VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

VITREE

VIT Research Entrance Examination

JANUARY - 2024 Session

SYLLABUS

Admission to Research Programmes

Ph.D. / Direct Ph.D.

VIT - A place to learn; A chance to grow

VITREE- January 2024 Session

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COMMON SYLLABUS FOR ALL SUBJECTS (Ph.D.)

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).

TECHNICAL (70 QUESTIONS)

Technical 70 questions from the respective syllabus of the subject

SUBJECT SYLLABUS FOR ENTRANCE EXAMINATION (Ph.D.)

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 ofdetailed 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.

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.

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

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 fieldsand 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 ondifferent 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-atmospheresystem, 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.

GPY – GEOGRAPHY

Geomorphology: Continental Drift, Plate Tectonics; Physical and Chemical Weathering; Geomorphic Cycle (Davis and Penck); Earth Movements (seismicity, folding, faulting and vulcanicity); Landform Occurrence and Causes of Geomorphic Hazards (earthquakes, volcanoes, landslides and avalanches)

Climatology: Composition and Structure of Atmosphere; Insolation, Energy Budget; Temperature; Pressure and Winds; Atmospheric Circulation (air-masses, fronts and upper air circulation, cyclones and anticyclones (tropical and temperate); Climatic Classification of Koppen & Thornthwaite; ENSO Events (El Nino, La Nina and Southern Oscillations); Meteorological Hazards and Disasters (Cyclones, Thunderstorms, Tornadoes, Heat and Cold waves Drought, Glacial Lake Outburst (GLOF); Climate Change: Evidences and Causes of Climatic Change in the past, Human impact on Global Climate.

Oceanography: Relief of Oceans; Composition: Temperature, Density and Salinity, Circulation; Warm and Cold Currents; Waves, Tides, Sea Level Changes; Hazards: Tsunami, Cyclones

Environmental Geography: Concept of Ecosystem, Ecosystem Structure, (Components, Trophic Structure, Ecological; Pyramid, Food Chain, Food Web, Ecological Pyramid, and Keystone Species); Ecosystem Function (Energy Flow in ecosystem, Biogeochemical cycles such as carbon nitrogen and oxygen cycle, Gross and Net productivity); Environmental Ethics and Deep Ecology; Environmental Hazards and Disasters (Global Warming, Urban Heat Island, Atmospheric Pollution, Water Pollution, Land Degradation); National Programmes and Policies: Legal Framework, Environmental Policy, International Treaties, International Programmes and Polices (Brundtland Commission, Kyoto Protocol, Agenda 21, Sustainable Development Goals, Paris Agreement)

Settlement Geography: Rural Settlements (types, patterns and distribution); Contemporary Problems of Rural Settlements (rural-urban migration; land use changes; land acquisition and transactions); Theories of Origin of Towns (Gordon Childe, Henri Pirenne, Lewis Mumford); Characteristics and Processes of Urbanization in Developed and Developing Countries (factors of urban growth, trends of urbanisation, size, structure and functions of urban areas); Urban Systems (the law of the primate city and rank size rule), Central Place Theories (Christaller and Losch); Models of Urban Land Use (Burgess, Harris and Ullman and Hoyt); Concepts of Megacities, Global Cities and Edge Cities; Changing Urban Forms (peri-urban areas, rural-urban fringe, suburban, ring and satellitetowns); Social Segregation in the City; Manifestation of Poverty in the City (slums, informal sector growth, crime and social exclusion).

Population Geography: Demographic Transition; Theories of Population Growth (Malthus, Sadler, and Ricardo); Fertility and Mortality Analysis (indices, determinants and world patterns); Migration (types, causes and consequences, Ravenstein's laws of migration, models); Population Composition and Characteristics (age, sex, rural-urban, occupational structure and educational levels); Population Policies in Developed and Developing Countries.

Geography of India: India's location and its frontiers; India's political divisions; Physiographic divisions: Northern Mountains, Northern plains, Peninsular plateau, Coastal plains, and Islands; Drainage System (Himalayan and Peninsular); Climate: Seasonal Weather Characteristics, Climatic Divisions, Indian Monsoon (mechanism and characteristics), Jet Streams and Himalayan Cryosphere; Types and Distribution of Natural Resources: Soil, Vegetation, Water, Mineral and Marine Resources; Population Characteristics (spatial patterns of distribution), Growth and Composition (rural-urban, age, sex, occupational, educational, ethnic and religious), Determinants of Population, Population Policies in India; Agriculture (Production, Productivity and Yield of Major Food Crops), Major Crop Regions, Regional Variations in Agricultural Development, Environmental, Technological and Institutional Factors affecting Indian Agriculture; Agro-Climatic Zones, Green Revolution, Food Security and Right to Food; Industrial Development since Independence, Industrial Regions and their characteristics, Industrial Policies in India; Development and Patterns of Transport Networks (railways, roadways,

waterways, airways and pipelines); Internal and External Trade (trend, composition and directions); Regional Development Planning in India, Globalisation and its impact on Indian Economy; Natural Disasters in India (Earthquake, Drought, Flood, Cyclone, Tsunami, Himalayan Highland Hazards and Disasters).

Geographic Thought: Contributions of Greek, Roman, Arab, Chinese and Indian Scholars; Contributions of Geographers (Bernhardus Varenius, Immanuel Kant, Alexander von Humboldt, Carl Ritter, Scheafer & Hartshorne); Impact of Darwinian Theory on Geographical Thought; Contemporary trends in Indian Geography: Cartography, Thematic and Methodological contributions; Major Geographic Traditions (Earth Science, man-environment relationship, area studies and spatial analysis); Dualisms in Geographic Studies (physical vs. human, regional vs. systematic, qualitative vs. quantitative, ideographic vs. nomothetic); Paradigm Shift; Perspectives in Geography (Positivism, Behaviouralism, Humanism, Structuralism, Feminism and Postmodernism).

Cultural and Social Geography: Concept of Culture, Cultural Complexes, Areas and Region, Cultural Heritage, Cultural Ecology. Cultural Convergence; Social Structure and Processes; Social Well-being and Quality of Life; Social Exclusion; Spatial distribution of social groups in India (Tribe, Caste, Religion and Language); Environment and Human Health,Diseases Ecology, Nutritional Status (etiological conditions, classification and spatial and seasonal distributional patterns with special reference to India); Health Care Planning and Policies in India, Medical Tourism in India.

Geographical Techniques: Sources of Geographic Information and Data (spatial and non-spatial); Types of Maps, Techniques of Map Making (Choropleth, Isarithmic, Dasymetric, Chorochromatic, Flow Maps); Data Representation on Maps (Pie diagrams, Bar diagrams and Line Graph; GIS Database (raster and vector data formats and attribute data formats); Functions of GIS (conversion, editing and analysis); Digital Elevation Model (DEM), Georeferencing (coordinate system and map projections and Datum); GIS Applications (thematic cartography, spatial decision support system); Basics of Remote Sensing (Electromagnetic Spectrum, Sensors and Platforms, Resolution and Types, Elements of Air Photo and Satellite Image Interpretation and Photogrammetry); Types of Aerial Photographs, Digital Image Processing: Developments in Remote Sensing Technology and Big Data Sharing and its applications in Natural Resources Management in India; GPS Components (space, ground control and receiver segments) and Applications.

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, IR 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, TPcycle, 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, methodsfor 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.

SLS – LIFE SCIENCES

Biophysics: Biophysics fundamentals and principles, prediction of proteins and nucleic acid structures, biochemical kinetics, methods in biophysics (Spectroscopy-UV-vis, IR, circular dichroism, fluorescence and NMR, and diffraction-X-ray and neutron diffraction).

Biochemistry: Structural properties, metabolism and biological importance of nucleic acids, proteins, lipids, carbohydrates and vitamins. Metabolic pathways and regulation (TCA cycle, glycolysis, pentose phosphate pathway, urea cycle, respiratory chain, ATP cycle), structural properties and functions of enzymes in biological systems.

Biotechnology: Fundamentals of Industrial biotechnology, bioprocess technology, upstream & downstream processing (unit operations, separation and purification techniques), instrumentation and process control, IPR in biotechnology.

Bioinformatics: Biological databases, file formats, sequence alignment, phylogenetic tree construction and validation, homology modeling, drug discovery, different visualization tools.

Cell Structure and Function of the Organelles: Eukaryotic and prokaryotic cells, cell membrane structure and functions, cell division, cell cycles (mitosis & meiosis), endocytosis and e xocytosis, ultrastructure of cellular organelles, receptors and signal transduction pathways.

Molecular Biology: Structure of DNA and histones, replication of prokaryotic and eukaryotic chromosomes, DNA damage and repair, mutation, transcription, translation and post translational modifications- processes, mechanism and biological significance.

Recombinant DNA Technology: Genetic elements that control gene expression, methods of creating recombinant DNA molecules (transgenic plants, animals, and genetically engineered microbes), safety guidelines for recombinant DNA technology, principles, applications and techniques in gene isolation, cloning, and expression.

Genetics: Classical genetics, Mendelian genetics, crossing over, linkage, chromosome maps, chromosomal theory of heredity, cytoplasmic inheritance, sex determination, sex-linked inheritance, epigenetics and RNA silencing, microbial genetics, and population genetics.

Microbiology: Basic concepts of microbiology- classification, morphology, physiology of microorganisms and microbial ecology, microbes of various plant and animal diseases, food microbiology.

