Appendix-1

SCHEME OF EXAMINATION

1. The examination will be conducted in the following successive stages -
   i. Written Examination
   ii Interview (Personality Test)

2. The written examination will be conducted in General English General Knowledge and concerned subject.

3. General English and General Knowledge will be covered in one paper consisting of 100 marks(50 marks each) & the examination shall be of 2 hours duration. The examination will be conducted in objective type pattern. There shall be negative marking of 25% weightage.

4. The examination in the concerned subject will cover 400 marks consisting of two papers i.e. Paper-I and Paper-II having 200 marks each. The examination will be in objective type pattern & each papers shall be of 3 hours duration. Candidates are required to answer the papers in English only. Chapter-wise distribution of marks and type of questions to be set for the written test shall be decided by the Commission. However, care shall be taken to cover all the chapters prescribed in the syllabus.

   The standard of Examination shall be of Master's Degree in respect of the posts/disciplines for which the qualification is Master's Degree and the standard of Examination shall be of Bachelor's Degree in respect of the posts/disciplines for which the qualification is Bachelor's Degree as prescribed in Schedule-A of the Odisha Technical Education and Training Service (Amendment) Rules, 2013.

5. The candidates, who will secure qualifying marks in the written examination, as may be fixed by the Commission, will be called for Interview in order of merit provided that where the number of vacancies is upto 2(two), the number of candidates to be called for interview shall be 5(five) and where the number of vacancy exceeds 2(two), the number of candidates to be called for interview shall be twice the number of vacancies.

6. The Commission shall conduct the Interview for 50 marks.

7. The Commission shall be competent to fix-up the qualifying marks and duration of examination in any or all the subjects of the examination and Interview in consultation with Experts. However, the merit list shall be prepared by taking both the marks in the written examination of General English, General Knowledge, Subject Papers (Paper-I & II) and Interview together discipline-wise and a combined merit list of all disciplines advertised through a common advertisement shall be prepared by the Commission and intimated to the Government.

COMPULSORY PAPER

General English

The question paper in General English will be designed to test the candidate's understanding of English and workmanlike use of words. The distribution of questions and marks would be as follows:

1. Grammar usages and Vocabulary - 35 marks
2. Comprehension - 15 marks

Total - 50 marks

The standard of questions of General English may be equal to Higher Secondary Level (+2 Level).

General Knowledge

The paper in General Knowledge will include knowledge of current events and matters as of everyday observation and experience in the scientific aspects of life as may be expected of an educated person. The paper will also include questions on History of India and Geography of such standard which the candidates should be able to answer without special study. Total 50 marks.

1. MATHEMATICS AND SCIENCE (PHYSICS)

PAPER– I

Unit-I: Mathematical Physics

1. Complex variable: Cauchy's theorem, Cauchy's integral formula, classification of singularities, branch point and branch cut, Residue theorem, evaluation of integral using residue theorem.

2. Special functions: Basic properties and solutions (series expansion, recurrence and orthogonality relations) of Bessel, Legendre, Laguerre functions, Solution of inhomogeneous partial differential equation by method of Green's function.

3. Tensors: Cartesian tensors, covariant, contravariant and mixed tensor, tensor algebra, properties of symmetric and anti symmetric tensor.

Unit-II: Classical Mechanics

1. Hamilton's principle: Hamilton's principle, Lagrange's equation from Hamilton's principle, Solution of Lagrange equation of motion for Simple harmonic oscillator. Hamilton' equations of motion, canonical equations from variational principle, principle of least action.

2. Canonical transformation: Generating function and Legendre transformation, Integral invariant of Poincare, Lagrange and Poisson's brackets.

3. Rigid body: Independent coordinates orthogonal transformation and rotations (finite and infinitesimal), Euler's angles, Euler's theorem on the motion of rigid body, Inertia Tensor and principal axis transformation, angular momentum and kinetic energy of rotation in terms of Euler's angles. Euler's equation of motion, torque free motion of rigid body, heavy symmetrical top with one point fixed.

Unit-III: Classical Electrodynamics

1. Electrostatics and Magnetostatics: Scalar and vector potential, Gauge transformation, multiple expansion of (i) scalar potential and electrostatic energy due to static charge distribution, (ii) vector potential due to stationary current distribution, Electrostatic and magnetostatic energy, Poynting 's theorem, Maxwell's stress tensor.

2. Relativistic electrodynamics: Equation of motion in an electromagnetic field, electromagnetic field tensor, covariance of Maxwell's equation, Maxwell's equations as equations of motion, Lorentz transformation laws for electromagnetic field, and the fields due to point charge in uniform motion, Field invariants , covariance of Lorentz force equation of motion, and equation of motion of a charged particle in an electromagnetic field.

Energy momentum tensor and conservation laws for electromagnetic field, Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field.

Unit-IV: Quantum Mechanics-I

1. Wave packet: Gaussian wave packet, spreading of wave packet, coordinate and momentum representation, x and p in these representation, Dirac delta function.

2. Operator method in Quantum Mechanics: Formulation of Quantum Mechanics in vector space language, uncertainty product of two arbitrary operators, one dimensional harmonic oscillator by operator method. Matrix representation of operators, Schrodinger, Heisenberg and interaction pictures. Dirac bracket notation.

3. Symmetry, invariance principle and conservation Laws: Space translational invariance, time translational invariance and rotational invariance and conservation laws.

4. Angular momentum: Angular momentum algebra, addition of two angular momenta j_1=1/2, j_2=1/2. Clebsch--Gordon Coefficients, examples, matrix representation of j_1=1/2 and j_2=1. Spin angular momentum, Pauli spin matrices and their properties, eigen value and eigen function,

5. Approximation methods: Time independent perturbation theory, First and second order correction to energy and eigen functions, Degenerate perturbation theory, application to one electron system, relativistic mass correction, Spin-Orbit coupling, Zeeman effect, linear Stark effect. Fine structure of spectral line of H-like atom.

Unit-V: Statistical Mechanics

1. Objectives of Classical Statistical Mechanics: Boltzmann's postulates of entropy, micro canonical ensemble, entropy of ideal gas, Gibb's paradox.

2. Canonical ensemble: Expression for entropy, canonical partition function, Helmholtz free energy, energy fluctuation,

3. Grand canonical ensemble: Grand canonical partition function, chemical potential, density fluctuation, chemical potential of an ideal gas,

4. Quantum Statistical Mechanics: Planck's law of black body radiation, equation of state for ideal Fermi gas at low density-high temperature and at high density-low temperature, theory of white dwarf star, relation between chemical potential and Fermi energy.

PAPER-II

Unit-I: Quantum Mechanics-II

1. WKB Approximation: Connection formulae, Bohr quantization rule, barrier penetration and α-decay,

2. Variational method: He atom as an example, First order perturbation, exchange degeneracy.

3. Time dependant perturbation theory: Interaction picture, Transition probability, constant and harmonic perturbation, Fermi Golden Rule, electric dipole radiation, selection rule, Spontaneous emission, Einstein's A and B coefficients, Principle of Laser

4. Identical Particles: Symmetric and anti-symmetric wave functions, Slater determinant, symmetric and anti-symmetric wave functions of two identical spin ½ particles.

Unit-II: Relativistic Quantum Mechanics and Field theory

1. Dirac Equation: Dirac equation, properties of Dirac γ-matrices,Non-relativistic reduction of Dirac equation,magnetic moment of electron, Spin-Orbit coupling, Covariance of Dirac equation and bilinear covarints.

2. Solution of Dirac Equation: Free particle solution of Dirac equation and its physical interpretation, projection operator for spin and energy.

Unit-III : Electronics

1. Amplifiers: Frequency response of linear amplifier, amplifier pass band, R-C, L-C and transformer coupled amplifier, feed back amplifier, book-strapping the FET, stability, noise.

2. Oscillators: Feedback criteria for oscillation, phase shift, Wien bridge, crystal controlled and Klystron oscillators, multi vibrators- astable, monostale and bistable.

3. Digital Circuits: Logic fundamentals, Boolean theorem, Logic gates-RTL,DTL,TTL, RS flipflop, JK flip-flops.

4.Boolean algebra: De Morgan theorem, AND,NAND,NOT,NOR gates(CMOS,NMOS), MOS circuits.

Unit-IV: Condensed Matter Physics

1. Band Theory of Solid: Bloch equation, empty lattice band, nearly free electron bands, no of states in band, tight binding method, effective mass of electron in the band, concept of holes, classification of metal, semiconductor and insulator, intrinsic and extrinsic semiconductors, intrinsic carrier concentration,

2. Dielectric Properties of solids: Electronic and ionic polarization of molecules, static dielectric constants of gases, Lorentz internal fields,. static dielectric constant of solids, classical theory of electronic polarization and optical absorption, Clausius-Mossotti equation, elementary idea of ferroelectricity.

3. Magnetic Properties of Solids: Origin of Magnetism, quantum theory of diamagnetism, paramagnetism, Pauli Paramagnetism, Ferromagnetism, Curie-Weiss law, ferromagnetic domain , ferri and anti ferromagnetism,

4. Superconductivity: Phenomenological description of superconductivity, Meissner effect, Type-I and type-II superconductors, London's equation, outlines of BCS theory.

Unit-V: Nuclear and Particle Physics.

1. Nuclear Properties: Basic nuclear properties: nuclear size, nuclear radius and charge distribution, nuclear form factor, mass and binding energy, Angular momentum, parity and symmetry, Magneticdipole moment and electric quadrupole moment.

2. Two body bound state: Properties of deuteron, Schrodinger equation and its solution for ground state of deuteron, rms radius, spin dependence of nuclear forces, electromagnetic moment and magnetic dipole moment of deuteron and the necessity of tensor forces.

3. β-decay: β- emission and electron capture, Fermi's theory of allowed β-decay, Selection rules for Fermi and Gamow-Teller transitions, Parity non-conservation.

4. Nuclear Reactions and Fission: Different types of reactions, Quantum mechanical theory, Resonance scattering and reactions, Nuclear fission: Experimental features, spontaneous fission, liquid drop model, barrier penetration, statistical model.

2. MATHEMATICS AND SCIENCE (CHEMISTRY)

PAPER-I

SECTION-A: PHYSICAL CHEMISTRY

Unit-I:

Classical thermodynamics

Brief resume of concepts of law of thermodynamics – free energy, chemical potential and entropies – Partial molar properties – partial molar free energy – partial molar volume and partial molar heat content and their significances – concept of fugacity and determination of fugacity – activity – activity coefficient – Third law of thermodynamics,

Unit-II:

Chemical dynamics

Empirical rate laws – Theories of reaction rates – Determination of reaction mechanism – Reaction in solutions – catalysed reaction kinetics

Electrochemistry

Electrochemistry of solutions – Debye – Huckel – Onsager treatment and its extension, Ion association – Thermodynamics of electrified interfaces – Lipmann equation – Butler Volumer equation – theory of double layer at interfaces and semiconductor – corrosion and prevention methods.

Unit-III:

Surface chemistry

Adsorption – Surface tension, Capillary action – pressure difference across curved surface isotherm – BET equation – surface films on liquids.

Polymers : Definition, type of polymers – kinetie of polymerization – mechanism of polymerization –Solid state chemistry : Structural classification of solids of binary and ternary compounds – defects in solids – Electrical properties : Metals, insulator, semiconductor, super conductors – band theory of solids.

