Syllabus for selection to the post of Assistant Engineer (Electronics) in Public Works Department.

Cat No:071/2024

Total marks : 100

Module-1 (10 Marks)

Electronic devices: Evolution of electronics – Vacuum tubes to nano electronics. Resistors, Capacitors and Inductors (constructional features not required): types, specifications. Standard values, color coding. **PN Junction diode:** Principle of operation, V-I characteristics, principle of avalanche breakdown, Zener diode, Photo Diode, Light Emitting Diodes (LED), **Bipolar Junction Transistors:** PNP and NPN structures, Principle of operation, relation between current gains in CE, CB and CC, input and output characteristics of common emitter configuration. **MOSFET- Structure**, Enhancement and Depletion types, principle of operation and characteristics. **Power Electronic Devices :** Silicon Controlled Rectifier (SCR), TRIAC working, characteristics.

Module-2 (10 Marks)

Analog circuits: RC differentiating and integrating circuits, Diode Clipping circuits, Diode Clamping circuits, Transistor biasing: operating point, DC load line, bias stabilization. **BJT Amplifiers:** RC coupled amplifier– design, AC load lines, voltage gain and frequency response. Small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency and low frequency. High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier. **MOSFET amplifiers:** MOSFET circuits at DC, MOSFET as an amplifier, Biasing of discrete MOSFET amplifier, small signal equivalent circuit. Multistage amplifiers - effect of cascading on gain and bandwidth. Cascode amplifier. **Feedback amplifiers:** Effect of positive and negative feedback on gain, frequency response and distortion. The four basic feedback topologies, Analysis of discrete BJT circuits in voltage-series and voltage-shunt feedback topologies**. Oscillators:** Classification, criterion for oscillation, Wien bridge oscillator, Hartley and Crystal oscillator. **Power amplifiers:** Classification, Transformer coupled class A power amplifier, push pull class B and class AB power amplifiers, complementary-symmetry class B and Class AB power amplifiers, efficiency and distortion. **Operational amplifiers(Op Amps)**: The 741 Op Amp, Differential Amplifiers using BJT, DC Analysis- transfer characteristics; AC analysis- differential and common mode gains, CMRR, input and output resistance, Voltage gain. **Op-amp with negative feedback:** Op Amp circuits with voltage series and voltage shunt feedback, current series and current shunt negative feedback, Virtual ground Concept; Closed loop gain, Input Resistance and Output Resistance of inverting and non-inverting amplifiers. Op-amp applications: Summer, Voltage Follower-loading effects, Differential

and Instrumentation Amplifiers, Voltage to current and Current to voltage converters, Integrator, Differentiator, Precision rectifiers, Comparators, Schmitt Triggers, Log and antilog amplifiers. **Op-amp Oscillators and Multivibrators:** Phase Shift and Wien-bridge Oscillators, Triangular and Sawtooth waveform generators, Astable and monostable multivibrators. Active filters: Comparison with passive filters, First and second order low pass, High pass, Band pass and band reject active filters, state variable filters. **Timer and VCO**: Timer IC 555- Functional diagram, Astable and monostable operations;. Basic concepts of Voltage Controlled Oscillator and application of VCO IC LM566, Phase Locked Loop – Operation, Closed loop analysis, Lock and capture range, Basic building blocks, PLL IC 565, Applications of PLL.

Module-3 (10 Marks)

Digital Circuits: Binary and hexadecimal number systems; Methods of base conversions; Binary and hexadecimal arithmetic; Representation of signed numbers; Fixed and floating point numbers; Binary coded decimal codes; Gray codes; Excess 3 code. Alphanumeric codes: ASCII. Basics of verilog -- basic language elements: identifiers, data objects, scalar data types, operators. **Boolean Postulates and Fundamental Gates** : Boolean postulates and laws – Logic Functions and Gates De-Morgan's Theorems, Principle of Duality, Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Canonical forms, Karnaugh map Minimization. Modeling in verilog, Implementation of gates with simple verilog codes. **Combinatorial and Arithmetic Circuits** : Combinatorial Logic Systems - Comparators, Multiplexers, Demultiplexers, Encoder, Decoder. Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder. Modeling and simulation of combinatorial circuits with verilog codes at the gate level. **Sequential Logic Circuits:** Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Conversion of Flipflops, Excitation table and characteristic equation. Implementation with verilog codes. Ripple and Synchronous counters and implementation in verilog, Shift registers-SIPO, SISO, PISO, PIPO. Shift Registers with parallel Load/Shift, Ring counter and Johnsons counter. Asynchronous and Synchronous counter design, Mod N counter. **Logic families and its characteristics:** TTL, ECL, CMOS - Electrical characteristics of logic gates – logic levels and noise margins, fan-out, propagation delay, transition time, power consumption and power-delay product. TTL inverter - circuit description and operation; CMOS inverter - circuit description and operation; Structure and operations of TTL and CMOS gates; NAND in TTL and CMOS, NAND and NOR in CMOS.