Immunology: Basic concepts of immunology, clonal selection theory, hypersensitivity, hybridoma technology, vaccine development, epitope mapping and immunomics, immunological tolerance and transplantation immunology.

Plant and Environmental Sciences: Taxonomy and systematic botany, plant structure and development, morphology and anatomy, embryogenesis of monocots and dicots. Phytohormones, photosynthesis and respiration, nutrition, transpiration, plant tissue culture- fundamentals and principles. Molecular markers and gene editing tools (TALEN, ZFN, CRISPR/Cas9). Bio-geo chemical cycles, ecosystems, energy flow, ecological succession, global environmental issues, bioremediation, environmental auditing, environmental impact assessment, alternative energy, environmental carbon footprint, climate events, legislations on environment, forest and wildlife, biodiversity and conservation biology.

Zoology and Physiology: Blood and circulatory system, cardiovascular system, respiratory and nervous system, animal physiology, endocrinology, developmental biology and reproduction, animal behavior, phylogeny, and evolution.

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 ofbeams 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.

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.

CIE— COMPUTER SCIENCE AND ENGINEERING / INFORMATION TECHNOLOGY

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.

ELE—ELECTRICAL AND ELECTRONICS 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 speedcontrol; 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.

EIE - ELECTRONICS AND 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.

ECE— ELECTRONICS AND COMMUNICATION 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 andboundary 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 designtechniques.

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.

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 dataand 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.

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 topicsrelated 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.

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).

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.

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—SOCIOLOGY

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

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.

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.

சிறப்பு – வாழும்மொழி – பன்னாட்டு மொழி – கணினி மொழி.

அலகு–6: செம்மொழித் தமிழ்

செம்மொழி வரலாறு – காரணங்கள் - உயர்தனிச்செம்மொழி – தொன்மைச்சிறப்பு – தலைமைச் சிறப்பு – செவ்வியல்

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.

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 Sameeksha 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.

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

HIS – HISTORICAL STUDIES

Unit: 1 History of India: Comprehensive knowledge of Indian history, including ancient, medieval, and modern periods. Ancient India: Prehistoric to the end of the Mauryan Empire. Medieval India: From the Gupta period to the Mughal Empire. Modern India: From the British East India Company to the Indian Independence movement.

Unit: 2 World History: Major historical events: Including but not limited to ancient civilizations, the Renaissance, Industrial Revolution, World Wars, and the Cold War. Global perspectives: Understanding the interconnectedness of historical events and their impact on different regions of the world.

Unit: 3 Historiography and Research Methodology: Historical methods: Learning about various historical research methodologies, such as empirical, comparative, and interdisciplinary approaches. Theories and approaches: Understanding the evolution of historical theories and approaches, like Marxist history, post colonialism, and feminist historiography. Archival research: Learning how to access and analyse historical documents in archives. Primary source analysis: Developing skills to critically evaluate primary sources. Historiographical research: Understanding the existing historiography in a given field of study.

Unit: 4 Regional History: Specialized regions: Focusing on specific regions of historical significance, which could include South Asian history, Southeast Asian history, East Asian history, European history, Comparative analysis: Examining the unique historical developments and cross-cultural interactions in these regions.

Unit: 5 Historical Documents: Familiarity with significant documents: Studying primary sources like treaties, manuscripts, letters, and oral histories relevant to historical research. Contemporary Relevance: Analysing the modern-day implications and interpretations of historical events and processes. Understanding how historical narratives can influence contemporary debates and policies. Historians and Their Works: Prominent historians: Studying the works and contributions of key historians in various historical periods and regions. Their impact on historical scholarship: Recognizing how these historians shaped the field of historical studies.

INR – INTERNATIONAL RELATIONS

Unit 1 Introduction to International Relations: Theories of International Relations: Realism - Classical Realism: Neorealism (Structural Realism), Liberalism. Constructivism: - Norms and Identity - Social Constructivism - Historical Development of International Relations: Pre-20th Century Theories: Thinkers like Thucydides, Machiavelli, and Grotius; Emergence of International Relations as a Field: Influential scholars and early schools of thought; Post-World War II Developments: The impact of the Cold War on the field.

Unit 2 International Political Economy and Security Studies: Trade Theories and Policies - Absolute and Comparative Advantage - Tariffs, Trade Agreements, and Trade Blocs. International Financial Systems: Role of International Monetary Fund (IMF) and World Bank. Globalization and Its Impacts: Economic Globalization:

Trade, investment, and economic interdependence; Political and Cultural Aspects: Spread of ideas, technology, and cultural exchange.Theories of Security: Balance of Power - Deterrence and Nuclear Strategy: Mutually Assured Destruction (MAD) and deterrence theory. Conflict Resolution and Peacekeeping - Mediation and Diplomacy - Peacekeeping Missions - Nuclear Proliferation and Arms Control: Non-Proliferation Treaty (NPT) and its significance, Arms Control Treaties.

Unit 3 International Organizations and Institutions: United Nations and Its Agencies: Structure of the UN: General Assembly, Security Council, and specialized agencies. Peacekeeping and Conflict Resolution: The UN's role in addressing international conflicts. Humanitarian Efforts: UNICEF, UNHCR, and humanitarian aid programs. Regional Organizations: European Union (EU) - ASEAN and SAARC - African Union (AU).

Unit 4 Comparative Foreign Policy Analysis: Foreign Policy Decision-Making Processes: Rational Actor Model: Analysing foreign policy decisions based on national interests. Bureaucratic Politics Model: The role of government agencies and bureaucratic processes. Case Studies of Different Countries' Foreign Policies - Comparative analysis of foreign policy strategies, challenges, and outcomes.

Unit 5 Global Issues and Challenges: Human Rights and Humanitarian Intervention: Climate Change and Environmental Diplomacy - International negotiations on climate goals and adaptation measures. Terrorism and Counterterrorism: Roots and causes of terrorism; Counterterrorism strategies, intelligence-sharing, and international cooperation.

Unit 6 Contemporary Issues in International Relations: Emerging Powers in International Politics: Rise of China, India, Brazil, and other emerging powers; Their influence on global politics, trade, and regional dynamics. Cybersecurity and Information Warfare: Cyber threats, state-sponsored attacks, and the role of non-state actors; International norms and treaties related to cyberspace. Migration and Refugee Crises: Causes and consequences of mass migration and displacement; International responses, refugee conventions, and humanitarian efforts.

Unit 7 Area Studies: Regions: South Asia, Southeast Asia, East Asia, and the Pacific: Historical and contemporary dynamics in each region. Regional institutions, conflicts, and security challenges. Economic, political, and cultural interactions with the rest of the world.

MGT— BUSINESS ADMINISTRATION IN 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 usiness 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.

VSD-DESIGN

VITREE (VSIGN) 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 analyses 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) may not cover all the topics.

Part-B

Part-B of VITREE (VSIGN) 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) is an aptitude test and hence, no specific text book or guide is recommended for its preparation. Candidates may however practice 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.

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.

ABM—AGRI BUSINESS MANAGEMENT

Basic Concepts of Management, Insights About Organizational Behavior, Organisational Dynamics. Managerial Accounting and Control-Financial Accounting, Managerial Accounting, Cost Accounting. Applied Agribusiness Economics-Overview of Managerial Economics, Production, Cost and Supply Analysis, Macroeconomics. Human Resource Management for Agricultural Organisations Introduction to Human Resource Management, Industrial Relations, Ethical And Global Issues In HRM.

Production and Operations Management-Introduction to Production and Operations Management, Inventory Management, Quality Management. Agricultural And Food Marketing Management-Overview Of Marketing Management, Pricing Decisions, Channel Management and Physical Distribution, Marketing Communications, Agricultural and Food Marketing, Market Liberalisation, Marketing Strategy, Planning and Control, New Product Development, Commodity Marketing.

Agri Supply Chain Management- Overview of Supply Chain Management, Procurement Management in Agri. Supply Chain, Logistics Management, IT Application in SCM. International Trade in Agricultural Products-Introduction to International Trade, Regulations and Policy Measures for International TRADE.

Food Technology and Processing Management-Food Technology, Processing Management, Food Safety and Costs Analysis. Rural Marketing-Rural Marketing Environment, Rural Marketing Strategy. Fertilizer Technology and Management-Fertilizer Production, Testing and Field Trials. Management of Agro Chemical Industry-Agro Chemicals, Insecticide Act and Plant Protection. Seed Production Technology Management-Seed Technology, Seed Management, Seed Marketing. Technology Management for Livestock Products-Livestock Product and Technology, TQM and Marketing of Livestock Products. Fruit Production and Post-Harvest Management-Fruit Production, Post-Harvest Management, Marketing of fruits. Farm Power and Machinery Management-Farm Power And Machinery, Agricultural Equipment Industry and Cost Analysis of Operations.

