

**Advt. No: 10/2022 Dated:13.12.2022**

**English**

**English**

Multi-genre literatures in English—poetry, the novel and other forms of fiction including the short story, drama, creative non-fiction, and non-fiction prose—with emphasis on the long 19th and 20th centuries

Especially in a comparative context, anglophone and in English translation, literatures from India and, extending to some degree, the larger Indian subcontinent

Literary criticism and theory; critical and cultural intellectual-traditions and approaches widely referred to and used in the discipline of English

History of English literature and English literary studies

Research approaches and methodologies, including interpretive techniques responsive to literary forms, devices, concepts, and genres

**Linguistics**

**Language and Linguistics:** Language spoken, written and signed; description and prescription; language and cultural heritage; language and social identity; language as an object of inquiry – its structure, units and components; design features; writing systems; biological foundations and language faculty; linguistic competence and performance; levels of grammar; contrast and complementation; rules - context dependent and context free; levels of adequacy for analysis; interdisciplinary approaches; schools of linguistic thought (European, American) and the Indian Grammatical Tradition.

**Levels of Grammar and Grammatical Analysis:**

**A. Phonetics and Phonology:** vocal tract anatomy; phonation; articulatory parameters; classification of sounds; gestural theory of speech production; cardinal vowels; secondary and co-articulation; suprasegmentals - length, stress, tone, intonation and juncture; IPA; basic physics of sound and of phonation and articulation; acoustic cues for speech sounds; organisation of phones into phonemes; phoneme inventories and cross-linguistic properties; syllable structure and phonological properties; principles of phonological analysis - phonetic similarity, contrastive and complementary distribution, free variation, allophones; linear and non-linear approaches; levels of representation; phonological rules; distinctive features (major class, manner, place, etc.); feature geometry; rule ordering, markedness and unspecified featural values; core principles of lexical phonology, optimality theory, autosegmental phonology and prosodic morphology.

**B. Morphology:** Concepts of morpheme, morph, allomorph, zero allomorph, conditions on allomorphs; lexeme and word; types of morphemes – structural and functional; affixes vs clitics; grammatical categories; morphological theories - generative, lexicalist, process and distributed morphology; identification of morphemes and parts of speech;

alternation; morphophonology; inflection vs. derivation; conjugation and declension; word creation and word formation rules and processes; creativity and productivity, blocking, bracketing paradoxes, constraints on affix ordering; mental lexicon; lexical categories; valency changing operations.

**C. Syntax:** Basic syntactic units and their types: word, phrase, clause, sentence and their description and generation; grammatical and case relations; key ideas from syntactic theories, Generative Grammars including Minimalist Program, HPSG, Relational Grammar and Lexical Functional Grammar; phrase structure rules (including X-bar theory); universal grammar and cross-linguistic properties; idea of grammaticality judgements; solving the language acquisition problem; diagnostics of structure; syntactic phenomena such as movement, binding, ellipses, case-checking, islands, argument structure etc.; unergatives and unaccusatives.

**D. Semantics and Pragmatics:** Types of meaning, lexical and compositional; syntaxsemantics interface (semantic roles, binding, scope, LF etc.); sense and reference, connotation and denotation, lexical semantic relations (homonymy, hypo/hypernymy, antonymy, synonymy, ambiguity); prototype theory and componential analysis; sentence meaning and truth conditions, contradictions, entailment; basic set theory; propositions, truth values, sentential connectives; arguments, predicates, quantifiers, variables; in/definiteness, mood and modality; language use in context; sentence meaning and utterance meaning; speech acts; deixis; presupposition and implicature: Gricean maxims; information structure; politeness, power and solidarity; discourse analysis.

**Historical Linguistics:** Neogrammarian laws of phonetic change such as Grimm's, Verner's, Grassmann's Laws; genesis and spread of sound change; split and merger; conditioned vs. unconditioned change; lexical diffusion of sound change; analogical changes and paradigm levelling; relative chronology of different changes; study of sound change in progress; morphosyntactic (syncretism, grammaticalisation and lexicalisation) and semantic change (extension, narrowing, figurative speech); linguistic reconstruction - external vs. internal: the comparative method; lexicostatistics; language contact and dialect geography – borrowing and impact of borrowing; pidgins and creoles; bi- and multilingualism as the source for borrowing; dialect geography - dialect atlas; isogloss, focal, transition and relic areas.