Phase equilibria: Thermodynamic derivation of phase rule – Three component systems and their application.

Unit-IV

Quantum Mechanics

Postulates – Particle in box, rigid rotator – harmonic oscillator – variation principles, first order perturbation principle – angular momentum

SECTION – B : INORGANIC CHEMISTRY

Unit-I

Periodic properties and chemical bondChemical periodicity, VSEPR theory for different types of molecules, Walsh diagram (tri- and penta – atomic molecules), dπ-pπ bond, bent rule and energetic of hybridization some simple reactions of covalently bonded molecules.

Acid-base concept and Non-aqueous solvents

Hard-soft acid base concept – acid base strength – theoretical basis of hardness and softness. Non aqueous solvents: types and characteristics – reactions in non-aqueous solvents.

Symmetry and Group Theory in Chemistry

Symmetry elements and symmetry operations – definitions of group, subgroup, cosets relation between orders of a finite group and its subgroup – Conjugacy relation and classes. Point symmetry group – Stoneflies symbols – representations of groups by matrices (representation for the Cn, Cnv, Cnh, Dnh groups) – Character of a representation – The great Orthogonality theorem (without proof)

Unit-II

Chemistry of transition and inner transition elements: General characteristics of 1st row transition elements and inner transition elements with special reference to electronic structure, ionic radii, oxidation states, complex formation, magnetic behaviour and spectral properties.

Coordination compounds

Nomenclature and isomerism of coordination compounds – valence bond theory and its limitations – Crystal field theory and its applications to octahedral, tetrahedral and square planer complexes – Limitations of crystal field theory – Molecular orbital theory: sigma bonding and energy level diagram in octahedral, tetrahedral and square planar complexes: bonding and energy level diagram in octahedral complexes.

Unit-III

Metal – Ligand Equilibria in Solution

Stepwise and overall formation constants and their interrelation, factors affecting the stability of metal complexes – chelate effect and its thermodynamic origin

Reaction mechanism of transition metal complexes

Energy profile of a reaction – Thermodynamic and kinetic stability of metal complexes – Kinetic application of valence bond and crystal field theories.

Substitution reactions of octahedral complexes: acid hydrolysis – base hydrolysis: conjugate base mechanism and the direct/indirect evidences – Substitution reactions in square planar complexes: the trans effect and its application to synthesis of complexes – theories of trans effect – mechanism and factors affecting the substitution reactions

Nuclear chemistry

Radioactive disintegrations, radio isotopes and their applications, nuclear reactions, fission and fusion, radio analytical techniques and activation analysis.

Unit-IV

Metal π complexes

Metal carbonyls: synthesis, structure and bonding – vibrational, spectra of metal carbonyls for bonding and structural elucidation – EAN concept and application to metal carbondyOrganometallic Chemistry

Organometallic Chemistry

Preparation, properties and applications alkyl and aryls of group-I and II metal (Li, Mg, Zn) and transition metals (Ti, Ni,. Cu and Pd).

Bioinorganic Chemistry

Essential and trace metals in biological processes – role of alkali and alkaline earch metal jons - Na+- K+ Pump – metalloporphyrins with special reference to hemoglobin and myoglobin, Metal complexes in transmission of energy – chlorophylix, photosystem-I and photosystem-II in cleavage of water - ATP as energy currency in biological system.

Structure and function of metalloproteins in electron transport processes – cytochromes and ferrodoxin.

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidences – Metal complexes in medicine.

PAPER-II

SECTION-A : ORGANIC CHEMISTRY

Unit-I

Stereochemistry, structure and reactivity

Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding. Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiopticanddiasterotopic atoms, groups and faces, sterospecific and steroselective synthesis – Asymmetric synthesis – Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape.

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects.

Aliphatic nucleophilic substitution

The SN2, SN1, mixed SN1 and SN2 and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by p and s bonds, anchimeric assistance

The SN1 mechanism.

Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon.Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.

Aliphatic electrophilic substitution

Bimolecular mechanisms – SE2 and SFi. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving ground and the solvent polarity on the reactivity.

Unit-II

Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams, the ortho/para ratio, ipso attach, orientation in other ring systems – Quantitative treatment of reactivity in substrates and electrophiles – Diazonium coupling – Vilsmeir reaction, Gattermann - Koch reaction.

Aromatic Nucleophilic Sustitution TheSNAr, SN1, benzyne and SRN1 mechanisms. Reactivity – effect of substrate structure, leaving group and attacking nuleophile. The von Richter, Sommelet – Hauser, and Smiles rearrangements.

Free radical reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance – Reactivity for aliphatic and aromatic sustrates at a bridgehead.Reactivity in the attacking radicals – The effect of solvents on ractivity. Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

Addition to Carbon – Carbon Multiple Bonds

Mechanism and stereochemical aspects of addition reactions involving electrophies, nucleophiles and free radicals, regio – and chemo selectivity, orientation and reactivity. Addition to cyclopropane ring – Hydrogenation of double andtriple bonds, hydrogenationof aromatic rings. Hydroboration – Michael reaction

Addition to Carbon – Hetero Multiple Bonds.

Mechanism of metal Hydride reduction of saturated and unsaturated carbony1 compounds, acids, esters and nitriles. Addition of Grignard reagents,organozinc and organolithium reagents tocarbony1 and unsaturated carbony1 compounds. Witting reaction – Mechanism of condensation

reactions involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions.

Elimination Reactions

The E2, E1 and E1CB mechanisms and their spectrum –Orientation of the double bond Reactivity – effect of substrate structures, attacking base, the leaving and the medium.Mechanism and orientation in pyrolytic elimination.

Unit-III

Pericyclic Reactions

Molecular orbital symmetry, frontier orbitals of ethylene, 1, 3- butadiene, 1,3,5 – hexatriene and ally1 system. Classification of pericyclic reactions. Woodward – Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions – conrotatory and disrotatory motions – antrafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and chelotropic reactions.

Sigmatropic rearrangements – suprafacial and antrafacial shifts of H, Sigmatropic shifts involving carbon moieties, 3,3 – and 5,5 – Sigmatropic rearrangements, Claisen, Cope and aza- Cope rearrangements. Fluxional tautomerism.Ene reaction.

Photochemical Reactions

Interaction of electromagnetic radiation with matter, type of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

Photochemistry of Alkenes : Intramolecular reactions of the olefinic bond – geometrical isomerism, cyclisation reactions, rearrangement of 1,4- and 1.5- dienes.

Photochemistry of Carbony1 Compounds : Intramolecular reactions of carbony1 compounds – saturated, cyclic and acyclic, β,γ-unsaturated and α, β- unsaturated compounds, cyclohexadienones

Photochemistry of Aromatic Compounds :Isomerisations, additions and substitutions.

Photochemical formation of smog.

Unit-IV

Disconnection approach

An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversion, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reaction and amine synthesis.

Protecting groups : Principle of protection of alcohol, amine, carbony1 and carboxy1 groups.

SECTION-B: ANALYTICAL CHEM

Unit-I

Introduction to analytical chemistry and data processing -Role of analytical chemistry, classification of analytical methods, types of instrumental analysis

Environmental samples and their analyses

Aquatic pollution: Inorganic, organic, pesticides, agricultural, industrial etc.-Water qualify parameters: dissolved oxygen, biochemical oxygen demand, solids, metals, content of chlorides, fluoride, sulfate, phosphate, nitrate.

Analytical methods for measuring BOD, DO, COD, fluoride, nitrate (As, Cd, Cr, Hg, Pb, Se etc.)

Unit-II

Ultraviolet and Visible Spectroscopy

Various electronic transitions, Beer-Lambert's Law, effect of solvent on electronic transitions, ultraviolet bands for carbony1 compounds, unsaturated carbony1 compounds, dienes, conjugated polyenes.Fieser – Woodward rules for conjugated dienes and carbony1 compounds, ultraviolet spectra of aromatic compounds

Infrared Spectroscopy

Principles – Vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols, ary1 aminers. Detailed study of vibrational frequencies of carbony1 compounds (Ketones, aldehydes), esters, amides, acids, anhydrides, lactones, lactams and conjugated carbony1 compounds. H-bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance.

Nuclear Magnetic Resonance Spectroscopy

Principles, chemical shift, spin-spin interaction, shielding mechanism, chemical shift values and correlation for protons bonded to carbon (Aliphatic, olefinic, enols, carboxylic acids, amines, amides &mercapto) chemical exchange, effect of deuteration, complex spin-spin interaction between two, three, four and five nuclei (first order spectra), virtual coupling. Stereochemistry, hindred rotation, Karplus curve-variation of coupling constant with dihedral angle.Simplification of complex spectra nuclear magnetic double resonance, chemical shift reagents, solvent effects.

Mass Spectrometry-analysis and abundance – Mass spectral fragmentation of organic compounds, common functional groups – Molecular ion peak -- Metastable peak, Mc Lafferty rearrangement.

Problems relating to elucidation of structure of simple organic molecules using UVVIS, IR, NMR and Mass spectral data.

Unit-III

Solvent Extraction and ion exchange

Solvent Extraction: Principles, classification of extraction, mechanism of extraction, extraction equilibria, techniques of extraction, applications in analytical chemistry.

Ion exchange: Type of ion exchange resins, synthesis and characteristics of ion exchange resins, action of ion exchange resins, ion exchange equilibria, technique of ion exchange, application of ion exchange in analytical chemistry

Unit-IV

Electron spin resonance

Principles zero filed splitting and Kramer's degeneracy, factors affecting the g value, hyperfine splitting and applications to sample radicals.

3. MATHEMATICS AND SCIENCE (MATHEMATICS)

PAPER – I

UNIT – I ALGEBRA AND NUMBER THEORY

Group Theory: Groups, Subgroups, Normal Subgroups and Quotient Groups, Homomorphisms and applications, Permutation groups, Conjugacy and Class equation, Simple group, Sylow Theorms.

Ring Theory: Rings, Special Classes of rings, Homomorphisms, Ideals and Quotient rings, Maximal and Prime ideals, Polynomial rings, Principal Ideal Domain, Unique Factorization Domain.

Field : Field of Quotients of an Integral Domain, Polynomials over the rational field, Algebraic Extension of Fields: Irreducible polynomials and Eisenstein Criterion, roots of Polynomial, Splitting field and its degree of extension, Multiple roots, Ruler and Compass Constructions, Symmetric function of roots, Solution of Cubic and Biquadratic Equations.

Number Theory: Integers, g.c.d., Fundamental Theorem of Arithmetic, Euclidean Alogorithm, Arithmetical functions (Euler-function, Mobius function-), Dirichlet multiplication, Linear Congruences, Euler-Fermat Theorem, Linear Diophantine Equations, Fermat's Theorem, Fermat Little Theorem, Polynomial Congruence, Lagrange's Theorem, Chinese Remainder Theorem, Wilson's Theorem and Applications.

UNIT –II

ANALYSIS –I

Basic Topology: Finite, Countable and Uncountable sets, Metric Spaces, Topological Spaces, Basis, Closed sets, Open Sets, Limit Points, Properties of Connected Spaces and Compact Spaces, Heine Boril Theorem.

Sequence and Series : Convergent Sequences, Subsequences, Convergence of Monotone Sequences, Couchy Sequences, Upper and Lower limits of Sequences, Bolzano Weirstrass Theorem, Series of non-negative terms, Convergence tests, Power Series, Couchy Convergence Criterion, Absolute Convergence, Alternating Series.