Food Retail Management-Retail Marketing Strategy. Management of Agricultural Input Marketing-Marketing of Agricultural Inputs, Marketing of fertilizers, pesticides, tractors. Feed Business Management-Feed Preparation and Distribution. Management of Veterinary Hospitals-: Information System & Quality Control. Poultry and Hatchery Management-Hatcheries and Risk Management. Management of Floriculture and Landscaping-Landscaping and Trading. Dairy Business Management- Dairy Business Strategy. Renewable Energy Sources Management-Institutional Framework and Types. Agri Infrastructure and Warehousing Management,

Quality Management for Agribusiness-Quality Grades, Standards and Control. Risk Management in Agri Business-Risk Management Process, Banking Operations and Risk Management. Management of Agribusiness Cooperatives-Cooperative Movement and Management. Business Analytics for Agriculture-Machine and Deep Learning. Agri Extension Management-Cyber Extension, Implications and Contemporary Issues, Market – Led Extension, Agri-Commodity Markets and Futures Trading Farmer - Led Extension, Concept of Farm Field School, Farm School, Public - Private Partnership. Contract Farming-Policies, Prospects And Global Issues, Human Resource Competence and Capacity Building System, Strategic Management for Agri Business Enterprises, Operations Management, Communication for Management and Business, Research Methodology for Agri Business Management-: Use of Software for Statistical Analysis. Project Management and Agribusiness Entrepreneurship, Agri Business Laws and Ethics, Advertising and Brand Management-Branding Decision, Managing Brand Equity and Loyalty.

AGR—AGRONOMY

Current trends in agronomy; agro-physiological basis of variation in yield, recent advances in soil plant-water relationship, Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, ITK, crop residue management, Mechanization in crop production, modern agricultural precision tools and technologies, allelopathy, GIS, GPS and remote sensing for crop management, global warming, GM crops, dryland farming, classifications and evaluation indices, sustainable and conservation agriculture.

Recent trends in crop growth and productivity; Growth analysis and PAR, root-shoot relationship in inter and mixed cropping systems under rainfed and irrigated conditions. Criteria in assessing the yield advantages.

Irrigation management; global water resources; water deficits and crop growth. SPAC, WUE, Irrigation scheduling and crop water requirement, recent advances in micro irrigation, economic analysis of irrigation, crop water production function, drainage methods and its management.

Recent trends in weed management; Crop-weed association and competition, weed management methods, herbicides biology, classifications, persistence and residue management. Herbicide resistant mechanism and tolerance in crops and site-specific precision weed management. Integrated farming Systems for sustainable agriculture;

Cropping and farming systems approach, cropping scheme, plant ideotypes, IFS models, components and evaluation. Resource recycling and energy analysis. Soil conservation and watershed management; Soil erosion and its impacts, In-situ and ex-situ soil water conservation techniques, watershed management and development programme, Land use capability classification, ALUS; agro-forestry; ley farming and grassland management. Stress crop production; Stress and strain terminology, nature and stress injury and resistance; causes of stress. Low and high temperature stress, water deficit temperature Excess water or flooding stress, Salt stress and its management. Mechanical impedance of soil and its impact on plant growth. Research methodologies in agronomy.

PBG—PLANT BREEDING AND GENETICS

PART-I (General Agriculture)

GENERAL AGRICULTURE Importance of Agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, pigeon pea, sugarcane, tomato, cauliflower, mango and rose.

Weathering of rocks; soil formation, major soils of India, soil erosion and its control; common farm implements; role of NPK and their deficiency symptoms; manures (FYM, compost and green manure) and fertilizers (urea, di-ammonium phosphate, single superphosphate and muriate of potash).

Structure and function and cell organelles - mitosis and meiosis; gametogenesis, fertilization and embryogenesis; chromosomal and extra-chromosomal basis of inheritance; mutation and polyploidy; selection methods, hybridization, backcross; plant growth regulators; elementary knowledge of photosynthesis, respiration and nitrogen fixation.

Isomerism; titrimetry and volumetry; structure and function of carbohydrates, proteins, nucleic acids, enzymes and vitamins.

Major pests and diseases of rice, maize, pulses, oilseeds, vegetables, wheat, cotton, sugarcane and their management.

Important principles of economics, structural transformation in economy and its globalization; principles of extension education; important rural development programmes in India; organizational set up of agricultural research, education and extension in India, elements of statistics.

Part II

Genetics: Structure and function of cell and cell organelles, cell cycle; mitosis and meiosis; nucleic acids their structure; Mendelian principles; chromosome structure and organization; types of chromosomes; chromosome function; linkage and crossing over and gene mapping in theories and molecular mechanism; recombination diploids, fungi, bacteria, and human; ploidy variations euploids and aneuploids; chromosomal aberrations; extrachromosomal inheritance; gene mutation mechanism, induction; gene concept; complementation, genetic fine structure; genetic code, information transfer and protein synthesis, gene regulation and gene

manipulation; gene transfer technology; origin and evolution of important crop plants like wheat, rice, maize, sugarcane, potato, brassica, cotton, etc.

Genetic basis of plant breeding; pure line selection; male sterility and incompatibility and their use in plant breeding; pedigree selection, mass selection and backcross method of selection; heterosis; plant introduction and exploration and their role in plant breeding; breeding for disease, insect and pest resistance; role of interspecific and intergeneic hybridisation; population improvement procedures; recurrent selection techniques; combining ability and its relationship with the components of gene action; seed production techniques; selection met hods and changes in gene frequencies; mutation and its role in breeding; use of biotechnology in plant breeding. Molecular markers and their applications in genetic analysis and plant breeding.

ABT—AGRICULTURAL BIOTECHNOLOGY

PART-I (General Agriculture)

GENERAL AGRICULTURE Importance of Agriculture in national economy; basic principles of crop production; cultivation of rice, wheat, pigeon pea, sugarcane, tomato, cauliflower, mango and rose.

Weathering of rocks; soil formation, major soils of India, soil erosion and its control; common farm implements; role of NPK and their deficiency symptoms; manures (FYM, compost and green manure) and fertilizers (urea, di-ammonium phosphate, single superphosphate and muriate of potash).

Structure and function and cell organelles - mitosis and meiosis; gametogenesis, fertilization and embryogenesis; chromosomal and extra-chromosomal basis of inheritance; mutation and polyploidy; selection methods, hybridization, backcross; plant growth regulators; elementary knowledge of photosynthesis, respiration and nitrogen fixation.

Isomerism; titrimetry and volumetry; structure and function of carbohydrates, proteins, nucleic acids, enzymes and vitamins.

Major pests and diseases of rice, maize, pulses, oilseeds, vegetables, wheat, cotton, sugarcane and their management.

Important principles of economics, structural transformation in economy and its globalization; principles of extension education; important rural development programmes in India; organizational set up of agricultural research, education and extension in India, elements of statistics.

Part – II (Subject Paper)

Structure and organization of prokaryotic and eukaryotic cells; organization and expression of prokaryotic and eukaryotic genome; concept of gene; quantitative trait loci, mutation; genetic recombination; transformation; transduction; conjugation; structure, function and regulation of genes in pro- and eukaryotes; transcription and translation; recombinant DNA, restriction enzymes, vectors, plasmids, cosmids and bacteriophages, expression vectors, cloning strategies, construction and screening of genomic and cDNA libraries, nucleic acid hybridisation and DNA sequencing; restriction fragment length polymorphism; monoclonal antibodies and their application; enzyme engineering; genetic transformation of eukaryotes; crop improvement through genetic engineering; role of tissue culture in crop improvement; microbes in agriculture and industry; structure and function of proteins, nucleic acids, carbohydrates, lipids, enzymes; metabolism, glycolysis, citric acid cycle; respiration, bioenergetics; nucleic acid and protein biosynthesis; photosynthesis, nitrogen fixation.

Biotransformation and biodegradation; Biofertilizers; Biosensors – living biosensors for the management and manipulation of microbial consortia; Role of biotechnology in energy production. Major bioinformatics resources (NCBI, EBI, ExPASy); Sequence and structure databases and analysis, Sequence analysis, Phylogeny, Comparative genomics; Molecular modeling and simulations. Overview and functions of a computer system; Basics of database management system.

Microbial genetics; Microbial production and purification of fermented food and food products, recombinant proteins, industrial enzymes; Free and immobilized enzyme kinetics; Types of bioreactors; Bioseparation techniques.

AET—AGRICULTURAL ENTOMOLOGY

History and development of Entomology, Evolution of insects, position of insects in the animal kingdom, characteristics of phylum Arthropoda, structural features of important arthropod groups. Classification of insects up to order level, habits, habitats and distinguishing features of different Order and important Families. Body wall, Body regions, Insect Colors. Head and head appendages, thorax structure, wings, their modification and venation, Abdomen structures.

Embryonic and post embryonic development, types of metamorphosis, physiology of ecdysis. Insect food and nutrition and their role in growth and development, artificial diets. Concept of ecology, Environment and its components-biotic and abiotic factors and their effects on growth, development, diapause, population structure and dynamics, distribution and dispersal. Principles of biogeography and insects biodiversity. Assessment of diversity indices. AESA, ecological niche, predator-prey and host-parasitoid interactions. Food chain, food web and trophic relations.

Life table studies, population models. Arthropod population monitoring, pest forecasting. Causes of pest out breaks. Importance and scope of biological control, history of biological control: Biocontrol agents-parasitoids, predators, insect pathogens and weed killers. Important entomophagous insect Orders and Families. Mass multiplication techniques and successful cases of biological control of pests. Use of biotechnological tools in enhancing the potentials of Bio-Control Agents. History, scope and principles of chemical control. Insecticides, classification and mode of action-Conventional and IRAC. Formulations of insecticides. Penetration of insecticides. Physical, chemical and toxicological properties of different groups of insecticides. rodenticides, insect growth hormones.