**Sociolinguistics:** Micro-and macro approaches to language in society; linguistic repertoire language, dialect, sociolect, idiolect; diglossia; taboo, slang and euphemism; elaborated and restricted codes; speech community and communicative competence; ethnography of speaking; lingua franca; diasporic language; linguistic variables and their co-variation along linguistic/social dimensions; language policies and development (especially in India); language contact and outcomes (language loss, pidginization and creolization); code-mixing and code-switching; language movements – state and societal interventions; script development and modifications; linguistic minorities; language ecology and endangerment linguistic vitality, language endangerment (EGIDS scale), parameters of endangerment, documentation and revitalisation.

**Areal Typology, Universals, Cross-linguistic Features:** morphological types of languages agglutinative, analytical (isolating), synthetic fusional (inflecting), polysynthetic (incorporating) languages; formal and substantive universals, absolute and statistical universals; implicational and non-implicational universals (Greenberg); linguistic relatedness—genetic, typological and areal classification of languages; universals and

parametric variation; word order typology; salient features of South Asian languages - Indo-Aryan, Dravidian, Austro-Asiatic, and Tibeto-Burman language families; Linguistic Survey of India; contact induced typological change.

**Methods of analysis:** Experimental and non-experimental methods; sampling and tools; identification of variables and their variants; data processing and interpretation; quantitative analysis of data; ethnomethodology; participant observation; field methods and elicitation; document creation; ethics.

**Applied Linguistics** (Can be expanded to include Interdisciplinary areas that focus on language and Language Teaching depending on interest and requirement.)

Example: Psycholinguistics: the study of how humans learn, represent, comprehend, and produce language. Topics include word recognition and storage, sentence production and comprehension, reading, speech perception, language acquisition, neural representation of language, bilingualism, and language disorders.

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**Humanities and Social Sciences**

**Microeconomics:** Theory of Consumer Behaviour: Cardinal Approach and Ordinal Approach; Consumer Preferences; Nature of the utility function; Marshallian and Hicksian demand functions; Duality Theorem. Slutsky equation and Comparative Statics. Homogeneous and Homothetic Utility Functions; Euler's Theorem. The Theory of Revealed Preference: Weak Axiom of Revealed Preference and Strong Axiom of Revealed Preference, Theory of Production and Costs: Short-run and Long-run Analysis, Existence, Uniqueness and Stability of Market Equilibrium: Walrasian and Marshallian Stability Analysis. The Cobweb Model, Decision making under uncertainty and risk. Asymmetric Information: Adverse Selection and Moral Hazard. Theory of Agency costs. The Theory of Search, Non-Cooperative games: Constant sum game, Mixed Strategy & Pure Strategy, Bayesian Nash Equilibrium, SPNE, Perfect Bayesian Equilibria., Theory of Firm: Market Structures — Competitive and Non-competitive equilibria and their efficiency properties. Structure-Conduct- Performance Paradigm, Factor Pricing: Marginal productivity Theory of Distribution in Perfectly Competitive markets; Theory of Employment in Imperfectly Competitive Markets — Monopolistic Exploitation, General Equilibrium Analysis. Welfare Economics: Fundamental Theorems, Social Welfare Function. Efficiency Criteria: Pareto-Optimality.

**Macroeconomics:** National Income Accounting: Closed Economy Concepts and Measurement and Open Economy Issues, Determination of output and employment: Classical & Keynesian Framework, Theories of Consumption: Absolute Income Hypothesis, Relative Income Hypothesis, Life Cycle Hypothesis, Permanent Income Hypothesis and Robert Hall's Random Walk Model; Investment Function Specifications - Dale Jorgenson's Neoclassical Theory of Capital Accumulation and Tobin's, Keynesian Stabilization Policies, (Autonomous) Multipliers and Investment Accelerator, Demand and Supply of Money, Components of Money Supply, Liquidity Preference and Liquidity Trap, Money Multiplier, Interest Rate determination, Central Banking, Objectives, Instruments (Direct and Indirect) of Monetary Policy, Prudential Regulation, Quantitative Easing (Unconventional Monetary Policy), Commercial Banking, Non-Banking Financial Institutions, Capital Market and its Regulation, Theories of Inflation and Expectations Augmented Phillips Curve, Real Business Cycles, Adaptive Expectations Hypothesis, Rational Expectation Hypothesis and its critique. Closed Economy IS — LM Model and Mundell Fleming Model: Monetary and Fiscal Policy Efficacy. The Impossible Trinity.

