Syllabus for Electrical Overseer/Sub Inspector in Labour Department

S.No.	TOPICS
1	*APPLIED CHEMISTRY*
	Problem based on Volumetric Gravimetric Analysis 1. Molecular-mass, mole, weak and strong electrolytes, Equivalent mass and Gram equivalent. 2. Strength, Normality and Molarity of a solution, Normality equation. 3. Problem base on Volumetric and Gravimetric Analysis. Analysis and treatment of water 1. Impurities in water, Hardness, Units of Hardness and Calcium carbonate equivalent. 2. Estimation of dissolved oxygen, Alkalinity and Hardness by EDTA method. 3. Problems in boilers, Ion Exchange process for softening of water. Fuel and Combustion 1. Units of heat, Characteristics of good fuel, Calorific value, Calculation and determination of calorific value, types of Coal, Petroleum, LPG, CNG, Producer gas, Water gas and Coal gas. 2. Problem based on combustion of solid, Liquid and Gaseous Fuel, Analysis of Flue gases by Orsat apparatus. Corrosion and Lubricant 1. Dry and Wet corrosion, Galvanic corrosion, Concentration corrosion, Pitting corrosion, Stress corrosion. 2. Protection of corrosion by proper designing, Alloying, Cathode protection and coating methods. 3. Types and Mechanism of Lubricant, Characteristics of Lubricants like Viscosity, Acid value, Saponification value, Cloud point, Pour point, Flash and Fire point. Atomic Structure and Bonding 1. Bohr's theory, Quantum no, Electronic configuration of first 36 elements, AUFBAU Principle, Pauli Exclusion Principle and Hund's Rule. 2. Electrovalent, Co-valent Compounds, Intermolecular Forces. 3. Metallic bonding and Free Electron theory.
2	*APPLIED MATHEMATICS-I*
	ALGEBRA Arithmetic progression, its nth term, sum to n terms. Geometric progression, its nth term, sum to n terms and sum of infinite tirms. Binomial theorem (without proof) for any index, General and middle term, terms independent of x, First and second binomial approximation. DETERMINANTS Determinants (upto 3rd order only), minors, co-factors, Properties of determinants, solution of linear simultaneous equations in three variables by Cramer's rule. MATRICES Definition and examples of matrices, types of matrices, basic operations, equality of matrices, addition, multiplication and scalar multiplication of matrices, transpose of a matrix, symmetric, skew-symmetric matrices, singular and non-singular matrices, cofactor matrix, adjoint of a matrix, inverse of a matrix, solutions of simultaneous equations in three variables by matrix inverse methods.

	CO-ORDINATE GEOMETRY OF TWO DIMENSIONS Definition of locus with problems, Equations of straight lines in various forms. Angle between two lines, Perpendicular distance formula, Conic sections, Circle, Parabola, Ellipse and Hyperbola. VECTORS Scalar and vectors, addition and subtraction of vectors and their simple applications, multiplication of vector by scalar, Scalar and vector product of two vectors. Scalar product of three vectors, Geometrical interpretation
3	*APPLIED MECHANICS*
	Introduction: Concept of engineering mechanics, its importance and necessity. Giving suitable examples on bodies at rest and motion, concept of rigid bodies. Laws of forces: Principles of mechanics-superposition, transmissibility etc, types of forces, systems of forces, principles of forces, resultant of forces. Parallelogram law, triangle law, polygon law of forces, resolution of forces, free body diagram. Equilibrium force and its determination, Lami's theorem. . Moments: Concept of moment, laws of moment, Varignon's theorem. Application of moment to simple mechanism, resultant of parallel / non-parallel forces, reaction at support in statically determinate beam due to point load, U. D. L and triangular load. Centre of gravity: centre of gravity and centroid of regular body (cone, cylinder, sphere and hemisphere), areas (rectangle, circle and triangle), composite bodies, composite areas, remainder. Moment of Inertia: Moment of inertia of Lamina-rectangular, circular (solid/hollow), triangular, parallel axis theorem, perpendicular axis theorem. Laws of motion: Newton's laws of motion, momentum, impulse, torque, linear and angular motion. Circular motion: centripetal and centrifugal force. Work, Power and Energy: Definition of terms, simple numerical problems. Friction: Concept of friction, laws of friction-static and dynamic, limiting friction, coefficient of friction, angle of friction. Equilibrium of a body lying on a horizontal plane, equilibrium of a body lying on a rough inclined plane. Simple Lifting Machines: Concept of machine, mechanical advantage, velocity ratio and efficiency of machine, their relationship, laws of machine, simple machine winch crab, wheel and axle, simple screw jacks. System of pulley-first, second and third system of pulley.
4	*FUNDAMENTALS OF ELECTRICAL ENGINEERING*
	D C Circuits Current, Voltage, Power, Energy and their units, Ohm's law, Resistance, Resistances in series, Resistances in parallel, Laws of resistance, Temperature coefficient of resistance, Grouping of cells, Numerical problems. Electromagnetism Introduction to electromagnetism, Magnetic field around a straight current carrying conductor, Magnetic field at the axis of a circular conductor, Magnetic field at the axis of a solenoid, Methods for finding the direction of magnetic field of straight conductor and solenoid, Force on a current carrying conductor placed in the magnetic field, Force between two parallel current carrying conductors, Numerical problems. Magnetic Circuits Magnetic field, Flux, Flux density, Magneto motive force, reluctance, Laws of magnetic force, Absolute and relative permeability, Series and parallel magnetic circuits, Leakage flux, B-H curve, Magnetic hysteresis, Hysteresis loop, Hysteresis loss, Ampere-turns calculations, Comparison between electric and magnetic circuits, Numerical

