bias stability of transistor and FET amplifiers. Amplifiers: single and multi-stage,differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators: criterion for oscillation; single-transistor and op-ampconfigurations. Function generators and waveshaping circuits, Power supplies.

DIGITAL CIRCUITS: Boolean algebra; minimization of Boolean functions; logic gates; digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift- registers. Comparators, timers, multivibrators. Sample and hold circuits, ADCs and DACs. Semiconductor memories. Microprocessor (8085): architecture, programming, memory and I/O interfacing

CONTROL SYSTEMS: Basic control system components; block diagrammatic description, reduction of block diagrams, properties of systems: linearity, time-invariance, stability, causality. Open loop and closed loop (feedback) systems. Special properties of linear time-invariance (LTI) systems- transfer function, impulse response, poles, zeros, their significance and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI system and frequency response. Tools and techniques for LTI control system analysis: Root, loci, Routh_Hurwitz criterion, Bode and Nyquist plots; Control system compensators: elements of lead and lag compensations, elements of proportional-integral- Derivative (PID) control. State variable representation and solution of state equation for LTI systems.

COMMUNICATION SYSTEMS: Fourier analysis of signals - amplitude, phase and power spectrum, auto-correlation and cross-correlation and their Fourier transforms. Signal transmission through linear time-invariant (LTI) systems, impulse response and frequency response, group delay phase delay. Analog modulation systems-amplitude and angle modulation and demodulation systems, spectral analysis of these operations, super-heterodyne receivers, elements of hardware's realizations of analog communication systems. Basic sampling theorems. Pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM). Digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK). Multiplexing - time division and frequency division. Additive Gaussian noise; characterization using correlation, probability density function (PDF), power spectral density (PSD). Signalto- noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions.

ELECTROMAGNETICS: Elements of vector calculus: gradient, divergence and curl; Gauss and strokes theorems, maxwells equation: differential and integral forms. Wave equation. Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth Transmission lines:Characteristic impedence; impedence transformation; smith chart; impedence matching pulse excitation. Wave guides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas; Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

IT – INFORMATION TECHNOLOGY, COMPUTER & COMMUNICATION ENGINEERING

Engineering Mathematics

Mathematical Logic: Syntax of First Order Logic, Semantics of First Order Logic, a Sequent Calculus, the Completeness Theorem, the Limitations of First Order Logic.

Differential and Integral Calculus: Limit, Continuity, Differentiability, Leibniz theorem, Mean Value Theorems, Taylor's theorem, Integrals, Improper integrals, Total Differentiation, Partial derivatives ,Maxima and Minima, vector calculus, Linear differential equations.

Probability and Statistics: Probability, conditional probability, Baye's theorem, means, median, mode, moments, standard deviation. Random variables, Uniform, Binomial, Poisson, normal distributions, Correlation and regression, Sampling and Tests of significance.

Numerical Methods : Solutions to algebraic and transcendental equations (Bisection and Newton Raphson's methods), simultaneous linear algebraic equations (Gauss elimination, Crout's, Gauss seidel and relaxation), Interpolation methods (forward, backward and central), numerical integration (Trapezoidal, Simpson's and Weddle's) eigenvalues and eigenvectors, Numerical solutions to ordinary (Euler, modified Euler, Runga Kutta 4th order) and partial differential (parabolic, elliptic and Hyperbolic) equations.

Linear Algebra and Transforms: linear vector space, determinants, matrices, eigen values, eigen vectors, elements of complex analysis, Laplace transforms, Fourier analysis.

Algebra and Complex Analysis: Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Canonical forms, diagonal forms, triangular forms, Quadratic forms, reduction and classification of quadratic forms Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations—Fourier series—harmonics.

Calculus and its Applications: Linear ordinary differential equations (ODEs), variation of parameters, Sturm-Liouville problem. Partial differential equations (PDEs) - Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations. Transformation techniques—Laplace transformation—Fourier transforms—z—transformation to solve differential and difference equations.

Numerical Methods: Numerical solutions of algebraic and transcendental equations iteration methods and Newton—Raphson method, Solution of systems of linear algebraic equations using Gauss elimination and Gauss-Seidel methods-Numerical differentiation and integration, Numerical solutions of ODEs and PDEs.

Descriptive statistics, Exploratory Data Analysis: Sample space, discrete probability, independent events, Bayes theorem. Random variables and distribution functions (univariate and multivariate) - expectation and moments. Independent random variables, marginal and conditional distributions. Characteristic functions. Standard discrete and continuous univariate distributions. Correlation and simple and multiple linear regression. Test of hypotheses—Large and small sample tests confidence intervals. Chi-square test goodness of fit. Simple non parametric tests for one and two sample problems, rank correlation and test for independence. ANOVA.

Discrete Mathematics: Sets, relations and functions, algebra of matrices and determinants, algebraic structures, Boolean algebra and applications, order relations and structures, graph theory, logic and combinatorics.

Theory of Computation: Regular languages and finite automata, context free languages and Push down automata, recursively enumerable sets and Turing machines, undecidability.

Programming Language Processors: Compiler, Interpreter, assembler, Linker, Loader, Macro processors, phases of compilers, Lexical analysis, parsing, Top-down parsing and bottom up parsing, syntax directed translation, runtime environment, Symbol table, type checking, intermediate Code generation, Code optimization, code generation.

Algorithmic Analysis and Data Structures

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best , worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness, code and query tuning techniques, numerical analysis, power analysis & resiliency, intractable problems.

Algorithms for Problem Solving: Tree and graph traversal, connected components, spanning trees, shortest paths, hashing, sorting, searching, design paradigms (Greedy, dynamic programming, divide and conquer).

Data Structures: Notion of abstract data types, stack, Queue, List, set, string, Tree, binary search trees, heap, graph.

Computer Architecture & Organization and Operating Systems

Electronics: Network analysis, semiconductor devices, bipolar transistors, FET's, Power supplies, amplifier, Oscillators, Operational amplifiers, elements of digital electronics, logic circuits.

Digital Logic: Number systems and codes, Gates, TTL circuits, Boolean algebra and Karnaugh maps, Arithmetic logic units, Flip flops, registers and counters, Memories, Combinational and sequential logic circuits .

Computer Architecture and Organization: Machine instructions and addressing modes, ALU and data path, Register Transfer Language , hardware and micro programmed control, memory interface, RAM, ROM I/O interface (Interrupt and DMA modes), serial communication interface, instruction pipe-lining, Cache , main and secondary memory storage, organization and structure of disk drives, RAID architectures Microprocessors: 8085, 8086, Interfacing and memory addressing.

Operating Systems: Memory management, page faults, overlay, processor management, device management, deadlocks, Process, thread and inter process communication, CPU scheduling, file systems, I/O systems, protection and security.

Software Engineering and Programming

System & Program Development Methodology : Software paradigms, principles of programming in any language, documentation, system analysis and design methodologies, User Interface Design (UID), software construction, software testing, software quality, Object Oriented Analysis and Design (OOAD) concepts.

Programming Methodology: Introduction to programming, pointers, arrays, control structures, Iterational control structures, functions, recursion, testing, debugging, code review, structures, files (C, C++, JAVA).

Computer Networks & Data Communications: Analog versus Digital communication, modems, multiplexers, and concentrators, serial versus parallel communication, simplex, duplex, and half duplex communication, synchronous and asynchronous communication, Error detection/correction methods, data link control protocols, balanced and unbalanced interfaces, communication media, ISO/OSI stack, Sliding window protocol, LAN Technologies (Ethernet, Token ring) , TCP/UDP, IP, switches, gateways, and routers.

Computing Technologies: Client server computing, Logical layers in client server architecture, Two-tier versus Three-tier, Distributed computing, Middle-ware, Mobile Computing, Cloud Computing.

Databases Management Systems: Data, database and DBMS, Data dictionary/directory, schema, description of database structure, forms of DBMS systems, Hierarchical, network and RDBMS, DDL, DML , stored data

structure language and query language, Recent trends in database management systems, Memory management techniques used in computers, query languages (SQL), file structures (sequential files, indexing, B* trees) Transactions and concurrency control, Basic concepts of transaction processing , ACID properties of transactions, serializability of transactions, concurrency control, recovery, OLAP.

PH – PHYSICS

Mathematical Physics: Fourier series - Fourier transform - properties – convolution theorem - Application to solve differential equations - Laplace 's transform - properties -application to ordinary and partial differentialequations-Cayley Hamilton Theorem - Eigen value problems

Classical Mechanics: Conservation laws; Variational principle; Lagrange's and Hamilton's formalisms; equation of motion, poisson bracket; special theory of relativity – Larentz transformations, relativistic kinematics, mass – energy equivalence.

Spectroscopy: Atomic and Molecular Physics: Spectra of one – and many – electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomicmolecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR

Electro Magnetic Theory: Faraday's laws of induction - Maxwell's displacement current - Maxwell's equations - vector and scalar potentials - Gauge invariance - wave equation and plane wave solutions - Coulomb and Lorentz Gauges - energy and momentum of the field - Poynting's theorem.