**Statistics, Econometrics and Mathematical Economics:** Probability Theory: Concepts of probability, Probability Distributions [Discrete and Continuous], Central Limit Theorem, Index Numbers and Construction of Price Indices, Sampling Methods & Sampling Distribution, Statistical Inferences, Hypothesis Testing, Linear Regression Models and the Gauss Markov Theorem, Heteroscedasticity, Multicollinearity and Autocorrelation, Spurious regressions and Unit roots, Simultaneous Equation Models — recursive and non-recursive. Identification Problem, Differential Calculus and its Applications, Linear Algebra — Matrices, Applications of Cramer's Rule, Static Optimization Problems and Applications, Input-Output Model, Linear Programming, Difference equations and Differential equations with applications

**International Economics:** Theories of International Trade, International Trade under Imperfect Competition, Gains from Trade, Terms of Trade, Trade Multiplier, Tariff and Non-Tariff barriers to trade; Dumping and Anti-Dumping Policies, GATT, WTO and Regional Trade Blocks; Trade Policy Issues, Balance of Payments: Composition, Equilibrium and Disequilibrium and Adjustment Mechanisms, Foreign Exchange Market and Arbitrage, Exchange rate determination, IMF & World Bank.

**Public Economics:** Market Failure and Remedial Measures: Asymmetric Information, Public Goods,

Externality, Regulation of Market — Collusion and Consumers' Welfare, Public Revenue: Tax & Non-Tax Revenue, Direct & Indirect Taxes, Progressive and non-Progressive Taxation, Incidence and Effects of Taxation, Public expenditure, Public Debt and its management, Public Budget and Budget Multiplier, Tax Incidence, Fiscal Policy and its implications, Environment as a Public Good, Market Failure and Coase Theorem, Cost-Benefit Analysis.

**Development Economics:** Theories of Economic Development: Adam Smith, David Ricardo, Karl Marx, J. Schumpeter, W. Rostow, Balanced & Unbalanced Growth, Big Push Approach, Indicators of Economic Development: HDI, SDGs, MDGs, Poverty and Inequalities — Concepts and Measurement Issues, Social Sector Development: Health, Education, Gender, Fertility, Morbidity, Mortality, Migration, Child Labor, Age Structure, Demographic Dividend, Models of Economic Growth: Harrod-Domar, Solow, Ramsey, Technical progress — Disembodied & Embodied, Endogenous Growth Models.

**Indian Economy:** Economic Growth in India: Pattern and Structure, Agriculture, Industry & Services Sector: Pattern & Structure of Growth, Major Challenges, Policy Responses, Rural & Urban Development — Issues, Challenges & Policy Responses, Flow of Foreign Capital, Trade Policies, Infrastructure Development: Physical and Social; Public-Private Partnerships, Reforms in Land, Labour and Capital Markets, Poverty, Inequality & Unemployment, Functioning of Monetary Policy in India, Fiscal Policy in the Indian context: Structure of Receipts and Expenditure, Tax reforms-Goods and Services Tax, Issues of Growth and Equity, Fiscal Federalism, Centre-State Financial Relations and Finance Commissions of India; Sustainability of Deficits and Debt, The Fiscal Responsibility and Budget Management Act 2003, Demonetization and aftermath. India's balance of payments, Composition of India's Trade, Competitiveness of India's exports, India's exchange rate policy.

**Social Psychology:** Social perception: Attribution; impression formation; social categorization, implicit personality theory, Social influence: conformity, compliance and obedience, Attitudes, beliefs and values: Evaluating the social world, attitude formation, attitude change and persuasion, cognitive dissonance, Prejudice, discrimination, Aggression, power and prosocial behaviour, Belief systems and value patterns. Group dynamics, leadership style and effectiveness, Theories of intergroup relations and conflicts.

**Development across the Life Span:** Nature versus nurture in human development, Prenatal development: Chromosomes, Genes and DNA. Physical, cognitive and psychosocial development in infancy, childhood, adolescence and adulthood, Theories of aging, Moral development.

**Applications of Psychology:** Psychological disorders: Conceptions of mental disorders; Assessment and diagnosis, DSM and Other tools, PTSD and Trauma; Psychotherapies: Psychodynamic, Phenomenological/Experiential therapy; Behaviour therapy; cognitive therapy; biological therapy, Applications of theories of motivation and learning in School: Factors in educational achievement; counselling & guidance in schools, Application of theories of motivation, learning, emotions, perceptions, group dynamics & leadership to organizational set up, Issues of Personal space, crowding, and territoriality.