Module-4 (10 Marks)

Microprocessors : Algorithms for binary multiplication and division. Fixed and floating-point number representation. Functional units of a computer, Von Neumann and Harvard computer architectures, CISC and RISC architectures. Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation – instruction cycle, instruction fetch, instruction decode, instruction

execute, timing response, instruction sequencing and execution (basic concepts, data path. **Architecture of Microprocessors and Embedded Processors :** Architecture – Block diagram, Registers, Internal Memory, Timers, Port Structures, Interrupts. Assembly Language Programming - Addressing Modes, Instruction set. **Programming and Interfacing**: Simple programming examples in assembly language. Interfacing using Assembly language programming: LED, Seven segment LED display. Programming in C - Declaring variables, Simple examples – delay generation, port programming, code conversion. Interfacing of – LCD display, Keyboard, Stepper Motor, DAC and ADC with microprocessors and its programming. **Advanced Concepts** : Timers/Counters - Modes and Applications. Serial Data Transfer – SFRs of serial port, working, Programming to transfer data serially. Introduction to ARM **The Memory System** : Types of memory - RAM, ROM. Memory Characteristics and Hierarchy. Cache memory – The basics of Caches, Mapping techniques, Improving Cache performance. Virtual memory – Overlay, Memory management, Address translation. Input/Output Organization – Introduction, Synchronous vs. asynchronous I/O, Programmed I/O, Interrupt driven I/O, Direct Memory Access.

Module-5 (10 Marks)

Introduction to Continuous Time Signals : Definition of signal. Basic continuous-time signals. Frequency and angular frequency of continuous time signals . Basic operation on signals. Classification of continuous-time signals: Periodic and Non periodic signals. Even and Odd signals, Energy and power signals. Noise and Vibration signals**. Discrete Time Signals** : Basic discrete-time signals. Frequency and angular frequency of discrete-time signals. Classification of discrete-time signals: Periodic and Non-periodic signals. Even and Odd signals, Energy and power signals. **Systems** : System definition. Continuous-time and discrete-time systems. Properties – Linearity, Time invariance, Causality, Invertibility, Stability. Representation of systems using impulse response**. Linear time invariant systems** : LTI system definition. Response of a continuous-time LTI system and the Convolutional Integral. Properties. Response of a discrete-time LTI system and the Convolutional Sum. Properties. Correlation of discrete-time signals **Frequency analysis of signals :** Concept of frequency in continuous-time and discrete-time signals. Fourier transform of continuous time and discrete-time signals. Parsevals theorem. Interpretation of Spectra. The sampling theorem. **Signal Processing Fundamentals** : Discrete-time and digital signals. Basic elements of digital processing system- ADC, DAC and Nyquist rate. Frequency aliasing due to sampling. Need for anti-aliasing filters. Discrete Time Fourier Transforms – Properties. Computation of spectrum.

Module-6 (10 Marks)

Electromagnetism - Introduction to Co-ordinate Systems – Rectangular, Cylindrical and Spherical Co- ordinate Systems – Co-ordinate transformation; Gradient of a Scalar field, Divergence of a Vector field and Curl of a Vector field- their physical interpretation;

