SYLLABUS: Junior Engineer (Electrical / Mechanical) in Delhi Jal Board

S.No.	TOPICS
1	APPLIED CHEMISTRY
	Problem based on Volumetric Gravimetric Analysis, Analysis and treatment of water, Fuel and Combustion, Corrosion and Lubricant, Atomic Structure and Bonding, Polymerization, Metal and Alloys.
2	APPLIED MATHEMATICS-I
	Algebra, Determinants, Matrices, Co-Ordinate Geometry Of Two Dimensions, Vectors.
3	APPLIED MECHANICS
	Introduction, Laws Of Forces, Moments, Centre Of Gravity, Laws Of Motion, Friction, Simple Lifting Machines.
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, Integral Calculus, Applications Of Calculus,Differential Equations, Complex Numbers.
7	APPLIED PHYSICS
	Unit and Dimensions, Electrostatics, Capacitor, D.C Circuit, Electromagnetism, Semi conductor physics, temperature and its measurement, expansion of solids, heat transfer.
8	ELEMENTS OF MECHANICAL ENGINEERING
	Transmission of Power, Steam Generators and Turbines, Internal Combustion Engines, Pumps, Refrigeration and Air Conditioning System.
9	ELECTRICAL ENGINEERING MATERIALS
	Conducting Materials, Semiconducting Materials, Insulating Materials, Dielectric Materials, Magnetic Materials.

10	BASIC ELECTRONICS
	Introduction to electronics engineering: Physical and applied electronics, PN Junction Diode & Rectifiers, Filters & Special Purpose Diodes, Bipolar Junction Transistor, Amplifier & Biasing Circuits.
11	WORKSHOP PRACTICE
	Machine shop, Carpentry shop, Sheet Metal Shop, Black Smithy Shop, Welding Shop, Fitting shop.
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, Measurement of Power and Energy, Measurement of Resistance, Measurement of low, medium and high resistance, megger, single phase power factor meter, AC Bridges, Maxwell's Bridge, Hay's Bridge and Wien's Bridge extension of range of instruments.
13	DIGITAL ELECTRONICS AND MICROPROCESSOR
	Number Systems, Logic Gate, Combinational circuits, 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, Alarm Circuits Without and with Relays, Electrical Installation of Small Residential Buildings, Electrical Installation of Commercial Buildings.
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, 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 controcta, 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, DC Motors, Single Phase Transformer, Equivalent Circuit and Phasor Diagram for 1-Phase Transformer, Three- Phase AC Machine.
20	POWER ELECTRONICS
	Introduction To SCR, Controlled Rectifiers, Inverters, Choppers, Cyclo-Converters.
21	ELETRICAL MACHINES-II
	Three Phase Transformers, Three Phase Induction Motors, Three Phase Alternators, Three Phase Synchronous Motors, Single Phase Motors (FKW motors) Single phase motors - Principle of operation, classification Single phase Induction Motors.
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 Laplace Transform, Transfer Function & Modeling of Electrical Systems, Time Response Analysis, Stability Analysis.
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, Distribution of Electrical Energy, Substations, Equipment's circuit elements of substations.
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, Brushless motor, Induction Generator, Frequency Changer, Eddy drives, Homopolar machines, Servo motor, Stepper motor, Schrage motor.
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. Operation and Control, Interchange of Power and Energy, Energy Audit, Economic Aspects of power factor.
31	THARMAL ENGINEERING I.C. Engines, Systems in I.C. Engines, Ignition, Cooling Systems, Combustion in I.C. Engines, Air Compressor, Gas Turbines and Jet Propulsion.
32	MECHANICS OF SOLID Stresses and Strains, Beam and Bending Stress, Columns, Torsion, Springs
33	MATERIAL SCIENCE Classification of Materials, Ferrous materials, Manufacture of Pig Iron, Wrought Iron, Cast Iron and Steel, Various types of Cast Iron and their usage, Heat treatment, purpose of Heat Treatment, Non-Ferrous metals and alloys, Miscellaneous materials.
34	THEORY OF MACHINE Simple Mechanisms, Friction, Power Transmission, Flywheel, Balancing
35	COMPUTER AIDED DESIGN & MANUFACTURING Introduction, 3D Graphics, Finite Element Method, CAD of Machine Elements, System Devices
36	MANUFACTURING PROCESSES Metal Forming Process, Milling, Advance Welding Techniques, Grinding, Jigs and Fixtures, Working with Plastics, Modern Machining Methods
37	ESTIMATING AND COSTING Definition and importance of Estimating and Costing, Estimating Procedure Elements of Cost, Cycle time unit time and total time, set up time, operation time and tear down time, Welding (Electric arc welding and gas welding) Estimation of gas welding and cutting cost, Estimation of arc- welding cost, factors affecting welding cost electrodes Consumed, Power consumed, gas consumed calculation of welding charges, Salvage value of different machine tools and equipment's To draw detailed dimensioned/views (full and sectional for Common mechanical devices such as M/c vice, Screw jack Spur gear, Depreciation.
38	AUTOMOBILE ENGINEERING Introduction, Power Plants, Multi-cylinder Engine, Transmission System, final Drive, Electrical System, Braking system, Steering System.
39	RENEWABLE ENERGY SOURCES Energy resources and their utilization, Solar radiations, Solar energy, Solar photovoltaic system, Biomass, Biogas, Wind energy, Magneto-hydrodynamics Energy, Fuel cells power plants, Hydrogen Energy, Geothermal energy, Tider power, Ocean energy.
40	INDUSTRIAL MANAGEMENT Management, Industrial Management, Different functions of Management, Trade Union, Grievances, Handling of grievances, Agitations, Lockouts. 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 act 1947, Business ethics, Managerial ethics, Codes of ethics. Causes of accidents, Safety consciousness, Safety measures, Factors causing pollution, Effect of pollution on human

	health, Entrepreneurship Development, Entrepreneur, Modern concept of entrepreneur, Types of Production, Job, Batch, Mass production. Concept of Total Quality Management, six Sigma concept Just in Time (JIT), ISO-9000 and ISO-14000 series.
41	MACHINE DESIGN
	Introduction, Bolted joints, Riverted Joints, shafts, Keys and Couplings.
42	POWER PLANT ENGINEERING
	Introduction, Economics of power generation, Steam power plant, Diesel power plant, Gas turbine power plant, Nuclear power plant, Hydro electric station, Pollution and Control Methology,
43	METROLOGY AND MEASUREMENTS
	Introduction, Sensors and Transducers, Strain measurement, Temperature measurement, Vibration, Standards of linear measurement, line and end standards. Limit fits and tolerances. Interchange ability and standardisation, Measurement of geometric forms like straightness, flatness, roundness.
44	REFRIGERATION & AIR CONDITIONING
	Principals of refrigeration, Refrigeration Components and Controls, Psychometry: Gibbs Dalton's law of partial pressure, psychometric Properties, Description of various types of loads, Sensible and latent heat loads. Cooling and heating load calculations, Sensible heat factor (SHF) and by pass factor (BPF) of cooling and heating coil, Principle of evaporative cooling, desert coolers, layout and working of ice plant and cold storage plant. Domestic Refrigerator, water cooler (Storage type), Deep freezer , Thermal insulating materials such as puff, glass wood etc.