Insecticide induced resurgence. Combination insecticides. Pesticide hazards and environmental pollution. Safe use of pesticides, precautions, first aid treatments and antidotes. Insecticides Act 1968, Functions of CIB & RC, Evaluation of toxicity, methods of toxicity testing, determination of LD 50, LT 50, RL 50 etc. Metabolism of insecticides and management of insecticide resistance. Principles of HPR. Basis of resistance. Host plant selection by phytophagous insects. Biotype development and break down of resistance. Tritrophic interactions, induced resistance. Breeding for insect resistant crops and evaluation techniques. Biotechnological approaches and development of transgenic insect resistant plants.

Behavioural control: semiochemicals pheromones-types and uses. Hormonal control, chemosterilants, antifeedants, attractants, repellents; their types. Genetic improvement and genetic engineering of bio control agents. Pest management in organic and precision agriculture. History, concept and principles of IPM. Components of IPM. System approach, Agro ecosystem and cropping system vs. IPM. Concept of damage levels- ETL, EIL and their determination. IPM strategies for field and horticultural crops. IPM case histories.Types of appliances used for insecticide application. Types of nozzles, spray patterns. Maintenance of appliances. Distribution, host range, biology and bionomics, nature of damage and management of arthropod pests of cereals, millets, nutricereals, oilseeds, pulses, fibre crops, green manures, sugarcane and tobacco. Pest of vegetables, fruits, plantation crops, spices, condiments, medicinal and aromatic crops, ornamentals, underutilized and exotic fruits. Pests of importance: locusts, termites, hairy caterpillars, cut worms white grubs and invasive alien pests. Vertebrate and molluscan pests. Pests of mushrooms.

Vertebrate and molluscan pests. Principles of grain storage. Storage structures, bulk storage and bag storage their merits and demerits. Insect and Non-insect pests in storage, biology, and nature of damage.Integrated management of storage pests. Regulated and quarantine pests.History of vector pathogen interactions, important vectors of plant diseases. Mechanism of pathogen transmission. Toxicogenic insects, mites and phytotoxemia. Management of vector and its effect on control of diseases. History of bee-keeping. Honey bees and their economic importance. Bee products. Bee species, their behaviour, habit and habitats.

Pollinators and their role in production of various crops. Conservation of pollinators.Silkworm species, salient features, systematic position. Production techniques of mulberry, muga, eri and tassar silkworms, silkworm breeds. Nutritional requirements of silkworms. Enemies and diseases of silkworms and their management. Sericulture organization in India. Lac insect, its biology, lac products, uses. Host Trees of lac and natural

enemies. Pollinators and their role in production of various crops. Conservation of pollinators. Use of insects and insect products in medicines.

Insects as bio-indicators. Usefulness of insects in scientific investigations Frequency distribution, mean, mode and median. Standard, normal, bionomial and Poisson's distribution, Sampling methods and standard errors. Correlation and regression: Partial and multiple, tests of significance; t, F, chi- square, Duncan's multiple range tests. Design of experiments: Principles of Randomized block design, Completely randomized block design, Latin square design, Split-plot designs. Probit analysis. Use of software packages like SPSS, SAS, etc. for the above tests and designs of experiments for analysis.

AEG—AGRICULTURAL ENGINEERING

Surveying and levelling: Surveying – Chain, compass – plane table survey – land measurement and computation of area; Area estimation – Simpson's rule and Trapezoidal rule. Soil erosion: causes – effects of soil erosion – USLE – soil estimation – erosion control measures; In-situ soil moisture conservation – micro catchments and eroded catchments; Watershed – concept – conservation – watershed management.

Farm Machinery: IC engine – working principles – different components; Engine Systems –Air cleaning – cooling – lubrication – fuel supply and hydraulic control system of a tractor; Power transmission system – clutch – gear box – differential and final drive of a tractor – tractor types; Primary and secondary tillage implement – implement for intercultural operations – sowing and planting – plant protection equipment – harvesting and threshing equipment.

Remote sensing, geographical information system (GIS) and global positioning system (GPS): Components – RS platforms-hardware and software – Data conversion – map coordinate systems – Data types and inputs - Raster based – multispectral, hyper spectral and thermal – Vector based data – point line and polygon. Image processing for various applications – spectral signatures – vegetative indices – uses and applications; Different sensors used in agriculture – Soil – Crop and weather sensors.

Hydrology: Precipitation – measurement-data analysis; Runoff – hydrograph – flow measurement- effective rainfall; Evaporation – Estimation – Evapotranspiration – infiltration; Groundwater – aquifer and its properties – recharge estimation-open wells – specific yield; Sedimentation – Estimation – yield – reservoir sedimentation; Watershed – delineation – Hydrologic Units – Measurements – geospatial softwares (ArcGIS, ERDAS Imagine).

MBT—MICROBIAL TECHNOLOGY

Microbial Technology, Useful microbes – fungi, bacteria, virus, algae, Classes of products obtained from microbes and their uses, Microbes used directly as products, novel metabolites from microbes. Microbes for agriculture Biofertilizers, classes of biofertilzers, mass production of biofertilizers, field application techniques, marketing. Biopesticides, microbes used as biopesticides, mass production, field application and economics, PGPR microbes, microbial endophytes

Microbes for environment Microbes for pollution control, immobilization of microbes, Bioremediation – strategies for bioremediation, biofilm based removal, quorum sensing, usage of microbes from extreme environments, microbes in waste management, water treatment,, bioleaching, biosorption Microbes for nutrition and health Antibiotics, commercial production of antibiotics, industrial production of vaccines, microbes in probiotics and prebiotics, microbes as food and food additives, mushrooms and commercial production, microbial transformation of bio-chemicals, cosmetic microbiology. Microbial biosensors, microbial biofuel, electricity from bacteria, bacterial rhodopsin in IT industry, microbes to contain oil spills, model microbes in biotechnology research, microbes in nano biotechnology.

Industrially important microbial products: Biomass – Yeast, Lactobacillus, Spirulina, Primary and secondary metabolites. Medical Antibiotics – Penicillin, Cephalosporin, Tetracyclins. Vaccines - TT, DPT, BCG, Anticancer compounds from microbes. Enzymes General aspects of enzyme production. Industrial scale production of Protease, Lipase, Cellulase, Pectinase, Amylase. Recombinant products Production of Insulin and Growth hormones. Recombinant enzymes and vaccine production. Food additives Organic acid Production: Acetic acid, Gluconic acid, Lactic acid. Amino acid production: Lysine and Glutamic acid. Vitamin Production: Pantothenic

acid, Riboflavin, Vitamin B12, Ascorbic acid. Biofuels Production of Bioethanol, Biobutanol, Biodisel, Biohydrogen, Methane production. Biopolymers, Biosurfactants, Microbial pigments.

FST—FOOD SCIENCE AND TECHNOLOGY

Introduction to food technology. Food attributes viz. colour, texture, flavour, nutritive value and consumer preferences. Causes of food spoilage, sources of microbial contamination of foods, food borne illnesses, water activity and its relation to spoilage of foods. Spoilage of processed products. Principles and methods of food preservation. Food fortification. Heat processing, dehydration, freezing, freeze drying, fermentation, chemical additives. Refrigerated and modified atmosphere storage. Aseptic preservation, hurdle technology, hydrostatic pressure technology and microwave processing. Use of non-thermal technologies, alternate-thermal technologies and biological technologies in food processing.

Post harvest handling and storage of fresh fruits and vegetables. Minimally processed products. Cold chain logistics, Canning; Intermediate moisture foods. Preparation and utilization of fruits and vegetables juices. Membrane technology. Chemistry and manufacture of pectin, Technology of preservatives, pickles, chutney's and sauces. control of spoilage, IQF products, packaging, storage and thawing. Spice Processing. Oleoresins and essential oils. Structure, composition and processing of different grains like wheat, rice, barley, oat, maize and millets. Anti-nutritional factors in food grains and oilseeds. Preparation of vital wheat gluten and its utilization. Enzymes (amylases and proteases) in milling and baking. Use of pulses in traditional products, protein concentrates and isolates. Modified starches and proteins. Oilseeds: edible oilseeds, composition and importance in India. Oilseed processing. Oil extraction and its processing. Dairy analogues based on plant milk. Spices Processing: Oleoresin and essential oil extraction Dairy plant operations. UHT, toned, humanized, fortified, reconstituted and flavoured milks. Technology of fermented milks. Milk products processing viz. cream, butter, ghee, cheese, condensed milk, evaporated milk, whole and skimmed milk powder, ice-cream, butter oil, khoa, channa, paneer and similar products. Judging and grading of milk products. Cheese spreads by spray and roller drying techniques. EMC (Enzyme modified cheese), Enzymes in dairy processing.

Chemistry and microscopic structure of meat tissue. Ante mortem inspection. Slaughter and dressing of various animals and poultry birds. Post mortem examination. Rigor mortis. Retails and wholesale cuts. Factors affecting meat quality. Curing, smoking, freezing, canning and dehydration of meat, poultry and their products. Structure and composition of egg and factors effecting quality. Quality measurement. Preservation and transportation of eggs. Egg powder, albumen, flakes and calcium tablets.