	problems. Electromagnetic Induction Faraday's laws of electromagnetic induction, Lenz's law, Fleming's rules, Principle of self and mutual induction, Self and mutually induced emf, Self-inductance and mutual inductance, Coefficient of coupling, Energy stored in inductor, Numerical problems. D C Transients Growth of current in an inductive circuit, Current in RL series circuit at different times, Time constant of RL series circuit, Decay of current in inductive circuit, charging of capacitor, Time constant of RC series circuit, Initial values, Final values, Discharging of capacitor, Numerical problems.
5	*ENGINEERING DRAWING-I*
	Introduction a. Drawing Instruments, Drawing instruments, Sizes and layout of standard drawing sheet, Sizes on drawing boards. b. Lines, Lettering and Dimensioning: Different types of lines and freehand sketching, Different types of lines in engineering drawing as per BIS specifications, Practice in freehand sketching of vertical, horizontal and inclined lines, geometrical figures such as triangles, rectangles, small and large circles, parabolas, curves and ellipses. Lettering Techniques and Practice Instrumental single stroke (vertical and inclined) lettering of 3 to 7 mm height. Instrumental double stroke lettering of 35 to 50 mm height ratio of 7:4 (vertical). Dimensioning Necessity of dimensioning, terms and notations- methods and principles, dimensioning small components (mainly theoretical instructions), dimensioning of overall sizes circles, thread holes, chamfered surfaces, angles tapered surface holes equally spread on PCD, counter sunk and counter bored holes, cylindrical parts. Space and gaps radii curves and arches, chain and parallel dimensioning. Scales Scales and their need and importance, definition of representative fraction (RF), calculating RF of a scale, types of scales, construction of plain and diagonal scales. Unit-V: Construction of curves such as ellipse, parabola, hyperbola, cycloids, epicycloid and hypocycloid, involute of simple curves.
6	*APPLIED MATHEMATICS-II*
	DIFFERENTIAL CALCULUS Limit and continuity (without problems), Differentiation of functions by First Principle, Differential of sum, product and quotient functions, Differential of a function of a function (Chain rule), Logarithmic differential, Higher order derivatives. INTEGRAL CALCULUS Indefinite integral, Integration of a function, standard formulae, the fundamental laws of integration, Integration by substitution method, by parts method and partial fractions method. APPLICATIONS OF CALCULUS Maxima and minima, Tangent and normal, Evaluation of definite integral. Properties of definite integral, Area bounded by a curve between two ordinates and x-axis. DIFFERENTIAL EQUATIONS

	Differential equation, Order and degree of differential equations, Solution of differential equations of first order and first degree, variable separable, Homogeneous and linear differential equations, Solution of linear differential equations of 2nd order with constant coefficient. COMPLEX NUMBERS Complex Number, representation of a complex number (Argand Diagram), Complex number in rectangular, polar and exponential forms, Conversion from one form to another form. De Moiver's Theorem, Roots of complex number.
7	*APPLIED PHYSICS*
	Unit and Dimensions Fundamental and derived units (SI System), Dimension of various physical quantities, uses of dimensional analysis and its limitations. Accuracy and precision of measuring instruments, error in measurement. Electrostatics Coulomb's law, Electric field, electric field at a point due to Point charge, Electric flux, Gauss's theorem, electric field at a point due to a due to a uniformly charged thin sheet, electric field intensity at a point due to a charged sphere, electric potential, potential due to a point charge, Equi potential surfaces, relation between electric potential and intensity. Capacitor Capacity of parallel plate capacitor, energy store in a capacitor, combination of capacitor (Series and Parallel) D.C Circuit Kirchhoff's law, application of Kirchhoff's law to the wheat stone bridge, Post office Box, Meter bridge and potentiometer. Heating effect of current, Electric Power. Electromagnetism Motion of charged particles in uniform magnetic field and electric field, Biot-savart law, Magnetic field due to straight wire, circular loop, Force experienced by moving charge and a current carrying conductor in a uniform magnetic field, Torque on current loop, force between two parallel current carrying conductors, Definition of an Ampere, Moving coil galvanometer, conversion of galvanometer into ammeter and voltmeter. Semi conductor physics Intrinsic Semiconductors, Conductivity, Atomic and Crystal structure of germanium and silicon, covalent bonds, generation and recombination, effect of temperature on conductivity of Intrinsic semi conductor, Energy level diagram of conductor, insulator and semi conductor, Extrinsic semi conductor, P and N type semiconductor and their conductivity.
8	*ELEMENTS OF MECHANICAL ENGINEERING*
	Transmission of Power Different modes of power transmission Belt Drive: Material of belt, flat belt V belt open belt and cross belt device, Length of belt (without derivation), Velocity ratio, Slip, Angle of contact, Derivation of tension ratio for flat belt, Power transmitted through belts. Advantage of V belt over flat belt, Simple numerical problem. ($T1/T2=e\mu^{\theta}$) Chain Drive: Classification, Clutch: Principal of clutch, comparison between chain and belt drive.Pulley: Introduction, type of pulleys, step pulley, split pulley, vee-grove pulley, rope pulley.Gears: Spur, Helical, Bevel, Spiral, Rack and Pinion, Gear Train: Simple and Compound gear train