Continuity and Differentiability: Properties of Continuous Function, Continuity and Compactness, Continuity and Connectedness, Discontinuity, Monotonic functions, Mean Value Theorem, Taylor Series.

Function of Several Variables: Continuity Differentiability, Extreme Values, Maxima and Minima, Line Integral, Surface Integral, Volume Integral, Applications of Green's Theorem, Stokes Theorem and Gauss Theorem.

UNIT – III COMPLEX ANALYSIS

Analytical Functions: Continuity, Differentiability, Couchy-Reimenn Equations, Analytic Functions, Harmonic Functions.

Bilinear Transformation: Elementary Transformations, Bilinear Transformation, Mapping by Elementary Functions.

Complex Integration: Cauchy- Gourset Theorem, Cauchy Integral Formula, Maximum Modulus Theorem, Liouville's Theorem, Morera's Theorem, Related Problems.

Singularities and Calculus of residues : Series Expansion, Taylor's Series, Laurent's Series, Zeros of Analytic Function, Singularities, Residues, Councy's Residue Theorem, Evaluation of Definite Integrals.

UNIT – IV OPERATIONS RESEARCH

Linear Programming: Simpler Method, Computational Procedure, Use of Artificial Variables.

Duality in Linear Programming: General Primal-dual pair, Duality Theorems, Complementary Slackness Theorem, Duality and Simplex Method, Dual Simplex Method.

Games and Strategies : Two-person-Zero Sum Games, Minimax-Maximin Principle, Games with Saddle Points, Mixed Strategies, Graphical Solutions, Dominance Property, Arithmetic Method of nxn Games, General Solution of nxn rectangular Games.

Transportation and Assignment: General Transportation Problem, Finding Initial Basic Feasible Solution, Test of Optionality, Transportation Algorithm, Transhipment Problems.

Mathematical Formulation of Assignment Problem, Method of Solution of Assignment Problem, Travelling Salesman Problem.

UNIT – V NUMERICAL ANALYSIS

Root Finding for Non-Linear Equations : Newton's Method, Secant Method, One-point Iteration Method, Multiple Roots, Newton Methods of Non-Linear Systems.

Interpolation Theory : Finite Differences, Newton's Forward and Backward differences, Newton's Divided differences, Lagrange's Interpolation, Errors in data and Forward differences, Hermite Interpolation, Piece-wise linear Interpolation.

Numerical Integration: Newton-cote integration formula, trapezoidal rule, Simpsons' rule, Gaussian quadrature, Asymptotic error formulas and their applications.

Numerical Methods for Ordinary Differential Equations : Euler's Method, Multistep Methods, Midpoint Method, Trapezoidal Method, Single Step Method and Runge-Kutta Method.

PAPER-II

UNIT-I ANALYSIS

Riemann stieltjes integral Existence of the integral, Properties of the integral, Fundamental theorem of calculus, change of variables in on integral, Differentiation of integral.

Sequence and series of functions

Uniform convergence of sequence of functions, Cauchy criterion for uniform convergence, weierstrass test for uniform convergence, uniform convergence and continuity, uniform convergence and differentiation, construction of continuous function on the real line which is nowhere differentiable.

Measure Theory Lebesgue outer measure , Properties of outer measure, Measurable sets, Cantor set, Borel set, and sets, Non measurable sets, Measurable functions, Properties of measurable functions.

Lebesgue integration and lp spaces comparison of Lebesgue and Riemann integral, Lebesgue integral of bounded measurable functions over sets of finite measure, Bounded convergence theorem, Lebesgue integral for nonnegative measurable function. Fatóu's Lemma, Monotone convergence theorem, lp spaces, essential supremum of a function, Minkowski and Holder inequalities, Absolute summable and summable series in a normal linear space completeness in lp.

UNIT-II FUNCTIONAL ANALYSIS

Normed Linear space Linear spaces, Subspaes, Quotient spaces, properties of norm, Riesz Lemma, Continuity of linear maps, Bounded linear operations, Equivalent norms, Hahn Banach theorem and its consequences.

Banach spaces Uniform boundedness principle, closed graph theorem and its consequences, open mapping theorem and its consequences.

Spaces of Bounded linear functional Duals and transposes, Duals of lp, Lp[a,b], C[a,b], Weak convergence, weak* convergence, Reflexivity.

Hilbert space Inner product spaces, Orthonormal sets, Gram Schmidt Orthonormalisation, Bessel's Inequality, Riesz. Fischer theorem, Projection theorem, Riesz representation theorem.

UNIT-III LINEAR ALGEBRA

Vectorspace, Subspace, Linear Dependence , Independence, Dimension and Basis , Linear Transformation, Range and Kernel, Rank and Nullity, Inverse of Linear Transformation, Linear Map associated with matrix.

Elementary Row Operations, Rank and Nullity of Matrix, Inverse of a Matr4ix, Determinants and product of Determinats, Eigen values, Eigen vectors, Characteristic roots.

Canonical forms, Tringular form, Nilpotent Transformations, Similarity of Matrices, Quadratic form.

Traces and Transpose, Hermitian, Unitary and Normal Transformation.

UNIT- IV DISCRETE MATHEMATICS

Logic- Fundamentals of logic, Normal forms, Logical Inferences, Methods of proof, Mathematical Induction, Rules of Inferences for quantified propositions.

Lattice and Boolean Algebra – Binary relations, Equivalence relations, prset, Lattice, Hasse Diagram, Algebraic properties of Lattice, Paths and closures, Directed graphs and adjacency matrix, Boolean Algebra, Boolean functions, Minimization of Boolean functions.

Recurrence relation –Generating functions of sequences, Calculating co-efficients of generating functions, Recurrence relation, solving recurrence relations by substitution and generating functions. Solution by the method of characteristic roots.

Graph Theory – Trees and their properties, spanning trees, Binary trees, Euler's formula, Euler's circuits, Hamiltanian Graphs

UNIT – V DIFFERENTIAL EQUATIONS

Linear Differential Equations with constant coefficients and variable coefficients, system of Linear Differential Equations. Laplace Transformation : Linearity of the Laplace transformation. Laplace transforms of derivatives and integrals, shifting theorems. Differentiation and integration of transforms. Convolution theorem. Solution of integral equations and systems of differential equations using Laplace Transformation.

Series Solution of differential equations: Power series method, Bessel, Legendre and Hypergeometirc equations. Bessel, Legendre functions and their properties . Sturra Liouville problem, Orthogonality of eigen functions. Orthogonality of Bessel fuctions and Legendre polynomials.

Partial Differential Equations of the 1st order. Lagrange's solution some special types of equations, their solution, Charpit's general method of solution. Partial Differential Equations of second and Higher orders. Classification of linear partial differential equations of second order. Homogeneous and non-homogeneous equations with constant colfffficients, Monge's method.

Fourier Series and Fourier Transform, Convergence of Fourier series, Application of Fourier series and Fourier Transforms to Boundary value problems. Solution of Laplace equation, wave equation and heat conduction equations.

4. ENGLISH

PAPER-I

The candidate shall answer questions from each Unit which are compulsory.

Unit-1

There shall be one question with a suitable alternative relating to major developments in English literature from Renaissance to the Age of Moderns from the following topics.

i) Elizabethan and Jacobean Drama
ii) Metaphysical Poetry
iii) Restoration Drama
iv) Augustan Satire
v) Rise of the Novel in the Eighteenth Century
vi) Romantic Poetry
vii) Victorian Crisis and Compromise
viii) Early and Later Victorian Novels
ix) The Modernist Movement
x) Modern Poetry
xi) Modern Drama
xii) Stream-of-Consciousness Novels

Unit – 2

The candidate shall answer four short-answer-type questions out of six relating to forms of literature.

i) Lyric ii) Ballad iii) Ode iv) Sonnet v) Epic vi) Elegy, vii) Verse libre viii) Tragedy ix) Comedy x) Romantic Comedy xi) Revenge Tragedy xii) Comedy of Humours xiii) Comedy of Manners xiv) Heroic Tragedy xv) Thesis Play/Play of Ideas xvi) Poetic Drama xvii) Theatre of the Absurd xviii) Epic Theatre xix) Theatre of Cruelty xx) Expressionist Drama xxi) Picaresque Novel xxii) Epistolary Novel xxiii) Gothic Novel xxiv) Historical Novel xxv) Science Fiction xxvi) Detective Fiction xxvii) Autobiographical Novel xxviii) Essay xxix) Short Story xxx) Travelogue

Unit –3

The candidate shall answer two questions out of four relating to literary theory from the following topics.

i) Plato : Theory of Mimesis ii) Aristotle : Definition of Tragedy iii) Coleridge : Theory of Imagination iv) Wordsworth : Theory of Poetry v) Matthew Arnold : Touchstone Theory vi) T.S. Eliot : Theory of Impersonality vii) New Criticism viii) Structuralism ix) Deconstruction x) Marxian Approaches to Literature xi) New Historicism xii) Feminism xiii) Psycho-analytical Approaches to Literature xiv) Post-Modernism xv) Post-Colonialism

Unit-4

The candidate shall attempt four short-answer-type questions out of six relating to the following basic concepts.

i) Allegory ii) Anagnorisis iii) Aporia iv) Catharsis v) Conceit vi) Comic Relief vii) Expressionism viii) Epiphany ix) Fancy x) Hubris xi) Imagery xii) Irony xiii) Metaphor xiv) Myth xv) Naturalism xvi) Negative Capability xvii) Objective Correlative xviii) Peripeteia xix) Paradox xx) Pun xxi) Personification xxii) Pathetic Fallacy xxiii) Poetic Justice xxiv) Realism xxv) Symbol xxvi) Surrealism xxvii) Three Dramatic Unities.

Unit – 5

The candidate shall attempt an appreciation of a poem commenting on aspects of its form content and style.

PAPER-II

The candidate shall answer questions from each Unit which are compulsory.

Unit- 1 The candidate shall write an essay on a subject of general interest in not less than 1200 words choosing one out of five topics.

Unit- 2 The candidate shall attempt a précis in 200-210 words of a given passage of about 600 words.

Unit- 3 The candidate shall answer five questions relating to a comprehension passage. The answer to each question should not exceed 30 words.

Unit- 4 The candidate shall be required to write a report on a given topic in not more than 300 words.

Unit- 5 The candidate shall be required to prepare a brochure/pamphlet on a given theme.

Unit- 6 The candidate shall answer objective type questions each carrying 1 mark relating to grammar in context. The following items are to be covered.

i) Tense and Aspects ii) Prepositions iii) Modals iv) Phrasal Verbs v) Linking Devices vi) Direct and Indirect Speech vii) Concord viii) Conditional Sentences ix) Correlatives x) Complement and Adjuncts.

5. CIVIL ENGINEERING

Paper I

1. Solid Mechanics:- Elastic constants, plane stress, plane strain, Mohr's circle, combined stress; Elastic theories of failure; Simple bending, Shear; Torsion of circular and rectangular sections and simple members. Bending Moment and Shear Force in statically determinate beams.

2. Structural Analysis:- Analysis of determinate structures - different methods including graphical methods. Analysis of indeterminate skeletal frames – degree of indeterminacy, moment distribution, slope deflection, stiffness and force methods, energy methods, Muller-Breslau principle and application. Plastic analysis of indeterminate beams and simple frames - shape factors.

