

SYLLABUS FOR THE POST OF JUNIOR ENGINEER (ELECTRICAL)

General Knowledge / Awareness	10 questions	10 Marks
Mental Ability / Reasoning	10 questions	10 Marks
Mathematical Ability	10 questions	10 Marks
Language Proficiency (Punjabi & English)	10 questions each 20 questions	20 marks
Professional (As per prescribed qualifications for job related)	50 questions	50 Marks
Total	100 questions	100 Marks

GENERAL KNOWLEDGE / AWARENESS (NATIONAL AND INTERNATIONAL) (10 Q): General information about the state of Punjab and India, Economy, Science and Technology, Current Events), Political Awareness/Polity, Persons in News, Places in News, Important Awards & Honors, Sports.

MATHEMATICAL ABILITY (10 Q): Number system, Simplification, HCF & LCM, Percentage, Average, Ratio & Proportion, Profit & Loss, Partnership, Time and Work, Time and Distance, Permutations & Combinations, Probability.

MENTAL ABILITY / REASONING (10 Q) Reasoning Ability: Analogy / Analogous Problems, Classification, Word formation, Ranking / Arrangement, Series, Coding & Decoding, Distance and Direction, Symbol & Notation, Scheduled Day or Date, problem based on Ages and Calendar, Data Interpretation.

LANGUAGE PROFICIENCY (ENGLISH 10 Q, PUNJABI 10 Q)

- i. General English up to 10th standard
- ii. General Punjabi up to 10th standard

PROFESSIONAL (50 Q)

PROFESSIONAL SYLLABUS FOR EXAMINATION FOR THE POST OF J.E. IN ELECTRICAL ENGINEERING

Basic Electrical Engineering: Basic electrical quantities, DC Circuits, Ohm's law, resistances in series and parallel, Kirchhoff's laws and their applications in solving electrical network problems, Network theorems such as Thevenin's theorem, superposition theorem, Maximum power transfer theorem and Norton's theorem, Star-delta transformation

Electro-magnetism: Magnetic field around a straight current carrying conductor and a solenoid, force between two parallel current carrying conductors, Force on a conductor placed in the magnetic field, Series magnetic circuits, simple problems, hysteresis loop and hysteresis loss, Electromagnetic Induction, Faraday's Laws of electromagnetic induction, Lenz's law, Principle of self and mutual induction, self and mutually induced e.m.f., Inductances in series and parallel, Energy stored in a magnetic field, eddy current loss

A.C. Circuits: Concept of alternating current and voltage, average value, r.m.s value, form factor, power factor etc., Phasor algebra, AC Circuits, susceptance, conductance and admittance, Active and reactive components of current and their significance, Power, Power factor and its significance, Resonance in series and parallel circuits

Polyphase Systems: Advantages of 3 phase over single phase system, Star and delta connections (relationship between phase and line voltages, phase and line currents, Power in 3 phase circuits

and measurement by one wattmeter method, Measurement of power and power factor of a 3-phase load by two wattmeter method using balanced/unbalanced load

Basic Electronics: Current and voltage sources and their conversion, Semi-conductor Theory - Atomic structure and Energy band theory, intrinsic and extrinsic semiconductors and effect of temperature on them; Semiconductor Diodes, forward and reverse biasing of a PN junction, Breakdown mechanism; characteristics, static and dynamic resistance; Half wave and full wave rectifiers using diodes, Types of diodes, their working characteristics and applications; PNP and NPN transistors, Transistor configurations: common base (CB), common emitter (CE) and common collector (CC), Transistor Biasing and Stabilization, operating point and effect of temperature, Different biasing circuits and limitations; Concept of h-parameters of a transistor, Single-Stage Transistor Amplifiers - Concept of DC and AC load line, Voltage gain, Concept of input and output impedance, AC equivalent circuit, voltage gain, Frequency response; Multi-Stage Transistor Amplifiers – Need, different types of couplings, their purpose and applications, RC coupled two-stage and direct coupled amplifier, Transformer coupled amplifiers, Construction, operation, characteristics and applications of JFET and MOSFET

Electrical Machines: Faraday's laws, magnetisation curve, constructional features of generators and motors, Hetero-polar and homopolar configurations, Space distribution of flux density and time-variation of voltage; **D.C. Machine** : basic principles, emf equation, description of different parts and working, different types, characteristics and applications of D.C. machines.