	and simple numerical problems. Steam Generators and Turbines Steam generators: Introduction, classification, Difference between Fire tube and Water tube boilers. Simple vertical boiler, Babcock and Wilcox boiler, Cochran boiler, Boiler accessories and mountings. Turbines: Introduction & classification of steam turbine, concept of reaction and simple impulse turbine, comparison between impulse and reaction turbines. Losses in steam turbine. Hydraulic turbine: Classification, construction, working of Pelton wheel, Francis turbine and application of reaction and impulse turbine. Internal Combustion Engines • Classification and application if I.C. engine commonly used spark ignition engine • Compression ignition (C.I) engines. • Working principals of two stroke and four stroke petrol and diesel engine. • Ignition system in petrol engine • Simple carbonator. • Cooling system of IC engine. Lubrications: Introduction, Method of lubrication: Petrol System, mixed, (D), Splash and forced lubrication system. Pumps: Construction and Working of reciprocating (single acting) centrifugal pump, Air compressor: Working of air compressor and applications of compressed air Material Handling: Tower and bridge crane. Jaw Crushers. Hydraulic jack and hydraulic Lift. Refrigeration and Air Conditioning System: Introduction, unit of refrigeration, coefficient of performance, vapour compression cycle: Simple vapour absorption cycle & applications. Air conditioning System: Purpose of air conditioning, Factors affecting air conditioning, definition relating to psychometric parameters like dry bulb temp., wet bulb temp., humidity etc. room air conditioner (window & split type) and desert cooler.
9	*ELECTRICAL ENGINEERING MATERIALS*
	Conducting Materials Introduction, Resistivity and factors affecting resistivity, Classification of conducting materials into low resistivity and high resistivity materials, Low Resistivity Materials and their Applications, Copper, Aluminum, Stranded conductors, Bundled conductors, High Resistivity Materials and their Applications, Tungsten, Carbon, Platinum, Mercury. Semiconducting Materials Introduction, Semiconductors, Electron Energy and Energy Band Theory, Excitation of Atoms, Classification of Insulators, Semiconductors and Conductors, Semiconductor Materials, Intrinsic Semiconductors, Extrinsic Semiconductors, N-Type Materials, P-Type Materials, Minority and Majority Carriers, Semi-Conductor Materials, Applications of Semiconductor materials. Insulating Materials Introduction, General properties of Insulating Materials, Electrical properties, Visual properties, Mechanical properties, Thermal properties, Chemical properties, Ageing, Insulating Materials – Classification, properties, applications, Classification of insulating materials on the basis physical and chemical structure. Dielectric Materials Introduction, Dielectric Constant of Permittivity, Polarization, Dielectric Loss, Electric Conductivity of Dielectrics and their Break Down, Properties of Dielectrics, Applications of Dielectrics.