3. Design of Concrete Structures:- Limit state design for bending, shear, axial compression and combined forces. Codal provisions for slabs, beams, walls and footings. Principles of prestressed concrete design, materials, methods of prestressing, losses.

4. Design of steel structures (Based on Limit State Method):- Analysis and design of tension and compression members, Column bases, Connections- simple and eccentric beam-column connections.

5. Building Material and Building Construction:-

(a) Building Materials:- Cement: Components, different types, setting times, strength. Cement Mortar: Ingredients, proportions, water demand, mortars for plastering and masonry. Concrete: Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, non-destructive testing, mix design methods. Bricks: Types, Indian Standard classification, absorption, saturation factor, strength in masonry.

(b) Building Construction:- Types of Foundations, Brick masonry, Stone masonry, Floorings, Causes and prevention of cracks in buildings, Damp proofing, Special maintenance of buildings.

6. Estimation, Construction Planning and Management:- Preliminary estimate, Detailed estimate, Specifications and cost analysis. Bar chart, Linked bar chart, Work-breakdown structures, Activity- on -- arrow diagrams, critical path, probabilistic activity durations, Event- based networks, PERT networks: Time- cost study, Resource allocation.

Paper II

1. Water Resources and Hydraulic Engineering:-

(a) Irrigation Engineering:- Consumptive use of water, irrigation systems, water demand assessment; Storages and their yields, ground water and well hydraulics; Waterlogging, drainage design; Design of rigid boundary canals, lining of canals; Sediment transport in canals; Forces acting on gravity dams and their design, Design of headworks, distribution works, falls, Crossdrainage works, outlets; River training

(b) Hydrology: - Hydrological cycle, precipitation and related data analyses, Probable maximum precipitation, unit hydrograph and synthetic unit hydrographs; Evaporation and transpiration; Floods and their management, Design Flood, Streams and their gauging; Routing of floods; Capacity of Reservoirs.

(c) Fluid Mechanics:- Fluid Properties, Pressure, Thrust, Buoyancy; Flow Kinematics; Integration of flow equations; Flow measurement; Relative motion; Moment of momentum; Viscosity, Boundary layer and Control, Dimensional Analysis,Flow development, losses in pipe flows, Pipe networks, Flow measuring equipment and structures.

(d) Open Channel Flow:- Momentum and Energy principles in Open channel flow, Types of flow, Flow sections and properties; Normal flow, Gradually varied flow,Hydraulic jump.

2. Environmental Engineering:-

(a) Water Supply Engineering: - Sources of supply, design of intakes, Estimation of demand; Water quality standards; Primary and secondary treatment, detailing and maintenance of treatment units; Conveyance of treatment units; distribution systems of treated water, leakages and control; Institutional and industrial water supply.

(b)Waste Water Engineering:- Urban rain water disposal;Quantity and characteristics of waste water, Collection of waste water, Primary, Secondary and tertiary treatment of waste water, Sludge disposal, effluent discharge standards, Institutional and industrial sewage management.

(c) Solid Waste Management:- Characteristics, Generation, Collection and Transportation, Engineered systems of solid waste management (reuse, recycle, recovery, treatment and disposal). Design and Management of landfills.

(d) Air and Noise Pollution: - Air pollution: sources and impacts, air pollution controls, standards and limits. Noise pollution- impacts of noise, permissible limits, measurements and control of noise pollution.

3. Geotechnical Engineering:-

(a) Soil Mechanics: - Fundamental definitions and interrelationships; Properties and Classification of soils, Permeability and seepage, Effective stress principles, Shear strength, Consolidation, Compaction, stress distribution in soils.

(b) Foundation Engineering:- Types of foundations, Foundation design requirements, Shallow foundations - bearing capacity, settlement analysis in sands and clays, Deep foundations- pile types, dynamic and static formulae, load carrying capacity of piles in sands and clays, group action, negative skinfriction , Earth pressure theories, effect of water table, layered soils, Stability of slopes, Sub-surface investigations- scope, drilling bore holes, sampling, penetration tests, plate load tests, geophysical tests.

4. Transportation Engineering:-

(a) Highway Engineering:- Geometric design of highways, Testing and specifications of paving materials, design of flexible and rigid pavements

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

5. Surveying:- Principles and classification of surveys, mapping concepts, Coordinate systems, Measurement of distance and directions, Levelling, Theodolite traversing, Contours, Plane table surveying, Errors and adjustments, Curves, Total station.

6. MECHANICAL

Paper-I

1. Theory of Machines:- Kinematic chain, Mechanisms and inversions, Motor Vehicle steering gears, Hookes' Joint, Toothed gears, Tooth profiles, Interference, Gear Trains, Compound gears, Differential, Cam profiles, Displacement, velocity and acceleration of cam followers, Flywheel and Turning moment diagram.

Governors, Stability, Sensitivity, Isochronism and hunting, Governor effort and power, Controlling force and effect of friction, Balancing of revolving masses.

Balancing of single and multicylinder engines, Friction and lubrication, Hydrodynamic theory of lubrication, Linear free and forced vibration of single and two degree freedom mechanical systems with or without damping, Critical speeds and whirling of shafts, Vibration of beams, Torsional vibration.

2. Machine Design:- Design of Joints: Cotters, Keys, splines, welded joints, threaded joints, threaded fastners, joints formed by interference fits, Design of friction drives: coupling and clutches, belt and chain drives, power screws.

Design of power transmission systems: gears and gear drives shaft and axle, wire ropes, Design of bearings: hydrodynamic bearings and rolling element bearings.

3. Mechanics of Solids:- Stress and strain for materials in tension, compression and shear, Relation between elastic constants for an isotropic, linear elastic and homogeneous materials, Uniaxial Loading, Thermal stresses, Stress-strain diagrams for ductile and brittle materials, Stress and strain in two dimensions, Principal planes, Mohr's circle, Strain rosette. Bending moment and shear force diagrams. Composite beams. Bending stresses, Shear stress distribution. Slope and deflection in beams. Torsion of circular shafts. Helical springs. Combined stresses. Theories of failure. Thick and thin walled pressure vessels, shrink-fit. Struts and columns. Energy principles. Strain energy due to bending, twisting and axial load. Castigliano's theorem. Reciprocal Theorem. Slope and deflection by energy methods.

4. Engineering Materials:- Basic concepts on structure of solids, Crystalline materials, Defects in crystalline materials, Alloys and binary phase diagrams, structure and properties of common engineering materials. Ironcarbon equilibrium diagram, TTT-diagram. Heat treatment of steels, Plastics, Ceramics and composite Materials, Common applications of various materials.

5. Manufacturing Science:- Basic principles of forging, drawing, extrusion and rolling, Pattern, Gating and risering system, casting defects, special casting process, welding: Gas welding, arc welding, resistance welding, thermit welding. Cutting tool materials, Tool geometry and nomenclature ASA, ORS and NRS, types of chips, cutting variables, Chip reduction coefficient, Merchant's force diagram, velocity relationship and Kronenberg's relationship. Ernest & Merchant angle relationship, Lee-shafer relationship-cutting fluid, Tool wear, Taylor's tool life equation, Drilling, Milling and boring, Gear Manufacturing, Economics of metal machining, Jigs and fixtures. Fits and Tolerances, NC, CNC, ECM, EDM, AJM, USM, LBM, Plasma machining, High energy rate forming.

6. Manufacturing Management:- Production Planning and Control, Forecasting-Moving average, exponential smoothing, Operations sheduling; assembly line balancing. Product development. Breakeven analysis, Capacity planning. PERT and CPM. Control Operations: Inventory control-ABC analysis. EOQ model. Materials requirement planning. Job design, Job standards, work measurement, Quality managementQuality control. Operations Research: Linear programming Graphical and Simplex methods. Transportation and assignment models. Single server queuing model. Value Engineering: Value analysis for cost/value. Total quality management and forecasting techniques. Project management.

Paper-II

1. Thermodynamic Cycles:- Basic concepts. Open and closed systems, Applications of laws of Thermodynamics, (Zeroeth, First and Second Laws), Gas equations, Clapeyron equation, Availability, Irreversibility and Tds relations, reciprocating air compressors.

2. I.C. Engines, Fuels and Combustion:- Spark ignition and compression ignition engines, Two stroke and Four stroke engines, mechanical, thermal and volumetric efficiency, Heat balance. Combustion process in S.I. and C.I. engines, preignition detonation in S.I. engine, Diesel knock in C.I. engine, Choice of engine fuels, Octane and Cetane ratings. Alternate fuels, Carburetion and Fuel injection, Engine emissions and control. Solid, liquid and gaseous fuels, stoichometric air requirements and excess air factor, fuel gas analysis, higher and lower calorific values and their measurements.

3. Heat Transfer, Refrigeration and Air Conditioning:- One and two dimensional heat conduction, Heat transfer from extended surfaces, Heat transfer by forced and free convection. Heat exchangers. Overall heat transfer coefficient, Fundamentals of diffusive and convective mass transfer, Radiation laws, heat exchange between black and non black surfaces, Network Analysis. Heat pump, refrigeration cycles (Air refrigeration, vapour compression and absorption refrigeration) and systems, Condensers, evaporators and expansion devices and controls.

Properties and choice of refrigerant, Refrigeration Systems and components, psychometrics, comfort indices, cooling load calculations, solar refrigeration.

4. Fluid Mechanics:- Properties and classification of fluids, Manometry, Forces on immersed surfaces, Center of pressure, Buoyancy, Elements of stability of floating bodies, Kinematics and dynamics: Continuity, Momentum and Energy Equations, Irrotational flow and incompressible, Inviscid flow, Velocity potential, Pressure field and forces on immersed bodies, Bernoulli's equation, Fully developed flow through pipes, Pressure drop calculations, Measurement of flow rate and Pressure drop, Elements of boundary layer theory, Integral approach, Laminar and turbulent flows, Separations, Flow over weirs and notches, Open channel flow, Hydraulic jump, Dimensionless numbers, Dimensional analysis, Similitude and modelling, Onedimensional isentropic flow, Flow through convergent-divergent ducts. Adiabatic and Isentropic flow, fanno lines, Rayleigh lines.

5. Fluid Machineries and Power Plants:- Theory and design of axial flow turbines and compressors, Reciprocating and centrifugal pumps, Impulse and Reaction turbines, Specific speed, Classification, Energy transfer, Flow through turbo-machine blades, cascades, centrifugal compressor. Dimensional analysis and modelling. Steam generators, Fire-tube and water tube boilers, Flow of steam through nozzles and diffusers, wetness and condensation, various types of steam and gas turbines, Selection of site for steam, hydro, nuclear and stand-by power plants, Selection base and peak load power plants, Modern High pressure, High duty boilers, Draft and dust removal equipment, Fuel and cooling water systems, heat balance, station and plant heat rates, operation and maintenance of various power plants, preventive maintenance, economics of power generation.

7.ELECTRICAL

Paper-I

1.Electrical Circuits–Theory and Applications

Circuit components; network graphs; KCL, KVL; circuit analysis methods: nodal analysis, mesh analysis; basic network theorems and applications; transient analysis RL, RC and RLC circuits; sinusoidal steady state analysis; resonant circuits and applications; coupled circuits and applications; balanced 3-phase circuits. Two-port networks, driving point and transfer functions; poles and zeros of network functions. Elements of networks synthesis. Filter-theory : design and applications. Active filters. Circuit simulation : Input formats; mathematical modelling; solution of equations; output formats; SPICE.