Transformers: Constructional details: selection of core material and winding materials, insulating materials, core and coil construction, Transformer oil, Accessories: tank & radiator, breather, conservator, bucholtz relay, bushings, pressure relief valve {PRV} & explosion vent, Different types of cooling methods. **1-phase Transformers:** E.m.f. equation, phasor diagram under no-load and load conditions, equivalent circuit and circuit parameters, Regulation, Losses and efficiency (including all-day efficiency), S.C. and O.C. Distribution and power transformers, 1-phase Autotransformer, tertiary winding, Parallel operation of transformers and their significances **Three-phase transformer:** Single unit or 3 single-phase units connections, Vector grouping, Scott-connected transformer, 3-phase transformers in parallel; **Alternator:** Construction details, Cylindrical and Salient type alternators, their salient features, merits and applications; Armature winding – Single layer and multilayer, Concentrated and distributed, 1-phase and 3-phase, E.M.F. equation; Brushless and static excitation systems; No-load characteristics and Load Characteristics at various p.f., Synchronous reactance, O.C. and S.C. tests; Phasor diagrams of cylindrical rotor m/c at different p.f. loads, Voltage regulation – sync. Imp. Method. Short circuit ratio (SCR) – concept & significance. Power characteristics of cylindrical rotor m/c - Synchronizing Power & Torque, Effect of Load and excitation on: Isolated synchronous Generator and Synchronous generator on infinite bus; Parallel operation of alternators – advantages, synchronizing using three lamps and Synchroscope, Load sharing between two alternators; **Synchronous Motor:** Principle of steady state constant speed operation, Methods of starting, hunting & damper winding, effect of variation of Load, speed torque characteristics, V and inverted V-curves, Applications; **3-phase Induction Motor** : Production of rotating magnetic field, construction, Principle of operation, Induction motor as transformer, equivalent circuit; various power stages and their relation, losses, efficiency, torque - starting, running and max torque, slip-torque characteristics. Effect of rotor resistance on torque, Cogging & crawling, Starters for both slip-ring and Squirrel cage induction motors, Speed control, Double cage rotor, braking of induction motors; **F.H.P. Motors:** Construction, principle of operation and applications of 1-ph Induction motor – split phase motors, 1-phase Synchronous motors – Reluctance Motors, AC – series motor: Universal motors.

Electrical Measurement and Measuring Instruments: Static and dynamic characteristics, Classification of instruments, Deflection torque and methods of production, Controlling torque and controlling system, Damping torque & methods of damping, **Different types of instruments:** construction & operating principle, Merits and demerits, Errors and remedies, Practical ranges, Applications of – PMMC, MI, Electrodynamometer type, Thermocouple instruments and Induction type instruments. Digital instruments- voltmeter, ammeter, multimeter, energy-meter; Wheatstone

Bridge, Working principle & construction of simple D.C. potentiometer; **Methods of measuring Electrical quantities:** Measurement of Low resistance, medium and high resistances, Measurement of 3-phase power by two-wattmeter & 3-wattmeter method; 1-phase Induction type energy meter, Errors adjustments, Phantom loading, A.C. Bridges

Electrical Engineering Materials: Classification of electrical engineering materials; **Conductors:** properties and characteristics of good conductors, usage for O/H lines and U/G cable, machine winding, resistor materials; Super conductivity; **Semiconductors:** Types and Application of semiconductor materials; idea and applications of thermistors, photoconductive cells, photovoltaic cells, varistors, LCD, LDR and strain-gauges. Working principle and applications of Hall-Effect Generators and Piezo-electric materials; **Magnetic materials:** Soft and hard magnetic materials, Classification of magnetic materials, Magnetisation curve, Effects of impurities on Ferromagnetic materials, Low carbon electrical steel, properties of electrolytic and carbonyl steel. **Special purpose materials:** Properties of materials for fuse, soldering, Contacts, Structures, fluorescence etc.; Electrical carbon material – characteristics of carbon brushes & graphite brushes; **Dielectric Materials:** Dielectric strength, dielectric loss, dissipation factor, Conduction through gaseous, liquid and solid dielectrics – Applications of dielectrics; **Insulating Materials:** General properties; factors influencing insulation resistance; Electrical properties: Insulation resistance, volume resistance, surface resistance, Mechanical properties: Viscosity, porosity, solubility; Thermal properties: Stability, melting point, flash point, volubility, thermal conductivity, Heat resistance; Chemical properties: Hygroscopic, Ageing, Temperature rating of insulation, Effect of moisture on insulation; Classification of insulating materials; Applications of Mica products and glass ; Insulating Resins - Natural and synthetic resins,