Quality systems and tools used for quality assurance, safety, recall and liability. The principles and practices of food plant sanitation. Total quality management, good management practices, HACCP and codex. International and National food laws. USFDA/ISO-9000 and FSSAI. Food adulteration, food safety. Sensory evaluation, panel screening, selection methods. Non-destructive food quality evaluation methods. Unit operations in food processing, packaging materials, packaging of fresh and processed foods, recent trends in packaging, aseptic, modified atmosphere, vacuum and gas packaging,Nutritional labelling. Fermentation technology, fermented food products (animal and plant based), microbial spoilage of foods, bacterial growth curve, hurdle technology. Role of biotechnology in productivity of plants, livestock and microbes of improved nutrition and quality. Consumer trends and their impact on new product development. Product development viz. to conceive ideas, evaluation of ideas, developing ideas into products, test marketing and commercialization. Role of food in human nutrition. Therapeutic / Engineered / Fabricated and Organic foods/ Nutraceutical and functional foods.

HRT—HORTICULTURE

Module 1: Importance and scope of horticulture, Layout and establishment of orchards; pruning and training; propagation, climatic requirement and cultivation of fruits like mango, banana, citrus, guava, grape, pineapple, papaya, apple, pear, peach and plum; cultivation of plantation crops like coconut and cashew nut and spices like black pepper, cardamom, cinnamon, coriander, turmeric. Cultivation of major vegetable crops of tropical, subtropical and temperate regions 'like cole crops (cauliflower, cabbage, broccoli and knol khol), cucurbits (pumpkin, bottlegourd, bittergourd, luffa, muskmelon and watermelon, cucumber), root crops (radish, tapioca

sweet potato and potato), leafy vegetables (fenugreek, amaranthus and spinach); solanaceous crops (tomato, chillies and brinjal). Importance and scope of cut and loose flowers, cultivation of important cut flowers (rose, gerbera, carnation, lilium, orchids, gladiolus) and loose flowers (marigold, jasmine, crossandra, chrysanthemum, tuberose), establishment and maintenance of lawns, turf management, trees, shrubs, creepers, hedges and annuals, type of gardens, landscaping and its principles, Production technology Medicinal crops: periwinkle, coleus, aswagandha, sarpagandha, aloe vera, isabgol, satavari; Aromatic crops: palmarosa, lemongrass, citronella, vetiver, geranium, mentha, ocimum.

Module 2: Genetics, breeding objectives, methods, varieties, and hybrids, breeding for biotic and abiotic stress, breeding for quality improvement, marker-assisted selection, use of molecular markers, heterosis, male sterility, self incompartibility, biotechnological approaches, genetic engineering and transformation inhorticultural crops.

Module 3: Maturity indices, harvesting practices and grading for specific market requirements, influence of pre-harvest practices, postharvest management in horticultural crop, methods of storage, Packing methods and transport, quality evaluation, principles and methods of preservation, food processing, processing waste management and food safety standards; Role of HACCP in fruits, vegetables and flower crops. Prospects of value addition, types of value- added products from flower crops, essential oil, Processing of Plantation Crops, Spices, Medicinal and Aromatic Plants.

Module 4: Plant growth regulators, dormancy, role of auxins, gibberellins, cyktokinins and abscisic acid; Application of PGR's, physiology and biochemistry of fruit ripening. Role and mode of action of antitranspirants, anti-auxin, plant growth retardant and inhibitors, fruit set, fruit development, parthenocarpy, senescence and abscission, fruit ripening and physiological changes associated with ripening in horticultural crops, Plant growth regulators in relation to morphogenesis and tissue culture techniques in vegetable crops.

Module 5: Protected cultivation, temperature, carbon dioxide, humidity, classification of protected structures, cladding material, media, drip and sprinkler irrigation, fertigation, special horticultural practices, hydroponics, aeroponics, aquaponics, micro greens, mulching, solarization, fumigation, and protected cultivation of high- value vegetables, flowers and fruit precision farming,

Module 6: Principle and practices of plant propagation: Sexual propagation – apomixis, polyembryony, chimeras. Factors influencing seed germination, hormonal regulation of germination and seedling growth. Seed quality, treatment, dormancy, packing, storage, certification and testing. Method of vegetative propagations, Physiological, anatomical and biochemical aspects of root induction in cuttings. Selection of elite mother plants. Establishment of bud wood bank. Stock, scion and inter stock relationship and incompatibility. Physiology of dwarfing rootstocks. Rejuvenation of senile and seedling orchards progeny orchard and scion bank.

Module 7: Importance, principles, perspective, concept and component of organic farming, biodynamic farming, Indigenous methods of composting; ITK's, managing soil fertility, pests and diseases and weed problems in organic farming system, crop rotation in organic horticulture, processing and quality control for organic foods, methods for enhancing soil fertility, mulching, raising green manure crops, pest and disease management in organic farming; Role of botanicals and bio-control agents; GAP and GMP- certification of organic products; organic production and export- opportunity and challenges.

AEE—AGRICULTURAL EXTENSION EDUCATION

Extension Landscape: Challenges before Extension and Advisory Services (EAS), New Functions and New Capacities, Pluralism in EAS, From the Linear Paradigm to Systems Paradigm, Evolving Extension Approaches, Extension Reforms and Policy Challenges.

Behavioural change of the stakeholders: Foundations of Human Behaviour, Cognitive Processes affecting Human Behaviour, Information Processing, Cognitive approaches of learning, principles theories and models, Judgement, Choice and Decision-making. Attitudes and Influence, Social Judgement, Social Identity and Inter- Group Relations.

Organizational Behavior: Basics of Organization and Organizational Behaviour, Individual and Group Behaviour in Organizations, Productive Behaviour and Occupational Stress, Organizational System, Overview of Organizational Development, Managing the Organizational Development Process, Organizational Development Interventions, Organizational Development Practitioner or Consultant

Research Methodology in Extension: Nature of Behavioural Research, The Behavioural Research Process, Steps in Behavioural Research Process - Formulating a Research Problem, Reviewing the Literature, Identifying Variables and Hypotheses, Formulating Research Designs, Methods and Tools, Sampling, The process of collecting data, Analyzing and Interpreting the Data, Reporting and Evaluating Research.

Capacity Development: An Overview, Approaches and Strategies, Planning and Organization of Capacity Development Programmes, Capacity Development Needs Assessment, Capacity Development Institutions and Management, Capacity Development Project Formulation, Capacity Development Process and HRD, Evaluation, Impact Assessment, Human Resource Development.

ICTs for Agricultural Extension and Advisory Services: Concepts and Status, ICTs in Knowledge Management, e-Extension initiatives in Agriculture and allied sectors, Application of ICTs in Extension and Advisory Services- ICT Expert Systems, ICT Networks; Knowledge Management and Standards- Policies in Knowledge Management, Web Standards, Social Media Applications to engage audience; Smart and Disruptive Technologies and Advanced Analytics for Agricultural Extension- Human Computer Interactions.

Programme Evaluation: Concept of Evaluation, Evaluation Theories, Evaluation Process, Programme Management Techniques, Programme Evaluation Tools, Impact Assessment, Approaches for Impact Assessment, Environment Impact Assessment (EIA).

Managing Extension Organizations: Basics of Management, Extension Management in public, private sector and other sectors, Motivation and Organizational Communication, Supervision and Control. Agricultural Innovation Systems: Concepts and Elements, Enabling Innovation, Scaling Up Knowledge for Innovation- Changing views, Approaches; Scaling Up Knowledge for Innovation- Tools, Approaches and Pathways.

Gender Mainstreaming: Historical Perspective of Gender, Agrarian Importance of Gender, Gender Related Concepts, Analysis, Gender and Technology, Gender Mainstreaming and Women Empowerment, Gender Mainstreaming and Women Empowerment, Entrepreneurship Development for Women.

PPY—PLANT PATHOLOGY

UNIT 1: History and general classification of fungus

Importance, definitions, and concepts of plant diseases, history and growth of plant pathology, biotic and abiotic causes of plant diseases. Growth, reproduction, survival, and dispersal of important plant pathogens, the role of environment and host nutrition on disease development Classification of fungi, economic mycology, edible fungi and entomogenous fungi mycorrhizal association, cell organelles, their morphology, functions, and chemical composition.

UNIT 2: Plant virus and viroid

Nature, composition, and structure of viruses and viroids. Symptomatology of important plant viral diseases, transmission, properties of viruses, host-virus interaction, virus vector relationship. Virus nomenclature and classification, genome organization, replication, and movement of viruses. Isolation and purification, electron microscopy, protein and nucleic acid-based diagnostics. Myco-viruses, satellite viruses, satellite RNAs, phages, prions. Origin and evolution, mechanism of resistance, genetic engineering, ecology, and management of plant viruses

UNIT 3: Plant Pathogenic bacteria

Importance of phytopathogenic bacteria. Evolution, classification, and nomenclature of phytopathogenic procaryota and important diseases caused by them. Growth, nutrition requirements, reproduction, preservation of bacterial cultures, and variability among phytopathogenic procaryota. General biology of bacteriophages, L form bacteria, plasmids, and bdellovibrios. Procaryotic inhibitors and their mode of action against phytopathogenic bacteria. Survival and dissemination of phytopathogenic bacteria.

UNIT 4: Role of toxics and enzymes on plant disease development

Host-parasite interaction, recognition concept, and infection, symptomatology, disease development- the role of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance. Disease management strategies.