2.Signals & Systems

Representation of continuous–time and discrete-time signals; LTI systems; convolution; impulse response; time-domain analysis of LTI systems based on convolution and differential/difference equations. Fourier transform, Laplace transform, Z-transform, Transfer function. Sampling and recovery of signals DFT, FFT Processing of analog signals through discrete-time systems.

3. E.M. Theory

Maxwell's equations, wave propagation in bounded media. Boundary conditions, reflection and refraction of plane waves. Transmission line : Distributed parameter circuits, travelling and standing waves, impedance matching, Smith chart. Waveguides : parallel plane guide, TE, TM and TEM waves, rectangular and cylindrical wave guides, resonators. Planar transmission lines; stripline, microstripline.

4. Analog Electronics

Characteristics and equivalent circuits (large and small-signal) of Diode, BJT, JFET and MOSFET. Diode circuits : clipping, clamping, rectifier. Biasing and bias stability. FET amplifiers. Current mirror, Amplifiers : single and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequencyresponse of amplifiers. OPAMP circuits. Filters; sinusoidal oscillators : criterion for oscillation; single-transistor and OPAMP configurations for oscillators. Function generators and wave-shaping circuits. Power supplies.

5. Digital Electronics

Boolean algebra; minimisation 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. Programmable logic controller.

6.Energy Conversion

Principles of electromechanical energy conversion : Torque and emf in rotating machines. DC machines : characteristics and performance analysis; starting and speed control of motors. Transformers : principles of operation and analysis; regulation, efficiency; 3-phase transformers, 3-phase induction machines : Characteristics, speed control. 3-phase synchronous machines : Characteristics, parallel operations. Reactive power control. Special machines : stepper motors, brushless dc motors, permanent magnet motors single-phase motors; Universal Motors.

7.Power Electronics and Electric Drives :

Semiconductor power devices: diode, transistor, thyristor, triac, GTO , MOSFET and IGBT; static characteristics and principles of operation; triggering circuits; bridge converters : fully-controlled and half-controlled; principles of choppers and inverters; basic concepts of speed control of dc and ac motor drives, applications of variable-speed drives.

Paper-II

1.Control Systems

Elements of control systems; block-diagram representation; open-loop & closedloop systems; principles and applications of feed-back. LTI systems : timedomain and frequency-domain analysis. Stability : Routh Hurwitz criterion, rootloci, Nyquist's criterion, Bode-plots, Design of lead-lag compensators. Proportional, PI, PID controllers. State-variable method and application. Principles of discrete-control systems.

2.Electrical Engineering Materials

Electrical/electronic behaviour of materials : conductivity; free-electrons and band-theory; intrinsic and extrinsic semiconductor, p-n junction; superconductivity. Dielectric behaviour of materials; polarization phenomena; piezoeléctric phenomena. Magnetic materials : behaviour and application. Photonic materials : refractive index, absorption and emission of light, optical fibres, lasers and opto-electronic materials.

3.Microprocessors and microcomputers

8-bit microprocessor : architecture, CPU, module design, memory interfacing, I/O, Peripheral controllers,Application. IBM PC architecture : overview, introduction to DOS, Advanced microprocessors.

4. Measurement and Instrumentation

Error analysis; measurement of current, voltage, power, energy, power-factor, resistance, inductance, capacitance and frequency. Electronic measuring instruments : multimeter, CRO, digital voltmeter, frequency counter, Q-meter, spectrum-analyser, distortion-meter. Transducers : thermocouple, thermistor, LVDT, strain-guage, piezo-electric crystal. Use of transducers in measurements of non-electrical quantities. Data-acquisition systems.

5.IC Technology

Overview of IC Technology. Unit-steps used in IC fabrication : wafer cleaning, photo-lithography, wet and dry etching, oxidation, diffusion, ion-implantation, CVD and LPCVD techniques for deposition of poly-silicon, silicon, siliconnitride and silicon di-oxide; metallisation and passivation.

6.Power Systems : Analysis and Control

Power Generation concepts, Steady-state performance of overhead transmission lines and cables; principles of active and reactive power transfer, Distribution system; Per-unit quantities; Bus admittance and impedance matrices; load flow; economic operation; Symmetrical components, analysis of symmetrical and unsymmetrical faults. Concept of system stability : swing curves and equal area criterion. Flexible AC Transmission Systems (FACTS). Computer control and Automation : Introduction to energy control centres; various states of a power system; SCADA systems and RTUs.

7.Power system protection

Principles of over current, differential and distance protection. Concept of solid state relays. Circuit brakers. Load frequency control, Reactive power control. Line bus, generator, transformer protection; numeric relays and application of DSP to protection. Computer aided protection.

8.Non-conventional Energy Sources and Energy Management

Introduction to the energy problem; difficulties with conventional energy sources. Wind-Energy: Basics of Wind turbine aerodynamics; wind-energy conversion systems and their integration into electrical grid. Solar-Energy : Thermal conversion : photo-voltaic conversion. Wave-energy. Importance of Energy Management : Energy audit; energy economics : discount rate, payback period, internal rate of return, life cycle costing.

8.ELECTRONICS

Paper -I

1. Network analysis: Network solution methods: nodal and mesh analysis; Network theorems: superposition, Thevenin and Norton's, maximum power transfer; Wye-Delta transformation; Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits; Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2-port network parameters: driving point and transfer functions; State equations for networks.

2.Analog Circuits :Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Single-stage BJT and MOSFET amplifiers: biasing, bias stability, mid-frequency small signal analysis and frequency response; BJT and MOSFET amplifiers: multi-stage, differential, feedback, power and operational; Simple op-amp circuits; Active filters; Sinusoidal oscillators: criterion for oscillation, single-transistor and op-amp configurations; Function generators, wave-shaping circuits and 555 timers; Voltage reference circuits; Power supplies: ripple removal and regulation.

3.Electronics Devices :Energy bands in intrinsic and extrinsic silicon; 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; Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography and twin-tub CMOS process.

4.Electronics Measurement & Measuring Inst. : SI units, systematic and random errors in measurement, expression of uncertainty - accuracy and precision index, propagation of errors. PMMC, MI and dynamometer type instruments; dc potentiometer; bridges for measurement of R, L and C, Q-meter. Measurement of voltage, current and power in single and three phase circuits; ac and dc current probes; true rms meters, voltage and current scaling, instrument transformers, timer/counter, time, phase and frequency measurements, digital voltmeter, digital multimeter; oscilloscope, shielding and grounding.

5. 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.

6. **Power Electronics:** 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,

Bi-directional 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.

Paper - II

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

8. Signals & Systems: Continuous-time signals: Fourier series and Fourier transform representations, sampling theorem and applications; Discrete-time signals: discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform, interpolation of discrete -time signals; LTI systems: definition and properties, causality, stability, impulse response, convolution, poles and zeros, parallel and cascade structure, frequency response, group delay, phase delay, digital filter design techniques.

9. Digital Circuits: Number systems; 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 and PLAs; Sequential circuits: latches and flip-flops, counters, shift-registers and finite state machines; Data converters: sample and hold circuits, ADCs and DACs; Semiconductor memories: ROM, SRAM, DRAM.

10. Microprocessors and microcomputers: 8-bit microprocessor (8085): architecture, programming, memory and I/O interfacing. Peripheral controllers, Application, overview of advanced microprocessors.

11. Electromagnetic: Electrostatics; Maxwell's equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Pointing 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, impedance transformation, S-parameters, Smith chart; Waveguides: modes, boundary conditions, cut-off frequencies, dispersion relations; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; Basics of radar; Light propagation in optical fibers.

9. INSTRUMENTATION AND CONTROL

Paper - I

01. Fundamentals: Coulomb's law – Ohms law – Fardays laws of electromagnetic induction, Kirchoff's laws, Ampere's law Resistance, Capacitance and Inductance. Thevenin's Theorem, Norton's Theorem.

02. Electronic Circuits: Graph, tree and links – Loop currents, node voltages two port net works, Z, Y and Hybrid parameters. Alternating currents, RMS value, form factor, R.L.C. in AC Circuits power; and power factor, network theorems – Harmonic analysis, Transient Analysis.

03. Digital Electronic Circuits: Logic circuits – Universal gates Booleans functions and their realisation – Product of sum and sum of product form – Combinational circuits – Sequential circuits, SR & JK flip flops, Series and parallel Counters Registers.

04. Electrical Measurements: Indicating instruments, D1 Arsonval type Galvanometer, Vibration Galvanometer, Ballistic Galvanometer, Measurement of resistance, DC & AC Potentio meters, Wheetstone Bridge, Kelvin's bridge, AC Bridges, Maxwell's, Anderson, Heaviside and Schering bridges.

05. Electronics Instruments: Cathode Ray Oscilloscope and its applications, Electronic Voltmeters – Balanced bridge type, transistor Voltmeter, Choper amplifier type Voltmeter, High Frequency measurements, Q-meter & wave form analyzer.

06. Analog Electronics: Characteristics of BJT, JFET & MOSFET, Diode circuits, Transistor law and high frequency amplifiers, OP-Amps, Instrumentation amplifier, V/I &I/V convertor OP-Amp based active filters.

Paper - II

01. Instrumentation: Transducers – Primary and Secondary – Classification of transducers, Potentiometers as displacement transducers, strain gauges, Induction and capacitive transducers, LVDT, Rotary variable differential transformer, Piezo electric transducer, Digital Voltmeters, Digital frequency meters, measurement of displacement, strain gauge circuits, measurement of pressure, Measurement of Velocity, measurement of temperature and measurement of flow. Torque, acceleration, vibration and shock, PH conductivity and Humidity measurement.

02. Control Systems: Elements of control systems; block-diagram representation; open-loop & closedloop systems; principles and applications of feed-back. LTI systems : timedomain and frequency-domain analysis. Stability : Routh Hurwitz criterion, rootloci, Nyquist's criterion, Bode-

plots, Design of lead-lag compensators. Proportional, PI, PID controllers. State-variable method and application. Principles of discrete-control systems. Mechanical, hydraulic and pneumatic system components. ON-OFF, Proportional, Derivative, P-D, P-I, P-I-D controller. Fuzzy controllers.

03. Microprocessors and microcomputers: 8-bit microprocessor: architecture, CPU, module design, memory interfacing, I/O, Peripheral controllers, Application. IBM PC architecture: overview, introduction to DOS, Advanced microprocessors.

04. Signals & Systems: Representation of continuous–time and discrete-time signals; LTI systems; convolution; impulse response; time-domain analysis of LTI systems based on convolution and differential/difference equations. Fourier transform, Laplace transform, Z-transform, Transfer function. Sampling and recovery of signals DFT, FFT Processing of analog signals through discrete-time systems.

05. Analytical, Optical & Biomedical Instrumentation: X-Ray and Nuclear radiation measurements. Optical source and detectors. LED, Laser, photodiode, photo resistor and their characteristics. EEG, ECG & EMG, Clinical measurements, ultrasonic transducer & ultrasonography.

10.COMPUTER SCIENCE & ENGINEERING

Paper - I

1. Digital Logic : Logic families, gates, Boolean algebra, minimisation, Combinational circuit design adder circuits ,Multiplexers, decoders, sequential circuit design, flip-flops, registers, counters, number systems, inter conversion, number representation.