Divergence Theorem, Stokes' Theorem; Coulomb's Law, Electric field intensity, Field due to a line charge, surface charge distribution. Electric Flux and Flux Density; Gauss's law and its application to determine the field due to an infinite line charge, infinite sheet charge; Electric Potential-Potential Gradient, conservative property of electric field, Equipotential surfaces; Electric Dipole; Capacitance - capacitance of co-axial cable, two wire line; Poisson's and Laplace's equations; Biot-Savart's Law, Magnetic Field intensity due to a finite and infinite wire carrying current; Magnetic field intensity on the axis of a circular and rectangular loop carrying current; Magnetic flux Density; Magnetic Vector Potential; Ampere's circuital law and simple applications; Inductance and mutual inductance. Boundary conditions for electric fields and magnetic fields; Conduction current and displacement current densities; Continuity equation for current; Maxwell's Equation in Differential and Integral form from Modified form of Ampere's circuital law, Faraday's Law and Gauss's Law. Wave Equations from Maxwell's Equations; Uniform Plane Waves, Wave equations in Phasor form; Propagation of Uniform Plane waves in free space, loss-less and lossy dielectric medium, Uniform Plane waves in good conductor; Skin effect and skin depth, phase velocity and group velocity, Intrinsic Impedance, Attenuation constant and Propagation Constant in all medium; Poynting Vector and Poynting Theorem. Transmission line: Waves in transmission line, Transmission line equation & solutions, Propagation constants, Characteristic impedance, Wavelength, Velocity of propagation. Standing Wave Ratio(SWR), impedance matching. Solution of problems. Electromagnetic interference.

Module-7 (10 Marks)

Basic Communication System (Analog, Digital, TV / CCTV) : Examples of analog communication systems, Frequency bands, Need for modulation. Noise in communication system, Definitions of Thermal noise (white noise), Various types of noise - Shot noise, Partition noise, Flicker noise, Burst noise, (No analysis required) Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise. **Amplitude modulation** (AM), Double-side band suppressed carrier (DSB-SC) modulation Single sideband modulation (SSB) – spectrum, power, efficiency of all the three variants. (Study of only tone modulation in DSB-SC, AM, and SSB.) Amplitude-modulator implementations – switching modulator, balanced modulator. AM demodulators -- Coherent demodulator. Envelope detector. **Frequency modulation** – modulation index, frequency deviation, average power, spectrum of tone modulated FM. Heuristics for bandwidth of FM. Narrow band FM and wide-band FM. FM generation: Varactor diode modulator, Armstrongs method. FM demodulation – slope detection, PLL demodulator. Module V Superheterodyne reciever, Principle of Carrier synchronization using PLL, NTSC Television broadcasting, CCTV. **Elements of digital communication system**: Sources, channels and receivers. Classification of communication channels. Discrete sources. Source coding techniques. Waveform coding methods. Sampling theorem. Sampling and reconstruction. Pulse code modulation. Sampling, quantization and encoding. Different quantizers. A-law and mu-law quantization. Practical 15 level mu and A law encoding. **Nonlinear Source Coding:** Differential PCM, adaptive PCM,

Delta modulator and adaptive delta modulator. Issues in delta modulation. Slope overload. **Signaling Codes in Telephony** : Signalling codes in digital telephony. T1 signalling system. AMI and Manchester codes. Binary Nzero substitution, B3ZS code, B6ZS code. **Digital Modulation Schemes** : Digital modulation schemes. Baseband BPSK system and the signal constellation. BPSK transmitter and receiver. Base band QPSK system and Signal constellations. Plots of BER Vs SNR (Analysis not required). QPSK transmitter and receiver. Quadrature amplitude modulation. **Channel Coding and Receivers** : Transmission through AWGN Channel. Capacity of an AWGN channel. Receivers. Correlation and matched filter receiver. Channel coding schemes. Repetition code. Block codes Cyclic codes

Module-8 (20 Marks)