	Magnetic Materials Introduction, Classification, Diamagnetism, Para magnetism, Ferromagnetism, Magnetization Curve, Hysteresis, Eddy Currents, Curie Point, Magnetostriction, Soft and Hard Magnetic Materials. Materials for Special Purposes Thermocouple materials, Bimetals, Soldering Materials, Fuse and Fuse materials.
10	*BASIC ELECTRONICS*
	Introduction: Introduction to electronics engineering: Physical and applied electronics, Applications of electronics engineering in different fields, Electronic components: active and passive, Ideal and practical voltage and current sources. PN Junction Diode & Rectifiers: PN junction, Behavior of PN junction under forward and reverse bias condition, Semiconductor diode characteristics, Static and dynamic resistances, Their calculation from diode characteristics, Diode as half and full wave rectifier: Center-tap and Bridge type, Ripple factor and its value for half and full wave rectified output, Calculation of DC voltage, RMS voltage and rectification efficiency. Filters & Special Purpose Diodes: Filters, Capacitor input filter, Choke input filter, L-type and ∏-type filter, Zener diode, Breakdown mechanisms: Zener and avalanche breakdown mechanism, Zener parameters, Application of Zener diode in voltage regulator, Varactor diode, LED. Bipolar Junction Transistor: . Introduction of Bipolar Junction Transistor, PNP and NPN transistors their symbol and mechanism of current flow, Explanation of fundamental current relations, Concept of leakage current in CB, CE and CC configuration, Input and output characteristics, Determination of input and output resistances: static and dynamic, Comparison of CB, CE and CC configurations. Amplifier & Biasing Circuits: Transistor as an amplifier in CE configuration, DC equivalent circuit, DC load line and operating point, Effect of temperature and replacement of transistor on operating point, Need for stabilization of operating point, effect of fixing operating point in cutoff and saturation region on the performance of amplifier, Transistor biasing circuits: Fixed biasing, Collector to base biasing, Self biasing and Emitter biasing circuits.
11	*WORKSHOP PRACTICE*
	Machine shop: Introduction of lathe and its operation Introduction of drilling machine and its operations. Introduction of milling machine and its operations Introduction of shaping machine and its operations. Carpentry shop: Introduction of carpentry tools such as Saws, C-Clamp, Chisels, Mallets, Carpenter's vices, marking gauges, Try-squares, steel rulers. Study about woods. Study about seasoning of wood. Making of various joints-Cross lap joint, half lap joint, Mortise and tenon joint, Dovetail joint. Sheet Metal Shop: Introduction to sheet metal shop, use of hand tools and accessories e.g. hard and soft mallet, sheet and wire gauge, necessary allowance required during job fabrication, selection of material e.g. G I sheet. Preparation of seam joints such as lap

	seam/ standard seam/flat lock seam/grooved seam. Black Smithy Shop: Introduction of tools hot working and cold working process. Different types of Hearths used in Smithy shop. Purpose, specifications, uses, care of various tools and equipments used in hand forging by segregating as cutting tools, supporting tools, holding tools, measuring tools etc. Types of fuel used and maximum temperature obtained. Types of raw materials used in Smithy shop Making of U clamp/fan hook. Welding Shop: Introduction and importance of welding as compared to other material joining processes. Specifications and type of welding machines, classification and coding of electrodes, welding parameters, welding joints and welding positions. Materials to be welded, safety precautions. A/C welding and gas welding. Edge preparation of lap joint/butt joint. Preparation of Oxy acetylene gas welding joints. Fitting shop: Introduction to fitting shop tools, marking and measuring devices/equipment. Identification of materials such as Iron, Copper, Stainless Steel, Aluminium etc. Identification of various steel sections (flat, angle, channel, bar etc.). Introduction to various fitting shop operations/processes (Hacksawing, Drilling, Chipping and Filing) and filing practice as per drawing Drilling.
12	*MEASUREMENT AND MEASURING INSTRUMENTS*
	Measurement of Voltage and Current Important terms, classification of errors, classification of instruments, essentials of indicating instruments, controlling torque, types of controlling torque, damping torque and its type. Construction of Instruments Construction and working of PMMC, construction and working of MI instruments, Construction and working of electrostatic instruments. Measurement of Power and Energy Rectifier type instruments, construction and working of dynamo meter type wattmeter, construction and working of single phase induction type energy meter. Measurement of Resistance Measurement of low, medium and high resistance, megger, single phase power factor meter. AC Bridges Basic principle of AC Bridges, Maxwell's Bridge, Hay's Bridge and Wien's Bridge extension of range of instruments.
13	*DIGITAL ELECTRONICS AND MICROPROCESSOR*
	Number Systems: Binary number system, Binary to decimal conversion and decimal to binary conversion, octal and hexadecimal number system, Representation of Negative numbers, I's complement and 2's complement representation. Binary Codes :BCD code, Grey code and excess -3 code. Logic Gate: symbol and truth table of AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR gates. Application of NAND and NOR gates as Universal gate. Boolean Algebra: Laws and theorems of Boolean algebra and their application, De-Morgan's theorem, minimization of logic expression by using Boolean laws, theorem and K-map.

	Combinational circuits: Half and full Subtractor, multiplexer and demultiplexer, Encoder and decoder, Flip Flop: Difference between Combinational and sequential circuits, Introduction of RS flip flop JK flip flop , D -type flip flop. Evolution of Microprocessors, 8085 architecture, ALU, Timing and control unit, Program counter, Registers, Flag registers, General Purpose Registers. Instruction set, PIN diagram of 8085 Microprocessor. Memories: Concept of Random-Access Memory (RAM), static and dynamic RAM, Read Only Memory (ROM), PROM, EPROM. Digital Waveform Generator: concept of timer IC 555 and its use for waveform generation.
14	*COMPUTER APPLICATIONS*
	Digital Computer systems, Characteristics, History, Computer Generations, Types of computers & their classifications, application of Computer in various fields, Computer Hardware & Software, Elements of computer hardware-CPU, I/O devices, storage media, Computer Software-Types of Software, System Software, Application Software. Basic concept & functions of an operating system, textual Vs GUI Interface, type of Operating Systems, concept of multiprogramming, multitasking, multiprocessing, Introduction to disk operating system (DOS), Commands and utilities, working with MS Windows, Unix and Linux, Working knowledge of PC Software Word Processor. Computer Languages, Generation of Languages, Translators- Assemblers, Interpreters, Compilers, Algorithm, Pseudo-code, Flowcharts- rules & symbols, Structured Programming concepts, various techniques of programming, Use of programming. Introduction to 'C', importance of C, basic structure of a C program, constants, variables and data types, operators and expressions, managing I/O operators, Control Statement: 'IF' statement and its various forms, goto statement, for, while and do-while loops, switch decision making statement, Arrays: Array notation, storage and representation, Functions: user defined functions and their use.
15	*ELECTRICAL DESIGN DRAWING & ESTIMATING*
	Electrical Symbols and Simple Light and Alarm Circuits: Electrical symbols used in electrical installation, Schematic and wiring diagrams, light and fan point controlled by individual switches, fluorescent tube controlled by one-way switch, one lamp controlled by two switches (staircase circuit) three lamps controlled by four switches (Corridor light circuit). Alarm Circuits Without and with Relays: One bell controlled by one push button, two ordinary bells (for day and night) used at a doctor's residence, bell response circuit using one bell and one relay, bell response circuit of an office (of three rooms). Traffic light control system for two road crossing, a Light circuit which automatically gets connected to DC supply in case of power failure. Electrical Installation of Small Residential Buildings: Internal Distribution system, Single-phase Light and Power Sub-Circuit, Systems of wiring, Installation plan, Multiline and Single line wiring diagrams, Design and Estimation of electrical installation of small residential buildings, list of material required along with cost by doing market survey, Description of various tests to test the wiring installation before commissioning.

	Electrical Installation of Commercial Buildings: Internal Distribution system, Busbar chamber, Mains, installation plan, Single-Line wiring diagram, Design and Estimation of electrical installation of large commercial buildings, list of material required along with cost by doing market survey, commissioning of electrical installation, Introduction to Intelligent Lightning system
16	*THERMO FLUIDS*
	Introduction and application areas of thermo-fluid sciences, Property, system, and surroundings. Enthalpy and internal energy, state and equilibrium, processes and cycles, Laws of thermodynamics, reversible, irreversible processes, heat and work, Formation of steam, dryness fraction, specific volume, specific enthalpy, specific entropy of saturated and superheated steam, simple numerical problems. Introduction to three modes of heat transfer (conduction, convection and radiation) and their governing equations, one dimensional steady state conduction. Thermal conductivity, thermal resistance, convective heat transfer coefficient, critical radius of insulation, Principle laws of thermal radiation, Kirchhoff 's law, Stefan Boltzmann's law, emissivity, absorptivity, reflectivity and transitivity, simple numerical problems. Properties of Fluid: Mass, density, weight density (specific weight), specific volume, specific gravity, viscosity (kinematic & dynamic viscosity), surface tension, compressibility and their units, Newtonian fluids. Pressure: Intensity of pressure, pressure head, Pascal's law with, atmospheric pressure, gauge pressure, vacuum pressure, absolute pressure. Measurement of pressure: Piezometer, simple manometer, differential manometer, inverted differential manometer. Loss of Energy in pipe flow: Loss of head during flow through pipelines, major &minor losses, Darcy's and Chezy's formula (without proof), loss of head in pipe due to sudden enlargement, sudden contraction, bend, elbow, obstruction (without Proof), power transmission through pipes, simple numerical problems. Types of fluid flow. Steady & unsteady, uniform & non-uniform. Laminar & turbulent flows. Reynold number and its significance, rate of flow, continuity equation, Bernoulli's theorem (without proof) and its limitations; discharge through venturimeter, pitot tube; and small orifice, vena contracta, coefficient of contraction(Cc), coefficient of velocity(Cv.), coefficient of discharge(Cd), coefficient of resistance(Cr), simple numerical problems Hydraulic machines: Introduction, selection of turbines, performance and Complex Number parameters, Complex Number of turbines: specific speed, unit speed. Unit discharge. Unit power, and efficiency, working principle and application of hydraulic coupling. Rotary air compressors, simple numerical problems.
17	*GENERATION OF ELECTRICAL ENERGY*
	Importance of electrical power in day today life, various sources of energy. Comparison of sources of power. Selection of site for thermal power stations, block diagram of thermal power station, operation of boiler, economizer, air preheater, super heater, steam prime movers, condensers, draft fans etc. Classification of hydroelectric plants. General arrangement and operation of hydroelectric plant, layout diagrams, hydraulic turbines, selection of turbines, dams, spillways, penstock, surge tank, fore bay, reservoirs, catchment area. Nuclear Power Plant, Diesel Power Plant and Gas Power Plant. Prospects of non-conventional power plants, solar power, wind power, tidal power, MHD