UNIT 5: Isolation and purification of plant pathogens

Pure culture techniques and, the use of selective media to isolate pathogens. Preservation of plant pathogens and disease specimens, use of haemo-cytometer, micrometer, centrifuge, pH meter, and camera lucida. Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides, etc.; field experiments, data collection, and preparation of references.

UNIT 6: Seed health testing and certification

Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds. Recent advances in the establishment and subsequent cause of disease development in seeds and seedlings. Localization and mechanism of seed transmission about seed infection, seed to plant transmission of pathogens. Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, and evolutionary adaptations of crop plants to defend against seed invasion by seed-borne pathogens. 37 Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection. Production of toxic metabolites affecting seed quality and its impact on human, animal, and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, and methods for detecting microorganisms.

UNIT 7: Molecular Plant -Pathogen interactions

Molecular mechanisms of pathogenesis, process of infection, variability in plant pathogens. Mechanism of resistance. Host defense system. Antiviral protein.SAR, active oxygen radicals. Hypersensitivity and its mechanisms. Tissue culture, elementary genetic engineering. Gene-for-gene concept, protein-for-protein, and immunization basis, management of resistance genes. Strategies for gene deployment.

UNIT 8: Integrated Disease Management

Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications. Development of IDM- basic principles, biological, chemical, and cultural disease management.IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapeseed, mustard, pearl millet, kharif pulses, vegetable crops and fruit crop

SST—SEED SCIENCE AND TECHNOLOGY

Unit 1: Seed Biology

Floral types, structure and biology in relation with pollination mechanisms. sporogenesis, pollination, fertilization, embryogenesis, fruit and seed development. Apomixis, parthenocarpy, polyembryony and somatic embryoids and synthetic seeds. Seed structure of monocot and dicot. Seed maturation and longevity in orthodox and recalcitrant seed. Chemical composition of seed. Seed dormancy - types, causes and mechanisms of induction and release, factors affecting, methods to overcome dormancy and its significance in agriculture. Seed germination – phases, types and requirements, physiological and biochemical changes in germinating seeds. Role of hormones in seed dormancy and germination

Unit 2: Seed Production

Genetic purity concepts and factors responsible for deterioration of varieties, maintenance of genetic and physical purity, Variety testing, release and notification. Generation system of seed multiplication. Seed production agencies. Compact area approach and seed village concept in seed production. Seed Multiplication ratio, seed replacement rate, seed renewal period, Varietal replacement rate. Classes of seeds – Nucleus, breeder, foundation and certified seed. Seed production planning. Factors affecting pollination and seed set viz., temperature, humidity, wind velocity, insect pollinators, and supplementary pollination. Male sterility, self-incompatibility and their role in hybrid seed production. Supplementary pollination. Isolation distance and types. Principles and methods of seed production of varieties and hybrids of cereals like wheat, paddy, sorghum, pearl millet and maize; pulses like chickpea, pigeon pea, green gram, black gram, soybean and cowpea; oilseeds like groundnut, brassica, sesame, sunflower and castor; fibre crops like cotton and jute; vegetables crops like tomato, brinjal, okra, chilli, important cole and cucurbitaceous crops time of harvesting and threshing/extraction methods. Micro propagation.

Unit 3: Seed Processing

Seed processing steps, seed processing sequence for different crops, Layout of seed processing, Seed processing machines like cleaner cum grader, specific gravity separator, indented cylinder, seed treater, weighing and bagging machines, their operation and maintenance., Principles of seed processing. Seed drying principles and methods and seed drying machines. Precleaning, grading, treatment, pelleting and packaging. Seed invigoration and enhancement treatment – seed coating, pelleting, seed priming and methods, seed hardening and their mechanisms. Seed quality maintenance during processing.

Unit 4: Seed Quality Control

Seed legislation - Seeds Act 1966, Seed Rules 1969, Seed Control Order 1983 and New Seed Bill 2004, Seed Law Enforcement. Seed certification – history, concept, organization, phases and minimum certification standards. Field inspection principles and methods. Inspection at harvesting, threshing and processing. Pre-and post-quality testing or genetic purity. Seed testing concepts and objectives. Seed Certification concepts and procedures. Seed sampling, Types of samples, sampling devices, procedure for seed sampling, sampling intensity. Seed moisture testing, purity analysis, germination testing, tolerance tests and equipment. Seed testing procedures for agricultural and horticultural crops. Quick viability tests. Seed vigour, its significance and testing methods. Testing for genuineness of varieties – principles and methods based on seed, seedling and plant characters, biochemical techniques namely electrophoresis of proteins and isoenzymes and DNA fingerprinting / Molecular markers. International Seed Testing Association (ISTA), its role in development of seed testing procedures, rules and seed quality assurance for international seed trade- OECD.

Unit 5: Seed Storage

Seed storage – principles - purpose and types. Factors affecting seed storage and role of moisture, temperature, RH and moisture equilibrium. Viability nomographs. Types of seed - Orthodox and recalcitrant seed - Seed deterioration causes and methods of control. Physiological, biochemical and molecular changes in seed ageing. Seed packaging material. Storage structures. Methods of stacking and their impact. Controlled storage. Germplasm storage. Cryo preservation. Operation and management of seed stores.

Unit 6: Seed Health

Importance of seed health. Procedure for seed health and rules. Mode and mechanism of transmission of microorganisms - fungi, bacteria and viruses. Externally and internally seed - borne pathogens, mode of infection, development and spread, methods of detection of seed borne diseases. Important seed-borne diseases of cereals, oilseeds, pulses, fibre crops, vegetables and their control measures. Quarantine and International procedures of phytosanitary certificates. Important storage pests, their identification and management. Use of pesticides, botanicals, mycotoxins for seed treatments. Principles of fumigation and safe use of fumigants.

Unit 7: Seed Industry Development and Marketing

National and International seed industry development. International Seed Trade Federation (ISF) and Indian seed associations. Role of WTO and OECD in seed marketing. Economics of seed production. Market survey, demand forecasting, pricing policies, marketing channels, planning and sales promotion. role of public and private sectors in seed trade. Seed import and export.

Unit 8: Protection of Plant Varieties

Plant Variety Protection (PVP) and its significance. Protection of Plant Varieties and Farmers' Right Act, 2001, its essential features. International Union for the Protection of New Varieties of Plants (UPOV) and its role in development of Plant breeders Rights and Seed Industry Development. Impact of PVP on seed supply system. DUS testing principles and application. Biodiversity Act. Criteria for protection of Essentially Derived Varieties (EDVs) and Genetically modified (GM) varieties.

ATR—ARCHITECTURE AND PLANNING

BUILDING SERVICES - PLUMBING AND SANITARY

Module: 1. Water Supply

Water Supply – Introduction, sources of water supply, qualitative and quantitative aspects, availability, the importance of water conservation. Storm water collection, drain design, regulators, filtration beds and ground water recharge systems, surface drainage and subsoil
drainage

Module: 2. Water Treatment

Water treatment-Conceptual understanding of public water distribution system. Sources of water pollution and preventive measures. Filtration, disinfection, water softening, standards for various uses, especially for portable use and in construction.

Module: 3. Water Distribution

Principles of hydro pneumatic systems in water supply. Control systems including valves and metering devices, user end controls such as angle valves, shower panels, jacuzzi systems.

Module: 4. Sewage Disposal

Introduction, importance and purpose of sanitation, types of refuse, collection and disposal of refuse, systems of drainage, methods of sewage and effluent disposal, re-cycling of sewage water, understanding of sewer sections and invert levels ,inspection chambers.

Module: 5. Rural Sanitation

Rural sanitation, aqua privies, biogas principles and systems

Module: 6. Sanitation in buildings

Environmental impacts, detailed study of septic tanks and sewage treatment plants and their various components .Sanitary requirements for various types of buildings as per the National Building Code

Module: 7. Fire fighting

Fire fighting services

BUILDING SERVICES- ELECTRICAL AND MECHANICAL

Module: 1. Electricity Basics

:Ohms and Kirchhoff's Laws, Single phase and three phase supply, power and different types of power measurement, Power Factor, Earthing, Substations, Low-Voltage Power Distribution Systems Requirements, Dimensions of power distribution systems, low voltage switchboards, bus bar system and types.

Module: 2. Electrical System Design

Wires and cables, Electrical Load Estimation – Preparation of Electrical Scheme and the electrical load calculations for building, Power handling equipment: Switch board, panel boards, lighting conductors, Captive Power Generation, Un-interrupted power supply, Emergency service, Inverters, Phase change over and methods

Module: 3. Illumination

Nature of radiation, definition, laws, photometry, lighting calculations, design of illumination systems types of lamps, energy efficiency lamps.

Module: 4. Security System

Introduction to security systems – Access control, Public Address systems, CCTV, fire detection and their interconnected role in protection. (Method of teaching to include pictorial representation).

Module: 5. Mechanical / Artificial Ventilation

Rate of ventilation, Methods and equipment, Air Conditioning – Definition to psychrometric process, air cycle and refrigeration cycle, Calculation of air conditioning loads, Zoning: Purpose and advantages. Air-distribution systems, Air-conditioning methods and equipment, energy conservation techniques, concept of "Clean Room".

Module: 6. Elevators, escalators and travellators

Types of Elevators-Traction, sky lobby, lift lobby, Provision of elevators for a building, planning considerations - location in building, Recommendations of the National Building Code, etc. Safety features and codes. Service requirements: Quality of service, quantity of service, time, passenger handling capacity, space and physical requirements, machine room spaces and their typical layout. Design of typical lift banks. Escalators, Application - Location and arrangement in buildings.