### **Sociological Concepts**

**Sociological Concepts:** Social Structure; Culture; Network; Status and Role; Identity; Community; Socialization; Diaspora; Values, Norms and Rules; Personhood, Habitus and Agency; Bureaucracy, Power and Authority; Self and society.

**Social Institutions:** Marriage, Family and Kinship; Economy; Polity; Religion; Education; Law and Customs.

Social Stratification: Social Difference, Hierarchy, Inequality and Marginalization: Caste and Class; Status and Power; Gender, Sexuality and Disability; Race, Tribe and Ethnicity.

**Social Change:** Evolution and Diffusion; Modernization and Development; Social Transformations and Globalization; Social Mobility — Sanskritization, Educational and Occupational change. **Agrarian**

**Sociology and Rural Transformation:** Rural and Peasant Society; Caste-Tribe Distinction and Continuum; Agrarian Social Structure and Emergent Class Relations; Land Ownership and Agrarian Relations; Decline of Agrarian Economy, De-Peasantization and Agrarian Change; Agrarian Unrest and Peasant Movements; Feudalism, Mode of production debate; Land reforms; Panchayati

Raj; Rural development programmes and community development; Green revolution and agricultural change; Peasants and farmers movements.

**Family, Marriage and Kinship; Theoretical Approaches:** Structural-Functionalist, Alliance and Cultural; Gender Relations and Power Dynamics; Inheritance, Succession and Authority; Gender, Sexuality and Reproduction; Children, Youth and Elderly; Emotions and Family; Emergent Forms of Family; Changing Marriage Practices; Changing Care and Support Systems; Family Laws; Domestic Violence and Crime against Women; Honour Killing.

**Indian Society / Sociology of India:** Colonial, Nationalist, Indological perspectives (G.S.Ghurye); Structural-Functional approach (M. N. Srinivas); Dialectical approach (A. R. Desai); Subaltern studies (R. Guha); Non Brahmin perspectives (Phule, Dr. Babasaheb Ambedkar); Feminist perspectives (LeelaDube, SharmilaRege); Social Institutions — Family, Kinship, Household, Village and Urban Settings; Social Stratification — Caste, Class, Tribe and Gender; Tradition and Modernity (M.N.Srinivas, Yogendra Singh, Dipankar Gupta); Peasants and agrarian sociology (Andre Beteille, AR Desai, D.N.Dhanagare); Village studies; Communalism and Secularism.

### **Social Movements**

**Introduction to social movements:** Nature, Definitions, Characteristics; Social Movement and Social Change; Types of social movements (Reform, Rebellion, Revival, Revolution, Insurrection, Counter Movement).

**Theories of Social Movements:** Structural –functional; Marxist; Resource Mobilization Theory; New Social Movements.

**Social Movement in India with specific reference to social basis, leadership, ideology and actions:** Peasant movement; Labour movement; Dalit movement; Women's movement, Environmental movement.

**Social Movements, civil society and globalization:** Social movement and its relationship with state and civil society; Social movements and impact of globalization: Debates; Issues of citizenship.

### **Sociology of Development**

**Perspectives on the Study of Development:** Definitions and Indices; Liberal, Marxist, and Neo-Marxist Perspectives (Dependency theory, World Systems); Epistemological Critiques of Development.

**State and Market:** Institutions and ideologies: Planned Development and Society; Globalisation and Liberalization.

### **The Micro-Politics of Development: Transforming Communities:**

Maps and Models; Knowledge and Power in Development; Re-inventing Development: Subaltern Movements; Post-colonial development; Decentralization and devolution; Participatory approaches.**Sustainable development:** Post-sustainable development; Development, violence and inequality; Post-structural perspectives (Escobar); Alternative development paradigms; Feminist critique; Human development.

# Computer Science and Engineering

## **Digital Logic**

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

## **Computer Organization and Architecture**

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

## **Programming and Data Structures**

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

## **Algorithms**

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

## **Theory of Computation**

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

## **Compiler Design**

Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation. Local optimisation, Data flow analyses: constant propagation, liveness analysis, common subexpression elimination.

## **Operating System**

System calls, processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU and I/O scheduling. Memory management and virtual memory. File systems.