Quantum Mechanics: Time Independent and Time Dependant Schrodinger wave equations, Justification of Schrodinger equation – the Schrodinger receipe - probabilities and normalization - Applications - particle in a box - simple harmonic oscillator – Dirac relativistic equations.

Statistical Mechanics: Equation of state - gas degeneracy - Bose-Einstein condensation - thermal properties of Bose-Einstein gas -liquid Helium-Tisza's two fluid model-Landau's theory of liquid Helium II-Black body radiation- phonons- Einstein and Debye models for lattice specific heat.

Experimental Design: Measurement of fundamental constants e, h, c - Measurement of High & Low Resistances, L and C - Detection of X-rays, Gamma rays, charged particles, neutrons etc - Ionization chamber - proportional counter - GM counter - Scintillation detectors - Solid State detectors - Measurement of Magnetic field - Hall effect, magnetoresistance - X-ray and neutrondiffraction - Vacuum Techniques - basic idea of conductance, pumping speed etc - Pumps - Mechanical pump - Diffusion pump - Gauges Thermocouple - Penning - Pirani - Hot Cathode - Low Temperature - Cooling a sample over a range upto 4 K and measurement of temperature.

Lasers: Ruby laser - Nd - YAG laser - colour centre lasers – Helium - Neon laser - Carbondioxide laser - excimer lasers – liquid dye laser - semiconductor lasers - Homojunction laser - Heteorjunction laser - Quantum well laser.

Nonlinear Fiber Optics: Introduction - Second harmonic generation (SHG) - optical mixing - phase matching - Third harmonic generation (THG) - parametric generation of light - Optical parametric oscillator - self-focussing of light.

Solid State Physics: Types of lattices - Miller indices - Simple crystal structures - Crystal diffraction - Bragg's law - Reciprocal Lattice (BCC, FCC) - Brillouin zone - Structure factor – Atomic form factor - Cohesive energy of ionic crystals – Madelung constant - Types of crystal binding.

Materials Science: Phase diagram - phase rule - single component system - binary phase diagram - microstructural changes during cooling - Lever rule - Magnesia - Alumina system – Copper - Zinc system -Iron - Carbon

system - Applications of phase diagram.

Electronics: Semiconductor devices; Bipolar junction Transistors, Field effect Transistors, amplifier and oscillator circuits; operational amplifier, negative feedback circuits, active fillers and oscillators; basic digital logic circuits, sequential circuits, flip-flops, counters, registers, A/D and D/A Conversion.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces; Linear transformations and their matrix representations, rank; systems of linear equations, eigen values and eigen vectors, minimal polynomial, Cayley-Hamilton theroem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices; 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 Taylor and Laurent's series; residue theorem and applications for evaluating real integrals.

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's, Stokes and Gauss. Metric spaces, completeness, Weierstrass approximation theorem, compactness; Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

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.

Algebra: Normal subgroups and homomorphism theorems, automorphisms; Group actions, Sylow's theorems and their applications; Euclidean domains, Principle ideal domains and unique factorization domains. Prime ideals and maximal ideals in commutative rings; Fields, finite fields.

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

Analysis: Numerical solution of algebraic and transcendental equations: bisection, secant method, Newton-Raphson method, fixed point iteration; interpolation: error of polynomialinterpolation, Lagrange, Newton interpolations Numerical differentiation; numerical integration: Trapezoidal and Simpsons's rules, Gauss Legendre quadrature, method of undetermined parameters; least square polynomial approximation; numerical solution of systems of linear equations: direct methods (Gauss elimination, LU decomposition); iterative methods (Jacobi and Gauss-Seidel); matrix eigenvalue problems: power method. Numerical solution of ordinary differential equations: initial value problems, Taylor series methods, Euler's method, Runge-Kutta methods.

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

Mechanics: Virtual work, Lagrange's equations for holonomic systems, Hamiltonian 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, moments; Weak and strong law of large numbers, central limit theorem sampling distributions, UMVU estimators, maximum likelihood estimators, testing of hypotheses, standard parametric tests based on normal, c^2, t, F- distributions; Linear regression; Interval estimation.

Linear programming: Linear programming problems and its formulation, convex sets and their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods; infeasible and unbounded LPP's, alternate optima Dual problem and duality theorems, dual simplex method and its application in post optimality analysis; Balanced and unbalanced transportation problems, Hungarian method for solving assignment problems.

Calculus of Variation and Integral Equations: Variation problems with fixed boundaries; Sufficient conditions for extremum, linear integral equations of Fredholm and Volterra type, their iterative solutions.

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