	generation. Prediction of load, load curves, plant capacity factor, utilization factor, Components for total cost of generation per unit, Methods for depreciation calculation, Effect of load curves on cost per kWh.
18	*NETWORK ANALYSIS*
	Network Terminology Basic circuit element, dependent and independent sources, KCL & KVL, its application in solving D.C. circuits, Mesh and Nodal Analysis. AC Fundamentals Generation of alternating Voltage and Current, important terminology: Peak value, RMS value, Average value of current and voltage, Form Factor & Peak Factor, phase and phase difference, addition of alternating quantities, AC circuit containing pure resistance, pure inductance, pure capacitance. Numerical problems Single Phase AC Circuits RL, RC and RLC series and parallel circuit, impedance triangle, phasor algebra, rectangular and polar conversion, addition, subtraction, division and multiplication, different methods for solving series and parallel circuits, series and parallel resonance, numerical problems. Network Terminology Concept of generation of 3-phase voltage, advantage of 3-phase over 1-phase, Star-Delta connection (relationship between phase and line values of current & voltage), Expression for power measurement by 2-Wattmeter Method & 3-Wattmeter Method, numerical problems. Network Theorems Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem and their applications, Conversion of circuits from Star to Delta and vice versa, and Numerical Problems.
19	*ELECTRICAL MACHINES-I*
	DC Generator Construction, Working principle of d.c. generator, e.m.f. equation, Types of DC generator, Equivalent circuits, Lap & Wave windings, armature reaction & commutation, improving commutation, Separately excited, self excited, Shunt wound, Series wound, Compound wound, Characteristics of d.c. generator, Application of d.c. generator, Losses and efficiency of d.c. generator, Numerical problems. DC Motors Working principle, Back emf and its importance, equivalent circuit, e.m.f. equation, torque equation, types of d.c. motors, armature reaction and interpoles, Characteristics of d.c. motors, Application of d.c. motors, speed equation & speed control, starting, DOL Starter, 3-pin starter, losses & efficiency, Numerical problems. Introduction to Single Phase Transformer: Principle of operation of 1-phase transformers, Construction, e.m.f. equation, Ideal Transformer, voltage transformation ratio, turn ratio, current ratio, Transformer on no-load. Transformer on load, resistance and leakage reactance. Equivalent Circuit and Phasor Diagram for 1-Phase Transformer Equivalent circuit and phasor diagram of 1-phase transformer at different power factors,

	referred values, application & simplified equivalent circuits with phasor diagrams, voltage regulation and calculation at different power factors, Losses, tests and efficiency, condition for maximum efficiency, All-day efficiency, cooling of transformer, Auto transformer, its construction, working and application, introduction to 3-phase transformer. Introduction to Three- Phase AC Machine: Working principle, Construction and types of 3-phase induction Motor, Concept of rotating magnetic field, slip and its importance, Construction and Working principle of Synchronous machines & their e.m.f. equations.
20	*POWER ELECTRONICS*
	INTRODUCTION TO SCR Construction and working principle of an SCR, Characteristics of SCR, Two Transistor analogy of SCR, Construction and working principle of DIAC, TRIAC, UJT and MOSFET, Triggering circuits of Thyristor, Commutation of Thyristor, Series and Parallel operation of Thyristors. CONTROLLED RECTIFIERS Introduction to Rectifiers and its applications, Single phase half wave-controlled rectifier with RL load, Single phase full wave-controlled rectifier with R-L load, fully controlled full wave rectifier, 3-phase full wave half-controlled bridge rectifier, 3-phase full wave fully controlled bridge rectifier. INVERTERS Introduction, applications, Series inverters, Parallel inverters, Bridge inverters, Voltage source inverter, Mc-Murray Bedford inverter, 3-phase inverter, Current source inverter CHOPPERS Introduction to Choppers and their working principles & applications, Types of Choppers, Jones Chopper, Morgan Chopper. CYCLO-CONVERTERS Introduction to Cycloconverters, working principle and applications, 1- phase step up & step down Cycloconverters, 3- phase to 1-phase, 3- phase to 3-phase, 1-phase to 3-phase Cycloconverters.
21	*ELETRICAL MACHINES-II*
	Three Phase Transformers: Constructional details, Advantages of 3 phase transformers over 1-phase transformers, Applications of different connections and their advantages over one another, Condition for parallel operation. Three Phase Induction Motors: Induced EMF & Torque Equations, Torque-Speed Characteristics, Speed control of 3 phase IM, Equivalent Circuit Model, Starting & Starters for 3 phase IM, Applications. Three Phase Alternators: Voltage Regulation, Methods for determining voltage regulation, Open circuit & Short circuit characteristics, Concept of distribution and coil span factor, Operation of alternator when connected to an infinite bus-bar, Effect of load on