2.Computer organisation& Architecture: Instruction formats, addressing modes, Basic computer operation Computer configuration , Functional units ,ALU organisation, multiplication and division algorithms, memory hierarchy, cache and associate memories, virtual memory, memory IC's, I/Oo organisation schemes, interrupts, arbitration, DMA, IOP

3. Microprocessor: 8-bit microprocessor architecture, CPU, module design, memory interfacing, I/O, Peripheral controllers, Application. IBM PC architecture : overview, introduction to DOS, Advanced microprocessors.

4.Discrete Mathematics: Logical Identities , proposition and predicate logic's, methods of deduction, set theory, relations, functions, algebraic structures, lattices, recursion, graph theory, representation, paths and walks, Connected graphs &Cycles, warshall's algorithm, Matrix representation of graphs, Spanning Trees & connector problems , Hamiltonian graph, Closure of a graph , Planner graphs, Combinatories.

5. Theory of Computation: Regular Languages& finite Automata, Automata, Deterministic finite Automaton & Non deterministic finite Automaton , pushdown automation, Turing machine, grammars, type 0, 1, 2, and 3, LL and LR grammars.

Paper - II

1.Programming in C: Algorithms, flow-charts, programming methodology, Programming in 'C' languages, An overview of C.

2.Data Structure & Algorithms: Pointers, array, Link list , Stack , Queue , Trees, Binary search trees, Binary tree traversal, Breadth first search, Spanning trees, Shortest path, Tree balancing, B-trees, searching and sorting methods

3. Databases: DBMS, RDBMS, database models, Database design, Normalisation, file structures, query languages

Operating System & System Programming: Functions of Operating system, processor scheduling, memory allocation, paging and segmentation, device management, deadlocks and prevention, concurrent processing, directory concept DOS and UNIX features, language processors, Compiler, syntax and semantic analysis, code generation, optimisation, assemblers, loaders and linkers.

5.Computer networks: OSI model, digital modulation techniques, modems, error detection and error correction, Flow Control, TCP/IP reference Model, BISYNC and HDLC protocols, , network routing algorithms, LAN operation methods

6.Computer graphics: DDA algorithms, graphic primities, 2-D transformations, graphic input devices.

7.Software Engineering :Software engineering development life-cycle, system analysis, modular design, testing and validation, CASE tools,

8. Artificial Intelligence :AI techniques, natural language understanding, learning, knowledge representation, expert systems, LISP, PROLOG.

11. AUTOMOBILE

Paper - I

01. Thermodynamics: systems – Zeroth Law of thermodynamics – First law of thermodynamics – Second Law of thermodynamics – Entropy – Statistical thermodynamics – Air Compressors I.C. Engines cycles and Process – Combustion in I.C. Engines – Engine performance – Scavenging and supercharging of Engines – Modern development in I.C. Engines – I.C. Engine plant layout.

02. Heat Transfer: Conduction Convection – Thermal Radiation – Heat Exchangers, Auto Electrical system: storage Battery, Starting System, Generating System, Alternator/ Dynamo, Ignition system, Wiring System.

03. Fluid Mechanics and Machinery: Fluid properties – Dimensional analysis – Fluid static's – Flow past immersed bodies – Centrifugal pumps – Axial flow pumps – Rotary pumps – Reciprocating pumps – Oil Hydraulic systems.

04. Instrumentation: Transducers – Flow measuring transducers – Temperature measurement – Strain gauges – Mechanical measuring devices – Slip gauges – Plug gauge – Micrometers in bars optical flat etc.

05. Automobile chasis & Systems: Chasis layout – Shock absorbers in dependent suspension – torsion bars – gear suspension – wheel balancing – tyres and tubes – constructional details of the engine – Ignition system – Fuel system – Lubrication system – Cooling system – Transmission system – Brakes steering mechanism – Electrical circuits and equipment's – Engine troubles – Air conditioning system – Modern trends in automobiles & Engines.

Paper -II

01. Material Science: Crystallography of metals – Binary alloys – Constitution and equilibrium diagram – methods of studying metal structure – Heat treatment – of steels – Casehardening and surface treatment of steels – Non Ferrous metals and alloys – Creep – Fatigue.

02. Kinematics of Machines: Kinematics – Velocity and Acceleration – Properties of instaneous centre – Gears – Gears trains – Cams – Governors – Brakes and dynamometers – Clutches – Power transmission – Chain drives.

03. Dynamics of Machines: Static force Analysis – Dynamic Force Analysis – Dynamics of Reciprocating Engines – Balancing – Vibration Analysis of Single degree freedom systems – Torsional Vibrations – Vibration isolation.

04. Design of Automobile Machine Parts: Design of welded joints Design of bolts & nuts – Shafts and Axles – Curved beams – Springs – Bearings – clutches – Brakes – Design of connecting rod – Crank shaft fly wheel.

05. Production Technology: Machine tools – Lathes – Shaper, planner and slotting machines – Drilling and boring machine – Milling – Lapping – Tool room – Electro machining – Welding – Brazing – Foundry.

06. Industrial Engineering: Industrial management – personnel function – Production facilities – Production Planning and control – Wages and incentives – Cost Control – Marketing and Sales Promotion.

12.TEXTILE TECHNOLOGY

Paper - I

1. Introduction of Textile Fibres, their general properties physical and chemical and classification of Textile Fibres. Microscopic view of fibres. 2. Application of cotton fibre and Raw material, cultivation of cotton, common diseases and plant protection methods. Important varieties. 3. Manmade fibres and their raw materials. Outline of production of synthetic fibres. Physical and chemical properties and microscopic view. 4. SPINNING: i) Methods of picking: manual and mechanical ii) Ginning: Objectives and methods iii) Mixing: Blending of different varieties, types of mixing, auto mixer, aeromixers. iv) Blow room line and various machines used in it. Convept of beating point and its use in spinning of different fibres. v) Lap defects and remedies vi) Calculations regarding beter speeds, lap weight, hank of lap, drafts and production.

2. Carding: Objectives and principles of carding, functioning of carding machine. Types of carding machine. Calculations regarding carding machine, lap sliver study, waste control in carding, Tandem cards, Auto leveler, card sliver, lap feed and chute feed systems.

3. Draw Frame: Objects, Principles and various machines used in drawing process. Functions of draw frame machines. Different types of Drafting systems, weighing systems, Roller settings and draft distribution. Calculations regarding draw frame. Study of lapping and lapping machines.

4. Comber: Objects, principles and different types of combing machines and calculations there of.

5. Speed Frame: Principles, objects and functions of speed frame. Working of speed frame and calculation regarding speed frames.

6. Ring Frame: Principles, objects and functioning of Ring Frame machines working of Ring Frame and calculations regard ring frame. Traveller, rings and other important parts of ring spinning frame. Drafting systems. Yarn defects – causes and remedies. Calculations regarding spinning.

7. Doubling: Objects and types of doubling. Features and two for one twisters. Manufacturing of sewing thread. Calculations regarding production with reference to various parameters of spinning. Open end Spinning: Types and methods of open end spinning.

8. Textile Chemistry: Coal tar distillation. Chemistry of sizing, Scouring Bleaching and dyeing. Various dyes and chemicals, types of printing and finishing machines and methods. Process of mercirising. Various dyes used in dyeing of different fibres.

9. Calculations regarding all processes mentioned above.

PAPER - II

1. Weaving: Object of the preparatory process and types of warp preparation. Classification types of preparatory machines. Principle of warp winding process. Warp winding machines, Automatic warp winding machines. Pirn winding machines.

2. Sizing: Importance and objects of sizing. Requirements and application of size and preparation of size. Slasher sizing machines. Principles of modern size controls used in sizing machines. Study of the development in sizing.

3. Principles of weaving process: Basic requirements of weaving loom and types of looms. Study of handlooms and plain powerlooms. Working of the mechanisms faults and remedies with references to the powerloom weaving and cloth production.

4. Principles of Automatic and shuttle less weaving: Study of Modern Automatic looms viz., Dornier, Airjet, Waterjet, rapier, Grib pebloom.

5. Fabric Structure: Principles of fabric structures. Different types of weaves and their construction. Drafting and peg plans according to weaves, Double Cloth, Dobby and Jaquard designs.

6. Understanding Mill maintenance: Functions and utilizes. Maintenance and lubrication schedules in various departments.

7. Textile Testing: Sampling of various material viz., cotton, yarn, fabric etc., Physical and chemical testing of fabrics and other material. Defects of materials and their identification. ISO & TQM. Concepts and Application.

8. Textile industry and management – introduction, concepts mill management – production, material, financial, marketing management. Feasibility study and Industrial safety.

9. Calculations regarding all processing mentioned above.

13.ARCHITECTURAL ASSISTANTSHIP

PAPER - I

1. Basic Design: Design definition and description, Importance of Design, Fundamental elements of Design, Principles of design, Colour Theory, elements of composition, Anthropometrics Study, Ergonomics, Study of Different spaces, Optimum areas for various functions, Space standards, Lighting and Ventilation standards for various activities, Design Process and thinking and Introduction to the study of aesthetics.

2. Building Materials: Clay Bricks, Stones, Sand, Mortars, Cement, Concrete, Reinforced cement concrete, Timber, Veneers, Paints and Varnishes, Glass, Rubber, Adhesives, Asphalt & Bitumen, Plastics, Roofing & Flooring Materials, Metals, Alloy Steels, Non-ferrous metals.

3. Building Construction: Foundations. Footings, Walls, Lintels, Carpentry & Joinery, Openings (doors & windows), Composite Masonry, Partition Walls, Staircases, Cladding, Sloping and flat roofs, Floorings, Structural steel work and Types of steel trusses

4. Architectural Drawing & Graphics: Importance of Scale, Different forms, Architectural representation of different objects, Solid geometry, Building Geometry -- isometric, axonometric, etc., Types of Arches, Sciography, Perspectives, Rendering, visualization skills and importance of free hand drawing.

5. Engineering Mechanics: Simple stress and strain, Types of stresses, elastic limit, modulus of elasticity, Bending moment and shear forces, Moment of inertia, Deflection, Buckling & Crushing failures, Slenderness ratio, Torsion, Design of RCC & Steel Structures.

6. Introduction of art and architecture: Importance of art, Development and exploration of art, Relationship between art and architecture, Role of an architect in society, relationship with other consultants, Technical knowledge and expertise, Evolution of Shelter forms.

7. History of Architecture: Architectural development in Egypt, Greek, Roman, Early Christian, Romanesque, Gothic & Byzantine. Hindu & Islamic architecture. Influence of Industrial revolution on building materials, construction technology, characteristic styles of modern architecture, Arts and Crafts movement, Art Nouvean, Monumentalism, Expressionism and pioneers of Modern architecture and their contributions.

8. Surveying and Site Studies: Principles of Surveying, Traversing & Plain table surveying, Computation of Areas & leveling, Automated Surveying.

9. Water supply and Sanitary Engineering: Sources of water supply, Quality of water, Treatment of water, Distribution system of water, Collection and Treatment of refuse, Sewage, Principles of drainage, plumbing and Sanitary fittings and fixtures, Roads & Pavements.

10. Climatology: Building Climatology, Tropical Climates, Thermal Comfort, Heat flow, Natural Ventilation, Passive cooling, Sun & Design Process.