Space requirement, travelators.

Module: 7. Introduction of acoustics

Nature of sound, basic terminology, Behaviour of sound in enclosed spaces, Absorption of sound, sound absorption coefficient, reverberation, Use of Sabine's and Eyring's formulae, sound absorbents. Auditoria, seminar and multipurpose hall design

ARCHITECTURAL ILLUMINATION AND ACOUSTICS

Module: 1. Introduction Lighting

History and basics of lighting; Light and electromagnetic spectrum; Fundamentals quantities of lighting; Photometry

Module: 2. Lighting design basics

Brief history of light sources; Different types of lamps; Luminous Efficacy of Light Sources; Energy efficient lighting; Luminaries and its components; Luminaries types and classification; Lighting systems; Lighting Distribution Patterns

Module: 3. Illumination and lighting

Quantity of lighting: Minimum Illumination levels for different facilities Quality of lighting: Glare (Direct and Reflected/Veiling); Control of Direct and Indirect glare; Visual comfort probability; Concept and fundamentals of color; Color temperature of different light sources; Color Rendering
and Color Rendering Index (CRI) of light sources.

Module: 4. Lighting Design and Calculation

Lighting calculation methods: Lumen method, Zonal cavity method and point method. Permanent Supplementary Artificial Lighting in Interiors (PSALI). Lighting Application for Different Facilities: Hospitals, Institutional and Educational Buildings, Restaurants, Office Buildings, Outdoor, Landscape; Assembly Rooms, Auditoriums, And Multipurpose Spaces; Sports facilities,
Laboratories, Library etc.

Module: 5. Nature of sound

Sound and it's Physics: Speed, Wavelength and Frequency, Octave bands, Sound
Propagation; Ray and Particle nature of the sound, longitudinal motion, spherical dissipation, inverse square law.Fundamentals of Human Ear & Hearing mechanism: Equal Loudness contours; Expressing Sound Magnitude; Sound Power; Sound Pressure; Sound Intensity; Decibel; Attenuation; Sound Power Level; Sound Pressure Level;Common Sound Pressure Levels

Module: 6. Acoustics of Architectural Spaces

Sound in enclosed spaces: Acoustical defects of architectural space & Measures to Solve; Types of Sound Absorption Material & their use in architectural Spaces; Sabine; Sound Absorption Coefficient; Acoustical Material Rating methods; Reverberance and reverberation time calculation for spaces; Optimal Reverberation time; Variable Acoustics; Acoustical Design criteria of spaces for speech, music and open-air auditorium;
Methods adopted in designing acoustics for
architectural spaces.

Module: 7. Noise Control and Sound Reinforcement

Types of Noise and its sources in buildings: Rating system of Noise; Noise Rating System of Building components; Noise control methods in buildings for different noise types. Mechanical Systems Noise &control; HVAC lining materials- difference between thermal and acoustical insulation. Vibration
Isolation and Control; Active sound and Noise cancelation; Environmental Acoustics; Traffic noise; Planning to mitigate environmental / outdoor noise; Sound barriers; Principles of sound barrier attenuation, shadow zone, distance from receiver etc. Acoustic compliance, NIHL, OSHA and NIOSH guidelines for acceptable ambient noise exposure levels in different places.

CONSTRUCTION TECHNOLOGY – TIMBER , WOOD, CONCRETE, STEEL ,GLASS

Module: 1. Mud,Lime and Bamboo

Mud and lime, bamboo and casuarinas as construction materials.

Module: 2. Stone and Bricks

Stone and Brick as a construction material - Types of construction Stone, Brick and their properties and use in building construction. Nature of stone wall and Brick construction in various building components like foundations, walls, buttresses, arches and roofing

Module: 3. Special types of Concrete

Types of concrete, precast concrete, ready mix concrete, batching plants. Ferro cement in building construction, Concepts behind prestressed, post-tensioned concrete, pre cast concrete structures. Studies on large span structures, multi-storeyed buildings, marine structures, special application steel structures, special technologies such as tunneling.

Module: 4. Ferrous Metals and Non Ferrous Metals In Building Construction

Ferrous metals, brief review of pig iron, cast iron, wrought iron Non-ferrous metals -aluminium, copper, lead, zinc, tin, nickel. Alloys of aluminium copper and steel , galvanisediron, gal volume

Module: 5. Steel in Building Construction

Brief review of steel manufacture process, its properties and uses, various forms of architectural steel

Module: 6. Glass

Types of glass, treatment of glass and Brief review of glass manufacture, composition, properties and uses of glass, Glass and aluminium in frameless glass systems, structural glazing

Module: 7.

Studies on high rise structures including structural implications, effects of wind and climate, services integration, safety, typical floor construction cycle, construction techniques, National Building Code references. Environmental issues in construction, disaster management technologies, emergency structures, cost reduction technologies for mass construction.

COMPUTER GRAPHICS - SKILL DEVELOPMENT

Module: 1. Introduction to architectural simulation

Introduction to computers – getting hands on familiarity with software's related to architectural simulation - the need and scope of using computers in architectural simulation.

Module: 2. Digital Software

Digital Software like AUTOCAD - understanding various aspects of line, shapes, commands, layers, printing color codes

Module: 3. Visualisation software

Visualisation software like sketchup - understanding 3d creation

Module: 4. Building Information modelling

Building information modelling software like REVIT - introduction - commands description - hands on with various plans - services plan - basic simulation

Module: 5. Presentation software

Presentation software including -GIMP & rendering plugins

Module: 6. Options in visualisation software

Options in visualisation software

PART-2 Specialized Architecture Subjects

SUSTAINABLE ARCHITECTURE

Module: 1. Sustainability in Built Environment

Introduction to Sustainability in Built Environment

Module: 2. Environmental impacts and need for sustainability

Environment, Energy, Climate Change and Economics, need for sustainability.

Module: 3. Sustainability in Vernacular Architecture

Vernacular Architecture and Sustainability

1) Factors that contributed to its evolution.

2) Vernacular architecture in India

Module: 4. Elements of Sustainability

Elements of sustainability

Module: 5. Sustainable Building Materials and Construction

Role of Materials in Sustainable architecture Building with regional/renewable materials:

Bamboo, casuarina,types of thatch, palm trunks, palm rafters, Straw, Reed, Mud, lime, Stabilised mud blocks, Rammed Earth construction, Terracotta

Module: 6. Sustainable concepts and the design strategies

Method of Achieving Sustainability in Buildings

Understanding Energy Efficiency, Daylighting, Passive Heating/cooling, Water Resource management, Renewable Energy etc

Module: 7. Rating methods

Assessment or Rating methods of Sustainable buildings.

Green Building or Contemporary High Performance Buildings:

URBAN ECOLOGY

Module: 1. Urban Ecology

Urban Ecology—Introduction, characteristics of urban ecosystems, differences withnatural ecosystems

Module: 2. Ecological Niche

Ecological Niche—which species succeed in urban ecosystems Island Biogeography—space and urban ecology

Module: 3. Habitat and Fragmentation

Habitat and Fragmentation—historical development of urban eco-systems and habitat typesMeta-populations and corridors—dispersal in urban ecosystems

Module: 4. Urban Ecology and Disease

Urban Ecology and Disease—ecology of urban disease vectors

Disturbance, Succession, Restoration—processes affecting urban ecosystems over time

Module: 5. Ecological Footprints

Ecological Footprints—impact of urban ecosystems on environment

Module: 6. Ecological Footprint Analyses

Incorporating urban environmental history into Ecological Footprints Tools for EcologicalFootprint Analyses

Module: 7. Ecosystem Services

Ecosystem Services— benefits provided by urban eco systems, air and water quality. Tools for Ecosystem service analyses. Urban Metabolism, material flow analysis, substance flow analysis

LANDSCAPE ARCHITECTURE

Module: 1. Landscape design and its theoretical design

Introduction to understanding of landscape design and its theoretical design aspects to beconsidered.

Module: 2. Hard and Soft Landscape

Hard and Soft Landscape, Material of Construction, Types of vegetation color - scale - proportion – light and shade and shade effect - and its image ability creation / user -experience factors

Module: 3. Cultural aspects of the landscape architecture

Cultural aspects of the landscape architecture with contextual understanding - history of landscape architecture and its theoretical aspect behind its design.

Module: 4. Scenic beauty of landscape design

Scenic beauty of landscape design and its various theoretical aspects.

Module: 5. Urban & regional landscape

Urban & regional landscape characteristics

Module: 6. landscape setting

The characteristics of landscape setting and its intended outdoor activities and experience

Module: 7. Sustainability and landscape Architecture

Sustainability and landscape Architecture - the indigenous aspect of landscaping

ARCHITECTURAL CONSERVATION

Module: 1. Architectural Conservation and its significance

Introduction to concepts of heritage and conservation, defining preservation, adaptive reuse,international and domestic agencies and their roles in conservation.

Module: 2. Role of National agencies in Architectural

Conservation Museums, monument preservation, role of ASI and INTACH, central and state governmentpolicies and regulations, projects.

Module: 3. Architectural Conservation – National case examples

Case studies in conservation such as Hampi and Mamallapuram

Module: 4. Components in Architectural Conservation:

Listing of monuments, documentation, assessing architectural character, structural condition,techniques for preservation and adaptive reuse.