Digital Electronics:

Boolean Algebra : Representation and truth table for logic gates; Rules and laws of Boolean algebra, Canonical form of equation, Simplification of Boolean expression, Karnaugh map, Don't care condition, Realization of Boolean expression with logic gates; **Combinational Logic Circuits :** Half adder, Full adder, Half subtractor, Full subtractor, 1's complement, 2's complement and 9's complement addition, Design of circuits using universal gates, Code converter, encoder and decoder – Multiplexer & demultiplexer, Parity generator and checker, Comparator; **Sequential Logic Circuits :** flip-flops, latches, counters and registers; **Memory Devices :** MEMORY ADDRESSING: Read, Write and Read Only operations ; MEMORY CELLS: ROM, PROM, EEROM, EPROM, CDROM ; Static and dynamic RA, Volatile and non-volatile memories, PLA, PAL, GAL, FPLA ; **Data Converters :** D/A CONVERTERS and A/D CONVERTERS; **Logic Families :** Comparative studies of logic families namely DTL, TTL, CMOS, and ECL

Power Systems:

Transmission System : Layout of power system, selection of voltage for HT & LT lines, comparison between AC & DC systems for power transmission, cost of conductors ; Main components of Overhead lines, types of supports – RCC/PCC poles, steel tower, comparison between single circuit and double circuit design, ACSR conductors, concept of ground wire, skin effect and proximity effect, Types of insulators, selection, failure of insulators, string efficiency, methods of improvement of string efficiency; Sag calculations; Electrical features of Overhead line; corona and corona loss; Description of PVC, PILC, FRLS, XLPE cables, Gas filled (SF₆) cables, laying of cables; Performance of Transmission Lines; regulation and efficiency of lines, bundle conductors, transposition of transmission lines, Ferranti Effect, Reactive Power Compensation ; DC and AC Distribution Systems

Power system Protection

Faults in Generation, Transmission and Distribution: Types and causes of Faults, effects of faults, current limiting reactors, short-circuit KVA calculations for symmetrical faults ; **Circuit Breakers:** Classification and selection, rating of circuit breakers – breaking and making capacity, rated operating duty, rated voltage, Principle of Arc Extinction, Restriking and recovery voltage, Construction and Operations of MOCB, ABCB, SF₆ and Vacuum circuit breakers, Auto-reclosing ; Miniature Circuit Breakers; **Protection against over-voltages:** Protection of transmission lines from

over-voltages – protective ratio, protective angle, reduction of tower-footing resistance, Protection of Sub-Station & Power Stations from direct lightning Strokes, Surge Absorbers and Surge Diverters; **Protective Relaying**: Zones of protection, primary & back-up protection, classification of protective schemes, CT & PT Requirements, CVT and CCVT. Electromagnetic relays, thermal relays, static relays, and Microprocessor based relays; **Different Scheme of Protection**: Over-current Protection: Time-current characteristics of definite time, instantaneous, inverse time and IDMT Relays, use of very inverse-type O/C relay and extremely inverse type O/C relay, Time-setting, current-setting, PSM; **O/C** protective schemes; Distance Protection Scheme; **Equipment Protection**: (i) Generator protection (ii) Transformer protection (iii) Differential protection of Generator Transformer Unit

Industrial Electronics:

Power Devices : Principle of operation and switching characteristics of power diodes, power transistors; power MOSFET, IGBT, SCR, Protection of power devices, switching losses; **Switching & Timer Circuits** : Simple transistor timer using R-C as timing element, Classification of multi-vibrators, circuits using discrete components, pin out diagram, Internal block diagram and operating of IC555, use of IC 555 timer as Astable multi-vibrator; **Unijunction Transistor** : Construction, operation and characteristics, Equivalent circuit, UJT as relaxation oscillator ; **Thyristor** : Construction, operation and characteristics of SCR – Turn on and turn off mechanism – SCS, DIAC, TRIAC and their uses ; **Control of DC And AC Motor** : SCR power supply for DC motor, speed regulation by armature voltage control, Speed control of AC induction motor; **Switch Mode Power Supply** : Principle of operation of buck converter, boost converter and buck-boost converter, Principle of operation of a PWM switching regulator using IC3524