## **Databases**

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

## **Computer Networks**

Concept of layering: OSI and TCP/IP Protocol Stacks; Basics of packet, circuit and virtual circuit-switching; Data link layer: framing, error detection, Medium Access Control, Ethernet bridging; Routing protocols: shortest path, flooding, distance vector and link state routing; Fragmentation and IP addressing, IPv4, CIDR notation, Basics of IP support protocols (ARP, DHCP, ICMP), Network Address Translation (NAT); Transport layer: flow control and congestion control, UDP, TCP, sockets; Application layer protocols: DNS, SMTP, HTTP, FTP, Email.

## Civil Engineering

### **Structural Engineering**

**Engineering Mechanics:** System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Frictions and its applications; Centre of mass; Free Vibrations of undamped SDOF system.

**Solid Mechanics:** Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, Transformation of stress; buckling of column, combined and direct bending stresses.

**Structural Analysis:** Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

**Construction Materials and Management:** Construction Materials: Structural Steel – Composition, material properties and behaviour; Concrete - Constituents, mix design, short-term and long-term properties. Construction Management: Types of construction projects; Project planning and network analysis - PERT and CPM; Cost estimation.

**Concrete Structures:** Working stress and Limit state design concepts; Design of beams, slabs, columns; Bond and development length; Prestressed concrete beams.

**Steel Structures:** Working stress and Limit state design concepts; Design of tension and compression members, beams and beam- columns, column bases; Connections - simple and eccentric, beam-column connections, plate girders and trusses; Concept of plastic analysis - beams and frames.

### **Geotechnical Engineering**

**Soil Mechanics:** Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Seepage through soils – two - dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force; Principle of effective stress and quicksand condition; Compaction of soils; One- dimensional consolidation, time rate of consolidation; Shear Strength, Mohr's circle, effective and total shear strength parameters, Stress-Strain characteristics of clays and sand; Stress paths.

**Foundation Engineering:** Sub-surface investigations - Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes – Finite and infinite slopes, Bishop's method; Stress distribution in soils – Boussinesq's theory; Pressure bulbs, Shallow foundations – Terzaghi's and Meyerhoff's bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations – dynamic and static formulae, Axial load capacity of piles in sands and clays, pile load test, pile under lateral loading, pile group efficiency, negative skin friction.

### **Water Resources Engineering**

**Fluid Mechanics:** Properties of fluids, fluid statics; Continuity, momentum and energy equations and their applications; Potential flow, Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth; Concept of lift and drag.

**Hydraulics:** Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles.

**Hydrology:** Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy's Law.

**Irrigation:** Types of irrigation systems and methods; Crop water requirements - Duty, delta, evapo-transpiration; Gravity Dams and Spillways; Lined and unlined canals, Design of weirs on permeable foundation; cross drainage structures.



## **Environmental Engineering**

**Water and Waste Water Quality and Treatment:** Basics of water quality standards – Physical, chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment.

Sewerage system design, quantity of domestic wastewater, primary and secondary treatment. Effluent discharge standards; Sludge disposal; Reuse of treated sewage for different applications.

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

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

## **Transportation Engineering**

**Transportation Infrastructure:** Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments.

Geometric design of railway Track – Speed and Cant.

Concept of airport runway length, calculations and corrections; taxiway and exit taxiway design.

**Highway Pavements:** Highway materials - desirable properties and tests; Desirable properties of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible and rigid pavement using IRC codes

**Traffic Engineering:** Traffic studies on flow and speed, peak hour factor, accident study, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Traffic signs; Signal design by Webster's method; Types of intersections; Highway capacity.

## **Geomatics Engineering**

Principles of surveying; Errors and their adjustment; Maps - scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and vertical curves.

Photogrammetry and Remote Sensing - Scale, flying height; Basics of remote sensing and GIS.

# Electronics and Communication Engineering

## **Networks, Signals and Systems**

**Circuit Analysis:** Node and mesh analysis, superposition, Thevenin's theorem, Norton's theorem, reciprocity. Sinusoidal steady state analysis: phasors, complex power, maximum power transfer. Time and frequency domain analysis of linear circuits: RL, RC and RLC circuits, solution of network equations using Laplace transform.

Linear 2-port network parameters, wye-delta transformation.

**Continuous-time Signals:** Fourier series and Fourier transform, sampling theorem and applications.

**Discrete-time Signals:** DTFT, DFT, z-transform, discrete-time processing of continuous-time signals. LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeroes, frequency response, group delay, phase delay.