Module: 5. Adaptive reuse

Case studies in adaptive reuse- museums, hospitality centres, heritage hotels, etc

Module: 6. Conservation planning

Conservation planning, incentivisation, transfer of development rights, examples of developmentsin historic precincts.

BUILDING SYSTEMS MANAGEMENT

Module: 1. Introduction

History and Theory of Building Systems and Architectural Components

Module: 2. Statics of Architectural Structures

Structural Morphology, Basic structural elements and force systems, Equilibrium equations, Material behaviour

Module: 3. Building Systems

Performance requirements and Identification and specification of elements

Module: 4. Sustainable strategies

Best practices, Resource Efficiency, upcoming issues and ratings

Module: 5.

Systems integration and Building Codes

URBAN DESIGN

Module: 1. Introduction to urban design

Introduction to urban design, relationship to architecture and town planning, nomenclature andcommon terminology, applications

Module: 2. Urbanism

Factors affecting urbanism-built form, transport, land use, density, grain, texture, heritage, etc.

Module: 3. Historic Urban form -International Context

Historic Urban Form and Analysis in Greek, Roman civilizations, medieval towns, industrialization and city growth from the 18th through the 20th century.

Module: 4. Historic Urban form -National Context

Historic urbanism in the Indian subcontinent –Temple towns, Mughal towns, other settlements, colonial urbanism.

Module: 5. Contemporary Practices in Urban Design

Modern cities and place making in the 20th and 21st centuries, designers and their philosophies.

Module: 6. Articulation of urban spaces

Analysis of public and private spaces across cultures, role of architecture in defining andarticulating space

Module: 7. Urban Renewal

Concepts of redevelopment, renewal and conservation, socio economic issues relating to urban growth, smart cities, statutory bodies

PLANNING

Module: 1. Introduction to Planning

Origin & evolution of human settlements, Urban Growth and System of Cities, City – Region Linkages, Metro and Mega Cities: Problems and Issues Human Settlement Planning, Urban Development Policies and Programmes

Module: 2. Planning Theory

Evolution of City Building, Planning History, Theories of City Development and Planning Theories- Contribution of Ebenezer Howard, Le Corbusier, Clarence Stein, Patrice Geddes, C.A. Doxiadis

Various models and approaches – Advocacy and Pluralism in planning, Action planning, Mixed planning, Systems approach to planning, Rationalistic and Incremental approach, Mixed Scanning and Middle Range planning, Equity planning

Module: 3. Infrastructure and Transport Planning

Role of Infrastructure in Development, Planning and Management of Water, Sanitation and Storm Water, Transport Infrastructure Planning, Management and Design

Module: 4. Planning Management

Urban Development Management, Land and Real Estate Development, Information System and Urban Reforms

Module: 5. Planning Process

Types of plans and planning processes – Structure plans, Action plans, strategic plans; Autocratic planning, Democratic planning, Technocratic planning, Liberal planning, Socialist planning.

Module: 6. Planning Standards

Spatial standards, performance standards and benchmarks and variable standards; UDPFI guidelines, zoning regulations and development control regulations.

Module: 7. District and Rural Planning

Issues in Urban and Rural Development Poverty, Migration, Pollution, Safety/Security, Livelihoods, Energy, Infrastructure, Mobility, Land Conversion, Housing, Politics.

HOUSING

Module: 1.

Introduction/Context of urban and rural housing - Indigenous /traditional vernacular settlements –Typologies way of life technologies and materials

Module: 2.

Industrial Revolution and workers housing – Industrial Townships

Module: 3.

Post world war socialist housing – Housing in Russia and Vienna, Modern Moment in housing.

Module: 4.

Critical Regionalism - Experiments in housing by Charles Correa, B.V.Doshi, Laurie Baker,Giancarlodicarlo, Ralph Erskine.

Module: 5.

Sustainable Housing principles/ emerging technologies – Recycle, reuse renewable energy like Auroville Etc.

Section (B): Architectural Research

ARCHITECTURE RESEARCH

Module: 1. Introduction To Research

Importance, Purpose and Scope of Research and Field Studies. Application in architecture in terms of design,technology, environment, economic and behavioral areas.

Module: 2. Research Objectives and Methodology

Sequence and Methods of Research. Identification of Problem, Hypothesis Formulation, Objectives and Methodology.

Module: 3. Application of Research

Understanding and Applying Qualitative, Analytical, Interpretative, Correlational, Quasi- Experimental, Experimental, Simulation and Modelling techniques in Architectural Design

Module: 4. Field Studies

Pilot Studies, Field Surveys and Collection of Samples - Physical, Architectural, Environmental, Organizational. Preparation and Analysis of Data Sheets and Questionnaires.

Module: 5. Analysis, Preparation and Documentation

Preparation and Analysis of Data Sheets and Questionnaires. Arriving at conclusions from the Research at FieldStudies. Report Writing and Publications.

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 textilemachineries – 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.

LAW—LAW

Unit 1: Legal Research Methodology

Legal research Methods - Sociological Research methods - Empirical research in Law Theory - Hypothesis-Nullhypothesis - 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.

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COMMON SYLLABUS FOR ALL SUBJECTS (Direct 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

TECHNICAL (80 QUESTIONS)

Technical 80 questions from the respective syllabus of the subject

SUBJECT SYLLABUS FOR ENTRANCE EXAMINATION (Direct Ph.D.)

BT – BIOTECHNOLOGY

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 membraneproperties, 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 and Environmental Sciences: Taxonomy and systematic botany, Plant structure and development, morphology and anato my, embryogenesis of monocots and dicots. Phytohormones, respiration, nutrition, transpiration. Photosynthesis, C3 and C4, & CAM plants, photoperiodism, concepts of ecosystems and energy flow in biosphere. 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. Legal implications in bioremediation.

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 ofbeams 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. Foundationtypes 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.

CE – CHEMICAL ENGINEERING

Process Calculation and Thermodynamics : Laws of thermodynamics - reversible and irreversible process - concept of ideal gas and real gas - equations of states - Maxwell relations - adiabatic and isothermal compression - phase equilibrium - Gibbs phase rule - system of variable composition - vant Hoffs equation - applications of Gibbs - Duhem equation.

Law of conservation of mass and energy - material balance energy balance and their applications - unit operation and unit process - psychrometry - combustion calculations.

Momentum Transfer : Classification of fluids - fluid statics - basic equations of fluid flow - Bernoulli's equation - laminar flow – friction in flow through beds of solids - packed beds - fluid moving machinery - classification of pumps and its characteristics.

Particle Technology : Introduction to particulate solids - particle separation - size reduction - motion of a particle through fluid - classification of particulate solids - centrifugal classifier - sedimentation techniques - flotation - filtration equipments - agitation and mixing of liquids.

Heat Transfer and Chemical Reaction Engineering : Fourier's law of heat conduction - concept of thermal conductivity - heat transfer through fins - convective heat transfer - transfer of heat in flowing fluids - laminar and turbulent flow - heat transfer with and without phase change - types of evaporators - multiple effect evaporators.

Differential and integral method of analysis of rate data - ideal reactor design - Residence time distribution - C, E and F curves.

Chemical Technology : Basic principles of unit operation and unit process - schematic representations of unit operations - manufacture of sulfur, hydrochloric acid, cement, glass, products used in photography, ceramics and refractory, industrial gases, paints, pigments, fertilizers - fermentation process for the production of ethanol - manufacture of citric acid, antibiotics, penicillin, soaps, detergents – petroleum refining process - process for the production of petrochemical precursors - production of resins, nature and synthetic rubber.

Mass Transfer : Diffusion in liquids - development of rate equation for mass transfer - contracting devices for improving mass transfer characteristics - humidification, drying and crystallization - distillation, continuous rectification operation, absorption, liquid -liquid extraction and leaching - fundamental principles and design of the pressure, reaction vessels and related equipments in the above process.

Biochemical Engineering : Overview of industrial biochemical processes – industrially important microbial strains - enzymes used in industry, medicine and food - industrial production, purification and immobilization of enzymes - reactors types, characteristics and design-growth characteristics of microbial cells - free cell and immobilized cell reactors - downstream processing and effluent treatment.

IT – COMPUTER SCIENCE AND ENGINEERING / INFORMATION TECHNOLOGY

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 univariat e 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.

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 relationshipsof 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 multi meters, Phase, Timeand 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 – ELECTRONICS AND 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-s tep methods for differential equations.

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

INSTRUMENTATION ENGINEERING

Basics of Circuits and Measurement Systems: 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.

Transducers, Mechanical Measurement and Industrial Instrumentation: Resistive, Capacitive, Inductive and piezoelectric transducers and their signal conditioning. Measurement of dis placement, 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-s tage . Feed back amplifiers. Operational amplifiers, characteristics and circuit configurations. Instrumentation amplifier. Precision rectifier. V-to-I and I-to-V c o 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 multi meter. 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 s pace representation of sys tems. 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. Ultrasonic transducers and Ultrasonography. Principles of Computer Assisted Tomography.

EC – ELECTRONICS AND COMMUNICATION 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.

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

Transform Theory: Fourier transform, Laplace transform, 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-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, multi vibrators. 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-hete rodyne 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.

BM - BIO-MEDICAL ENGINEERING

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

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.

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

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.

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.

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 pulseshift 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.

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.

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.

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