	synchronizing power, Parallel Operation, Load sharing by two alternators & calculations. Three Phase Synchronous Motors: Starting methods, Motor on load with constant excitation, Equivalent circuit, Power developed, Motor with different excitations, Effect of load increment with constant excitation, Effect of changing excitation with constant load, Different Torques, Effect of excitation on armature current and power factor, Hunting, Applications. Single Phase Motors (FKW motors) Single phase motors - Principle of operation, classification Single phase Induction Motors- [Split Phase Motors, Capacitor Motors, Shaded Pole motors & Reluctance Start Motors] Single phase Synchronous Motors- [Reluctance Motor & Hysteresis Motor] Single phase Commutator Motors- [AC Series Motor, Universal Motor & Repulsion Motor].
22	*ELECTRICAL TROUBLE SHOOTING*
	General Maintenance, Classification of maintenance, function of electrical maintenance department. Advantages and disadvantages of various maintenance system, common testing equipment. Earthing Maintenance & Testing Reasons for earthing, classification of earthing, factors influencing the earth resistance, inspection and maintenance of earth electrodes. Maintenance of Machines Causes for failure and diagnosis of faults in transformers, induction motors and circuit breakers. Testing of Insulation Resistance Testing of electrical installation, testing of insulation resistance between conductors and between conductor and earth, Transformer oil testing Maintenance of Batteries and Safety Measures Maintenance of batteries, Shock treatment, artificial respiration and fire extinguishers.
23	*CONTROL SYSTEM ENGINEERING*
	Fundamental Elements and Components Introduction to control system: Types, Open loop and Closed loop system, Basic elements of feedback control systems, Position control system, Effect of feedback. Introduction to Laplace Transform Laplace transform: General Laplace transform of algebraic and other functions, Partial fraction expansion, Inverse Laplace transform, Application of Laplace transform in solving second order differential equations, Initial and final value theorems. Transfer Function & Modeling of Electrical Systems Block diagram representation, Reduction techniques, Signal flow graph, Mason's gain formula, Transfer function, Transfer function of electrical system. Time Response Analysis Standard signals, Steady state and transient response, Input test signals, Step signal, Ramp signal, Impulse signal and Parabolic signal, Transient response of control system, Rise time, Maximum overshoot, Peak time, Settling time, Steady state error. Stability Analysis Stability concept, Necessary conditions for stability, Hurwitz's stability criterion, Root locus plot, General rules for constructing root loci, Examples.

24	*ELECTRICAL INSTRUMENTATION*
	Introduction Important terms in measurement system, Errors, types of error, classification of errors Advantages of electrical instrumentation, Data transmission & their classification, Principle of telemetry system, Classification of telemetry system. Sensors and Transducers Introduction, Classification of transducers, advantages and disadvantages of electrical transducers, resistance transducers, Inductive transducers, Primary sensing element, Proximity sensors, Pneumatic sensors, Light sensors and selection of sensors. Displacement Transducers Potentiometric transducer, Inductive transducer, Capacitive transducer, LVDT, Photoelectric transducer, Piezo-electric transducer. Strain Gauge and Thermoelectric Transducers Principle of strain gauge and its applications, types of strain gauge, Resistance transducer and thermistor, Thermocouples and thermopiles, Pyrometer. Measurement of Non-Electric Parameters Measurement of Displacement scheme, Measurement of velocity and acceleration, Measurement of Force and Pressure, Measurement of Flow rate of liquid, Measurement of temperature.
25	*INDUSTRIAL MANAGEMENT*
	Management, Industrial Management, Different functions of Management, Planning, Organizing, co-ordination, Controlling, Structure of an Industrial Organization, Functions of different departments, Human relations and performance in organization. Trade Unions, Grievances, Handling of grievances, Agitations, Lockout. Labour welfare, Workers participation in management. Labour laws, and disputes. Wages: types of wages, wage & incentive plants. Factory Act 1948, Payment of Wages Act 1936. Industrial Dispute Act1947. Business ethics, Managerial ethics, Codes of ethics. Causes of accidents, Safety consciousness, Safety measures, Factors causing pollution, Effect of pollution on human health, Noise pollution. Entrepreneurship Development, Entrepreneur, Modern concept of entrepreneur, entrepreneurship, Qualities to becomes entrepreneur, Classifications of entrepreneurs. EDP training, Small Scale Industries, Classifications of Small Scale Industries, Project report guidelines, Content of project report, Project appraisal. Market survey, Preparation of project report, Role of financial institutions. Types of Production, Job, Batch, Mass Production. Concept of Total Quality Management, Six Sigma Concept, Just in Time (JIT), ISO-14000 Series. Concept of intellectual property right and patents. Breakeven analysis, Marketing management, Price Analysis, Determination of Economic order.
26	*TRANSMISSION AND DISTRIBUTION*
	Transmission Lines Introduction to overhead transmission line, Classification and Comparison of AC/DC transmission systems. Main components of transmission line i.e. tower, conductors, and overhead line insulators. Potential distribution over suspension