11. Landscape design and site planning: Importance and role of landscape designing, Historical Perspective, Elements in Landscape design, Plants and design, Landscape construction.

PAPER - II

1. Building Services: Electrical Services, Lighting, Air Conditioning, Elevators and Escalators, Telephones and EPABX, Security systems, Fire fighting systems, Swimming pools, Energy sources of building: wind energy, photo voltaic, Bio-mass, Waste Disposal: Industries & Hospitals, Hotel services and Elevated flooring.

2. Sociology of Human settlements: Sociological aspects, Elements of society, Urbanization, Historic Evolution, Transportation and communication, Principles of ekistics.

3. Economics, Estimating and Costing: Introduction on economics, Micro and Macroeconomics, economic issues, Financing of a project, Quantity surveying and estimating (approximate and detailed) and rate analysis.

4. Town Planning: Town forms in urban planning and development processes, various levels of planning: national, regional, urban, rural, local etc., objectives of town planning, O-D surveys, F.S.I. planning of industrial and recreational areas, urban renewals, TCPO and Town planning organization in India.

5. Building Acoustics: Need to study acoustics, history of acoustics, generation, propagation, transmission of sound, characteristics of sound, sensibility of human ear, resonance, reverberation time, sabine's formula, echoes, principles of acoustical design process and sound isolation.

6. Advances Construction: Decay and Damage, Building Failures, Maintenance and Renovation, Guniting, Strutting, Underpinning, Grouting, Propping, Effect of ageing, Weathering.

7. Professional Practice: Types of offices for practice, COA registration and rules, IIA Code professional conduct, architects duties, principles of Indian contract act, Tenders, Contracts, Easements, Arbitration, Valuation, Role of Consultants, Building Bye-laws, National Building Code, Consumer protection act, transfer of property.

8. Computer Applications: Hardware and Software requirements, Operating systems, Features of presentation package, drafting packages and benefits of Internet technology.

14.CHEMICAL

PAPER - I

1. Fluid Mechanics: Dimensional analysis, fluid statics, fluid flow phenomena, basic equations of fluid flow, flow of incompressible fluids in pipes – Friction factor, Hazen-Poiseullie equation. Turbulent flow, Transportation and metering of fluids. Calculation of pump power for transportation of fluids, flow meters – orifice, Venturi and Rotameters.

2. Heat Transfer: Conduction in solids – Steady state and unsteady state. Heat flow in fluids – overall heat transfer coefficient, Log-mean temperature difference, calculation of individual heat transfer coefficient and overall heat transfer coefficient. Fouling factors, Heat transfer to fluids without phase change – Thermal boundary layer, heat transfer by forced convention in laminar flow and in turbulent flow, empirical equations; Heat transfer from condensing vapors. Heat exchange equipment – Double pipe heat exchangers and evaporators.

3. Mass Transfer: Molecular diffusion in fluids, mass transfer coefficients, Distillation (binary system), gas absorption, drying and liquid extraction operations.

4. Reaction Engineering: Rate of reaction, variables affecting the rate of reaction. Interpretation of kinetic data in batch and flow systems. Theories of reaction rate, classification of reactors, design equations for batch and flow reactors.

5. Thermodynamics: First flow of thermodynamics – Internal energy, Enthalpy, heat capacity, first law for open systems. Second law of thermodynamics – statement, entropy function, calculations of entropy changes. Free energy functions. Calculation of enthalpy and entropy as function of pressure and temperature, Heat effects. Criteria for equilibrium and their application.

6. Mechanical Operations: Size reduction, Properties, Handling and Mixing of particulate solids, Mechanical separations, Screening Filtration, Sedimentation, Conveying and Storage of solids.

PAPER – II

1. Process Technology : Manufacture of following chemical products in process industries – Location and uses – Water, Soda ash, Caustic soda and Chlorine, Ammonia, Fertilizers – Industrial acids, Sulphuric acid, Nitric acid, Phosphoric acid – Industrial gases – Sugar, Pulp and paper, Cement, Electro thermal industries; Calcium carbide, Silicon carbide, Graphite, Coal chemicals, Pigments and Paints.

2. Material and Energy Balances: Basic calculations, Material balances with and without chemical reactions, energy balances, combustion.

3. Instrumentation and Process Control: Qualities of measurement, measurement of temperature, pressure and vacuum, liquid level, density and viscosity, composition and analysis. Process control _ Automatic process control – Elements of a control system – Controllers modes of control and its applications.

4.Petro Chemicals: 1. Origin of petroleum. 2. Natural Gas : Composition application as fuel. 3. Petroleum Refining : Refining of crude petroleum, production of gasoline, kerosene, heating oils and residual fuel. Lubricants, asphalts and solvents. 4. History of petrochemical industry and alternative sources. 5. Characteristics of petrochemical manufacture. Techniques involved Naphtha cracking, alkylation, isomerization and polymerization to produce petro-chemicals. 6. Petro-chemicals and their application. 7. Classification of petro-chemicals according to source a) Ethylene derivatives b) Derivatives of higher paraffins c) Propylene derivatives d) Derivatives of C4 hydrocarbons e) Derivatives of higher olefins f) Derivatives of aromatics g) Economic aspects of petro-chemical industry in India.

15.MINING

PAPER – I

1. General Mechanical Engineering: Strength of material and power transmission, elements of Hydraulics, Internal combustion Engines (OTTO cycle, Diesel Cycle) Power Transmission (Belt, Chain, Rope, Drive) compressor, pneumatic Machines.

2. Geology: Structural Geology: Definition and scope. Recognition of faults, folds, joints, unconfirmaties etc., Primary and induced structures, their importance in Mining, Bedding, Liniation, foliation, fracture, Cleat etc., field Geology; importance and scope of filed Geology, field techniques, geological mapping.

3. Principles of Stratigraphy.

4. Exploratory Drilling: Principles, selection of site, lay outs, details of equipment, methods of drilling and their variation, interpretation of bore holo data.

5. Explosives and Blasting: Classification, types and use of explosives storage and transport. Blasting techniques in UG and open cost mines.

6. Supports: Objectives, limitations of mine supports, Types of mine supports and systematic timbering, Power supports, roof stiching, roof bolting.

7. Mineralogy: Physical, chemical and optical characteristics of common rock forming silicate mineral groups. Structural classification of silicates. Minerals of Carbonate, Phosphate and sulphide groups. .

PAPER - II

1. Opening and Choice of Mining Methods: Opening, development of mineral deposits, classification of mining methods, merits, demerits and application. Bord and pillar mining. Long wall mining. Open cast mining and their variations. Design of suitable methodology of mining for specific conditions like thickness, depth, inclination, annual production etc., thick seam mining, stowing, bench parameters, box-cut.

2. Metal Mining: Scope and limitations of U/G metal mining methods, Classification of U/G metal mining systems and their applications in different conditions.

3.Mine Surveying: Principles of surveying. Different methods and their importance. Chain surveying. Compass ; surveying, theodolite surveying, plane labling, levelling, triangulation, correlation. Astronomical terms and definitions. Mine plans and sections. Regulations pertaining to plans and sections.

4.Mining Machinery: Elements of transport system, classification and techno economic indecies. Rope haulage, locomotive haulage, conveyers, Aerial ropeways, trackless haulage, Winding. Drainage and pumping.

5.Mine Environmental Engineering: Mine air and environment. Natural and mechanical ventilation, Types, design variables, selection, installation and maintenance. Mine fires, explosions and innundations, Rescue and recovery.

6. Mine Legislation and safety: Regulations pertaining to conservation's, exploitation of mineral deposits. Safety welfare and hygiene of mine workers.

16. MATHEMATICS AND SCIENCE (GEOLOGY)

PAPER- I

Unit – I

Geomorphology and Remote Sensing: Weathering and erosion, Geological action of River, wind and glacier. Physiography of India, Application of geomorphology.Principles of aerial photography, photogrammetry and satellite remote sensing – data products, their interpretation and application. Geographic Information System (GIS) – Principles and application.

Unit – II

Mineralogy: Physical, chemical and optical characteristics of common rock forming silicate mineral groups. Structural classification of silicates. Minerals of Carbonate, Phosphate and sulphide groups. Atomic substitution, isomorphism, polymorphism. Principles of X-Ray Diffraction. .

Unit –III

Structural Geology: Concept of stress, strain and rock deformation. Structural analysis of folds, joints and faults, Lineation and foliation. Unconformities and basement cover relation. Superposed deformations.

Unit – IV

Igneous and Metamorphic Petrology: Form, texture and structure of igneous rocks. Silicate melt equilibria, binary and ternary phase diagrams, magmatic differentiation, assimilation. Petrology and geotectonic evolution of granites, basalts, anorthosites, ophiolite, kimberlite. Texture and structure of metamorphic rocks, regional and contact metamorphism. Characteristics of different grades and facies of metamorphism. Plate tectonics and metamorphic zones. Metasomatism, granitisation, migmatites and paired metamorphic belts.

Unit – V

Sedimentology and Geochemistry: Sedimentary structures and textures. Provenance and diagenesis. Sedimentary environment and facies. Tectonics and sedimentation. Classification of sedimentary rocks. Sedimentary basins of India. Earth in relation to solar system, structure and composition of Earth. Geochemical cycle, meteorites. Concept and application of stable isotopes in sedimentology.

PAPER-II

Unit –I

Palaeontology: Morphology and time ranges of fossil groups. Evolutionary changes in mollusks and mammals in geological time. Siwalik vertebrate fauna, Gondwana flora. Evidence of life in Precambrians. Different microfossil groups and uses in biostratigraphic correlation.

Unit – II

Stratigraphy: Stratigraphic code and nomenclature, Geological time scale, Stratigraphic correlation, Precambrian stratigraphy of India. Stratigraphy of the Palaeozoic, Mesozoic and Cenozoic formations of India, Gondwana system and Deccan traps. Palaeoclimate and palaeogeography. Concept of seismic and sequence stratigraphy.

Unit – III

Geophysics and Fuel Geology: Geophysical techniques: gravity, electrical, magnetic and seismic. Origin and classification of coal, Indian coal deposits: Gondwana, Tertiary and lignite. Coal Bed Methane (CBM). Origin, migration and entrapment of natural hydrocarbons, structural, stratigraphic and mixed traps. Geographical and Geological distribution of onshore and offshore petroliferous basins of India.

Unit – IV

Economic Geology: Process of mineralization: magmatic, hydrothermal, supergene, sedimentary exhalation (SEDEX). Mineralogy, mode of occurrence and distribution of iron, manganese, aluminium, chromium, base metals and gold. Indian deposits of non-metals: mica, asbestos, graphite, placer deposits, gemstones, limestones, evaporites. Strategic, critical and essential minerals. Metallogenic epochs and provinces. Surface and subsurface exploration and prospecting.

Unit – V

Hydrogeology and Environmental Geology: Natural hazards – preventive / precautionary measures of floods, landslides, earthquakes, tsunami, coastal erosion. Impact assessment of anthropogenic activities: opencast mining, river valley projects, solid and radioactive waste disposal, excess withdrawal of groundwater, oil spill. Concept of global warming, sea level rise. Vertical distribution of groundwater, classification of aquifers, hydrologic cycle. Hydrological properties: porosity, permeability, Darcy's law and its application. Groundwater provinces of India. Groundwater quality and contamination, groundwater recharge, rainwater harvesting. Engineering properties of rocks, geological investigation for dams and reservoirs. Tunnels: type, method and problems.