## **Electronic Devices**

Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors.

**Carrier Transport:** diffusion current, drift current, mobility and resistivity, generation and recombination of carriers, Poisson and continuity equations.

P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell.

## **Analog Circuits**

**Diode Circuits:** clipping, clamping and rectifiers.

**BJT and MOSFET Amplifiers:** biasing, ac coupling, small signal analysis, frequency response. Current mirrors and differential amplifiers.

**Op-amp Circuits:** Amplifiers, summers, differentiators, integrators, active filters, Schmitt triggers and oscillators.

## **Digital Circuits**

**Number Representations:** binary, integer and floating-point numbers. Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders.

**Sequential Circuits:** latches and flip-flops, counters, shift-registers, finite state machines, propagation delay, setup and hold time, critical path delay.

**Data Converters:** sample and hold circuits, ADCs and DACs.

**Semiconductor Memories:** ROM, SRAM, DRAM.

**Computer Organization:** Machine instructions and addressing modes, ALU, data-path and control unit, instruction pipelining.

## **Control Systems**

Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Lag, lead and lag-lead compensation; State variable model and solution of state equation of LTI systems.

## **Communications**

**Random Processes:** auto correlation and power spectral density, properties of white noise, filtering of random signals through LTI systems.

**Analog Communications:** amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, super heterodyne receivers.

**Information Theory:** entropy, mutual information and channel capacity theorem.

**Digital Communications:** PCM, DPCM, digital modulation schemes (ASK, PSK, FSK, QAM), bandwidth, inter-symbol interference, MAP, ML detection, matched filter receiver, SNR and

BER.

Fundamentals of error correction, Hamming codes, CRC.

## **Electromagnetics**

**Maxwell's Equations:** differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector.

**Plane Waves and Properties:** reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth.

**Transmission Lines:** equations, characteristic impedance, impedance matching, impedancetransformation, S-parameters, Smith chart.

Rectangular and circular waveguides, light propagation in optical fibers, dipole and monopole antennas, linear antenna arrays.

# **Electrical and Electronics Engineering**

## **Electric circuits**

**Network Elements:** ideal voltage and current sources, dependent sources, R, L, C, M elements; Network solution methods: KCL, KVL, Node and Mesh analysis; Network Theorems: Thevenin's, Norton's, Superposition and Maximum Power Transfer theorem; Transient response of dc and ac networks, sinusoidal steady-state analysis, resonance, two port networks, balanced three phase circuits, star-delta transformation, complex power and powerfactor in ac circuits.

## **Electromagnetic Fields**

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

## **Signals and Systems**

Representation of continuous and discrete time signals, shifting and scaling properties, linear time invariant and causal systems, Fourier series representation of continuous and discrete time periodic signals, sampling theorem, Applications of Fourier Transform for continuous and discrete time signals, Laplace Transform and Z transform. R.M.S. value, average value calculation for any general periodic waveform.

## **Electrical Machines**

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three-phase transformers: connections, vector groups, parallel operation; Auto-transformer, Electromechanical energy conversion principles; DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, speed control of dc motors; Three-phase induction machines: 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 and characteristics, regulation and parallel operation of generators, starting of synchronous motors; Types of losses and efficiency calculations of electric machines.

## **Power Systems**

Basic concepts of electrical power generation, ac and dc transmission concepts, Models and performance of transmission lines and cables, Economic Load Dispatch (with and without considering transmission losses), 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, directional and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

## **Control Systems**

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

## **Electrical and Electronic Measurements**

Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multi-meters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

## **Analog and Digital Electronics**

Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers; operational amplifiers: characteristics and applications; single stage active filters, Active Filters: Sallen Key, Butterworth, VCOs and timers, combinatorial and sequential logic circuits, multiplexers, demultiplexers, Schmitt triggers, sample and hold circuits, A/D and D/A converters. Power Electronics

Static V-I characteristics and firing/gating circuits for Thyristor, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost Converters; Single and three-phase configuration of uncontrolled rectifiers; Voltage and Current commutated Thyristor based converters; Bidirectional ac to dc voltage source converters; Magnitude and Phase of line current harmonics for uncontrolled and thyristor based converters; Power factor and Distortion Factor of ac to dc converters; Single-phase and three-phase voltage and current source inverters, sinusoidal pulse width modulation.