	insulator string, string efficiency and methods of improving string efficiency, sag calculation of equal supports, effect of transmission voltage on efficiency and regulation of line. Kelvin law. Line Parameters Identification of Line parameters, R, L, C & G, Calculation of line parameters for 1-phase and 3phase lines, Skin and Proximity effect, Ferranti effect, Corona, Corona losses and other effects. Performance of Transmission Lines: Parameters of performance of transmission lines, Efficiency and regulation of line, performance of 1-phase short transmission line, Effect of load power factor on performance, Medium transmission lines- Nominal T & π-models, A, B, C & D parameters of short, medium and long lines. Distribution of Electrical Energy: Introduction, Classification of distribution system, A.C distribution, Connection schemes of distribution system, Requirements of Distribution systems, Design consideration, A.C. distribution calculation, Methods of solving A.C. 1-phase & 3-phase connected (balanced) distribution system, Underground cables, Introduction and requirements. Classification of cables, cable conductors, cable construction, cable insulation, Metallic sheathing and mechanical protection, Comparison with Overhead lines, Cable laying. Substations: Introduction, Classification of indoor & outdoor Sub-station, Advantages and Disadvantages, Selection and location of site, main connection schemes, Equipment's circuit elements of substations:-Incoming & Outgoing lines, Transformers, CT & PT, Relays, CB's, Fuses, Isolators, Batteries, lightning arresters. Insulators, Bus-bar's material types in detail, Connection Diagram and layout of Substation.
27	*SWITCHGEAR AND PROTECTION*
	Fault Analysis Concept of fault, Symmetrical and Unsymmetrical fault calculations, Fault level. Circuit Breakers Fuses, Circuit breakers, Arc phenomenon, Theories of arc extinction, Methods of arc extinction, Important terms as applied to fuses and circuit breakers, Classification of circuit breakers, Construction and working of modern circuit breakers, Circuit breaker ratings, MCB, RCCB, ACB and ELCB. Protective Relays and Relaying Circuitry Faults, Types of fault, Nature of faults, Causes and consequences of faults, Requisites of protective system, Relays, Classification of relays-Induction type overcurrent relay, Induction type reverse power relay, Induction type directional overcurrent relay, Earth fault relay, Distance relays, Static relays and relaying circuitry. System Protection Zones of protection, Types of protection, Principle of differential protection, Principle of distance protection, R-X diagram, Translay system, Principle of carrier protection. Protection of Generators, Transformers, Bus-bars, Lines and Induction motors. Surge Protection and System Grounding Surges, Protection against surges, Modern surge diverters, Purpose of neutral grounding, Methods of neutral grounding- Resonant, Solid and Impedance grounding, Earthing transformer, Earthing of all non-current carrying metallic parts, Introduction to lightning.
28	*SPECIAL PURPOSE MACHINES*
	Three Brush Generator: Construction, working and applications. Three Wire Generator: Construction, working and applications. Boosters: Types, working and applications.

	Cross field generator, Rotary amplifiers, Rototrol and Regulex. Brushless motor: Introduction, applications. Dynamotor: Construction, working and applications. Printed circuit Motor: Introduction and applications. The Osnos Motor (no lag motor): Introduction and applications. Linear Motor: Construction, working and applications. Induction Generator: Construction and working principle. Induction voltage Regulator: Introduction types and applications. Power Selsyn: Construction, working and applications. Position Selsyn: Construction, working and applications. Phase Advancer: Construction, working and applications. Frequency Changer: Construction and working. Brushless Generator: Construction, working and applications Eddy drives: Construction, working and applications. Homopolar machines: Construction, working and applications. Servo motor: Principle, construction, types and applications. Stepper motor: Principle, Construction. Types, working and applications. Schrage motor: Construction, working and applications.
29	***UTILIZATION AND TRACTION***
	Illumination Nature of light, definition, Measurement of candle power and MSCP, photometer bench, photometers, Principle of production of light, Sources of light, requirements of good lighting. Lamp fitting, basic principles of control. Factors affecting the design of indoor lighting installation, special precautions, street lighting, flood lighting and its design, various types of lamps, CFL, Mercury-vapour lamp, Sodium-vapour lamp, LED for lighting Electric Heating Classification of electric heating methods and their comparisons. Various types of resistance and arc furnaces, their power supplies and heat control, comparison of various furnaces, High frequency heating, induction heating, Core and coreless induction furnaces, choice of frequency and application of induction heating, high frequency generation, Dielectric heating, choice of voltage and frequency, Calculation of heating power, depth of penetration & Losses, Application and use of dielectric heating. Electric Welding Welding & its classifications, Various types of welding and power supply, Electron beam welding, Modern welding techniques, Electronic welding control, need for AC contactors, heat control unit, AC timer units, Sequence of welding timers. Electrolytic Processes Principle of Electro-deposition, Laws of electrolysis. Electroplating, Anodizing and Electropolishing. Traction Advantages of electric traction, requirements of an ideal traction system, train movement, mechanism of train movement, traction motors, traction motor control, Multi unit control, braking of electric motors, thyristors control of electric traction.
30	***ELECTRICAL ENERGY MANAGEMENT***
	Economic Aspects of Power Generation: Introduction, terms commonly used in system operations, factors affecting cost of generation, reduction of cost by interconnecting generators, choice of size and number of generator units, Input output curve, constraints of economic generation, economic loading of generator, load allocation among various generators, base load and peak load plants.