17. METALLURGICAL

PAPER - I

1. Mechanical Testing: Cohesion between atoms: bonds, potential energy Vs interatomic distance curves, Fundamentals of crystal structure of metals; tension testing: tensile properties, strain aging, ductile and brittle materials; Erichson cupping test, directionality; torsion test: specimen behaviour under torsion; hardness test: Brinell , Rockwell and Vickers test, relation between hardness and tensile strength, micro hardness testing; creep test: creep curve, stress rupture test; fatigue test: S-N curve, statistical nature, effect of mean stress; impact test: Charpy and Izod test, transition temperature; structures & properties of engineering materials.

2. Metallurgical Thermodynamics: Review of first and second laws of thermodynamics, Maxwell's relations; free energy concept and applications, general strategy of deriving thermodynamic relations; third law of thermodynamics; related problems. Solutions, partial molar properties, Gibbs-Duhem equation, fugacity, activity, equilibrium constant; regular solutions, integration of G-D equation, dilute solutions, interaction parameter; equilibrium in thermodynamic systems, structure of unary phase diagrams in (P,T) space, Clausius -Clapeyron equation, triple point, alternative representation of unary diagrams; Gibbs phase rule, Free energy-composition diagrams, Ellingham diagrams; activation energy, effect of activation energy on reaction rate, chemically controlled reactions (both ideal and non-ideal systems).

3. Physical metallurgy and phase diagrams: Structure of metals, space lattice, unit cells, crystal systems, metallic crystal structures, packing efficiencies, planes and directions, voids, imperfections in crystalline solids, dislocations and plastic deformation, theoretical shear strength, concept of dislocations, types of dislocations, Burgers vector, strain field associated with dislocations, dissociation of dislocations, climb and cross slip, dislocation interactions, plastic deformation by twin, yield point phenomenon, strain ageing, work hardening in single and polycrystalline materials, effect of temperature, composition and grain size on strain hardening, recovery, recrystallisation and grain growth, diffusion in solids, applications of diffusion concepts, solidification of metals, freezing of alloys, Scheil equation dendritic freezing in alloys, freezing of ingots, segregation, homogenization, growth of single crystals. PHASE DIAGRAMS : Types of solid solutions, Hume Rothery rules, intermediate phases, binary isomorphous system; phase rule and lever rule, miscibility gaps, eutectic systems, phase diagrams with intermetallic compounds; monotectics, syntetic, eutectoid, peritectic and peritectoid reactions in binary systems and solidification behaviour of typical alloys in these systems , Fe-Fe3C phase diagram , other commercially important binary systems.

4 Mineral dressing and principles of extractive metallurgy: Scope of mineral dressing in metallurgy , crushing and grinding , sampling and particle size analysis. Gravity concentration methods , froth flotation , magnetic and electrical separation cyclones , filters , solids conveyance and storage. Principles of extractive metallurgy: Sources of metals, pyrometallurgical processes, refining processes, hydrometallurgical processes, recovery of metal values from leach solution, electrometallurgical processes, electrorefining and electrowinning . copper: sources of copper, extraction from sulphide ores, refining, newer processes for copper extraction, hydrometallurgy of copper; zinc: sources, pyrometallurgical extraction, hydrometallurgical extraction, recovery of byproducts (cadmium); Imperial Smelting Process (ISP); lead: sources, extraction of lead, lead blast furnace, refining, modern developments in lead smelting, aluminium and magnesium extraction.

5. Fuels & Refractories: Definition & Classification of fuels. Distribution of fuel resources in India , their origin & geological formation. Classification of coal. Various tests for coal for selection of coal for metallurgical processes. Manufacture & testing of coke for various uses. Petroleum, its sources & distillation. Various tests for liquid fuel. Manufacture, uses & analysis of various gaseous fuels. Combustion calculation on solid, liquid & gaseous fuels. Classification & desirable properties of refractories. Testing of refractories. Special refractories. Use of refractories in ferrous & non ferrous industries. Manufacture of various refractories.

PAPER - II

1. Process engineering : Units and dimensions, applications of transport phenomena, properties of fluids, laminar and turbulent fluid flow, Stoke's Law, flow past submerged bodies, flow through packed and fluidized beds, Bernoulli's Equation, dimensional analysis, flow of compressible fluids, Fourier's law, conduction in solids, liquids and gases, concept of heat transfer coefficient; heat transfer, heat transfer in packed and fluidized beds; diffusion in solids, liquids and gases, Knudsen's diffusion, diffusion processing and homogenization of alloys, unsteady state mass transfer, concept of mass transfer coefficient .

2. Production of iron and steel: History of iron making, Evolution of Blast furnace, Distribution of Indian Iron ore, limestone and coking coal deposits ,problems associated with Indian raw materials, iron ore beneficiation and agglomeration, theory and practice of sintering and pelletising, testing of burden materials, blast furnace reactions, thermodynamics and kinetics study, recent developments in the design and operation of the blast furnace, irregularities in blast furnace operation and their remedies, blast furnace refractories and instrumentation, blast furnace slag and gas : importance, formation and use. Direct reduction methods, details of some commercial processes like Corex process PRODUCTION OF STEEL : History of steel making, principles of steel making, LD/ BOF, QBOP/OBM, Energy optimising furnace(EOF) , Inputs

required in oxygen Steel making, Yields from metallic inputs. Alloy and Stainless steel making, continuous steel making , steel making in induction furnaces, secondary steel making processes , steel degassing processes ,casting pit practice, continuous casting of steel, molds used for continuous casting use of casting powder, electromagnetic stirring , defects in continuous cast product .

3. Heat treatment : Nucleation and growth of austenite, pearlitic transformation, TTT diagrams, formation of martensite, annealing, normalizing, hardening and tempering, hardenability , heat treatment furnaces, austempering , martempering , ausforming ; thermo mechanical treatments; surface hardening of steels; effect of alloying elements on Fe-C diagram, structure and properties of steels; carbon and alloy tool steels, stainless steels, HSLA steels, maraging steels, dual phase steels; cast irons and their heat treatment, aluminium and its alloys .

4. Metal forming and corrosion engineering : Elasticity and plasticity, yield criterion theories of metal forming, hot, warm and cold working, , super plasticity and explosive forming, friction and lubrication in metal working processes, forging, CAD & CAM in forging, extrusion, mannesmann mill, rolling, drawing of rods, wire and tubes, dies, optimum die angle, bulk forming and sheet metal forming, deep drawing, redrawing, limiting draw ratio, role of texture defects in sheet metal working, bending, shearing, rubber pad forming, stretch forming, high energy rate forming, numerical problems and design aspects in forming. CORROSION ENGINEERING : Definition of corrosion, corrosion damage, classification of corrosion, electrochemical aspects, electrochemical reactions, mixed potential theory, polarisation, passivity, environmental effects, effect of oxygen and oxidisers, effect of temperature, effects of corrosive concentration, corrosion testing, standard expressions for corrosion rate, galvanic corrosion, erosion corrosion, crevice corrosion, intergranular corrosion, pitting, stress corrosion. Paint tests, sea water tests. Interpretation of results, Corrosion prevention ; cathodic and anodic protection , coatings, high-temperature corrosion .

5. Foundry technology Patterns, sand moulds, moulding processes, special casting process, evaluation and characterization of moulding materials, cores and core materials, mould production, core production, sand compaction, foundry machines, moulding equipments, foundry layouts, mechanization & automation, different types of foundries, solidification, growth structures in pure metals, applications of constitutional super cooling to castings, cast structures, gases & inclusions in castings, segregation, defects related to solidification, design of risers, runner systems and design of runners, elements of casting designs, foundry metallurgy of cast irons, production of S.G. iron and malleable iron, classification of gray cast iron, inoculation practice, ADI, steel foundry practice, melting practice, cupola, induction melting, melting of aluminium and copper alloys.

18. DRILLING ENGINEERING

PAPER – I

1. Basic Mechanical Engineering : Strength of materials, Air Compressors, Diesel Engine, Theory of Machines, Friction Laws of dry friction, Power Transmission, Governors, Hydraulics & , Hydraulics Machines- Properties of fluids, Bernoulli's equation and its applications, Flow through orifices & notches, Flow through pipes, Impact of jet, Miscellaneous Hydraulic Machines.

2. Explorating Drilling : Surface Exploratory Drilling, Methods of Exploratory Drilling, Drilling Practices, Wire line Coring System, Reverse Circulation System, Con-core Process of Coring Operation Ground Water Exploration Drilling, Foundation Exploration Drilling, Oil & Natural gas Exploration Drilling, Well activation, Off-Shore Drilling, Drilling for Geo-Thermal exploration.

3. Engineering Geology: The origin, nature and geological classification of rock materials. Surface processes causing rock disintegration, Elements of mineralogy , Elements of Structural Geology, Stratigraphy , Fossil fuel, Economic Geology, Sampling, Geology of soil, Prospecting & Exploration, Engineering Geology, Groundwater Engineering.

4. Drilling Machinery: Diamond drilling rig, Vibration in diamond drilling, Derrick, Core Barrels , Core Bit, Casings, Fishing. Oil well Rig & allied Machineries, Circulatory pump, Fishing, Oil Drilling Machinery, Borehole surveying Instructions.

5. Mine survey: Measurement of distance, Compass survey, Levelling, Contouring,. Calculating of ore reserves.

PAPER - II

1. Blast hole Drilling : Introduction, scope, purpose of drilling and historical development, Blast hole drilling by rock drills, Rotary Blast hole Drilling, Fire jet Drilling, Rock Mechanics, RATIONALE Since the outcome of mining depends upon the efficiency, Underground blast hole drilling for coal and metal.

2. Geological Prospecting & Exploration: Theory of prospecting & Exploration, Prospecting criteria & guides, Prospecting methods, Testing Equipments, Sampling.

3. Advance Drilling Technology: Standards of Drill String, Advance directional Drilling Technique & application, Advance Exploration Drilling Technique, Advance Rock Drilling Technique, Study and sketching of layout of drill site. Core splitter, hoisting plug, water swivel, different Types of rods and casings, Different type and design of barrels, diamond bits, T.C. bits, rock roller bit etc. Study and sketching of different rock drills, D.T.H. Compressors. Study & sketching of different feed mechanism.

4. Mud & Cement Technology: Circulating fluids, Mud chemistry, Cementation, Storage and maintenance. Mineral dressing – Introduction, Unit Operation, Grinding, Lab. Sizing, Industrial Screening, Gravity Concentration, Heavy Media Separation, Flotation, Magnetic & Electrostatic, Separators.

5. Drilling Safety and Environment Management: Health hazards from Rock drilling, Safety aspects relating to I/C engine drive, Electric drive, compressed air hydraulically driven drilling machineries. Safety precautions in Diamond drilling, Rig safety rule under safety rules for the use of mining equipment. Safety Precautions in oil well drilling, Environmental pollution and its control.

6. Tube well / Oil well Draining Technology: Occurrence of Ground water, Drilling Techniques, . Screening Water Wells, Well Development, Testing of Water, Failure of tube well, Well Planning, Exploratory Drilling Camp, Coring and core Analysis, Rock Characteristics, Evaluation oil Wells.