Sensors, Transducers, Speaker, Microphone, Recording, Public Address System : Transducers: Definition of transducers, sensors- classification based on transduction principle, measurand, material and technology, Analog and digital transducers, Active and passive transducers, Primary and Secondary transducers. Static and Dynamic characteristics of sensors, Loading effects, Resolution, Linearity, Accuracy. Resistance Transducer : Basic principle – Potentiometer – Resistance strain gauge–Types, Thermistors, RTD. Inductance Transducer :- Basic principle – Linear variable differential transformer (LVDT) – RVDT-types. Capacitance Transducer : Basic principle- transducers using change in area of plates – distance between plates- variation of dielectric constants-frequency response. Position sensors- Digital transducers encoders- linear, rotary, incremental linear encoder, absolute linear encoder, Incremental rotary encoder, absolute rotary encoder; Types Force and Torque Transducers: Proving ring, hydraulic and pneumatic load cell, dynamometer. Sound Transducers: Sound level meter, sound characteristics, Microphone, condenser microphone. Torque measurement system. Pressure Transducers: basic principle- different types of manometers-u tube manometer-well type manometers. Level transducer-continuous level measurement-discrete level measurement-mass – capacitive level gauges, Dead weight calibrator. Hall effect transducers, eddy current transducers, velocity sensors- tachogenerators and stroboscope, rotation rate measurement system. Magnetostrictive transducers, Fibre optic sensor, Semiconductor sensor. Basics of Seismic instrument and accelerometers, Flow Transducers: Bernoulli's principle and continuity, orifice plate, nozzle plate, venture tube, Rota meter, anemometers, electromagnetic flow meter, impeller meter and turbid flow meter. Acceleration sensors, Heading sensors- Compass, Gyroscope sensor, IMU, GPS, real time differential GPS, active optical and RF beacons, ultrasonic beacons, reflective beacons; Active Transducers: Thermocouple, Piezo-electric transducer. Tactile sensor, proximity- detection of physical contact or closeness, contact switches, bumpers , inductive proximity, capacitive proximity; Range sensors- IR, sonar, laser range finder, optical triangulation (1D), structured light(2D), performance comparison range sensors; motion/ speed sensors-speed relative to fixed or moving objects, Doppler radar, Vision based sensors - CCD and CMOS Cameras. Processing circuits for different types of sensors, **Elements of Public Address System**: Loud speakers, characteristics, audio signal recording fundamentals.

Module-9 (10 Marks)

Power System - Load curve -Load factor, diversity factor, Load curve - Numerical Problems. Generation-conventional-hydro, thermal, nuclear –renewable energy –solar and wind –Design of a rooftop/ground mounted solar farm – Energy storage systems as alternative energy sources- grid storage systems- bulk power grids –smart grids – micro grids. Power Transmission System-Line parameters -resistance- inductance and capacitance - Transmission line modelling- classifications -short line, medium line, long line- transmission line as two port network parameters- derivation and calculations Power Transmission System Calculation of Sag and tension-Insulators –string efficiency- grading–corona-Characteristics of transmission lines-Surge Impedance Loading- Series and shunt compensation. Underground cables-ratings- classification-Capacitance –grading-testing EHVAC, HVDC and FACTS Switchgear: Need for protection-circuit breakers-rating- SF6,VCB – Principle of GIS- protective relays – Electromechanical relay - Static, Microprocessor and Numeric types –Principles of overcurrent, directional, distance and differential- Types of protection schemes (Numeric relays) - causes of over voltages– Insulation co-ordination. Power Distribution Systems– Distribution systems- Aerial Bunched Cables -Insulated conductors- Network standards-Earthing- transformer location – balancing of loads. Methods of power factor improvement using capacitors. Per unit quantities-single phase and three phase-Symmetrical components- sequence networks- Fault calculations-symmetrical and unsymmetrical- Fault level of installations- Limiters - Contingency ranking. Load flow studies –types-network model formulation and admittance matrix, Gauss-Siedel, Newton-Raphson and Fast Decoupled method - principle of DC load flow - Introduction to distribution flow. Power system stability - steady state, dynamic and transient stability-power angle curve steady state stability limit -mechanics of angular motion-swing equation - solution of swing equation - Point by Point method - RK method - Equal area criterion application - methods of improving stability limits - Phasor Measurement Units- Wide Area Monitoring Systems, Turbines and speed governors-Inertia-Automatic Generation Control: Load frequency control: single area and two area systems - Subsynchronous Resonance - Automatic voltage control -Exciter Control-SCADA systems, Economic Operation - Distribution of load between units within a plant - transmission loss as a function of plant generation - distribution of load between plants **Rectifiers** Block diagram description of a dc power supply, Working of a full wave bridge rectifier, capacitor filter. **Regulated power supplies:** Zener voltage regulator, series voltage regulator, DC to DC conversion, Circuit/block diagram and working of SMPS. **Voltage Regulators:** Fixed and Adjustable voltage regulators, IC 723 – Low voltage and high voltage configurations, Regulated power supplies: Shunt voltage regulator, series voltage regulator, Short circuit protection and fold back protection, Output current boosting. **Uninterruptible power supplies** (UPS)-Online UPS, Offline UPS, Line Interactive UPS

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also

appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper