

SAVITRIBAI PHULE PUNE UNIVERSITY
[Formerly University of Pune]

DEPARTMENT OF ELECTRONICS & INSTRUMENTATION SCIENCE,
Syllabus for M.Sc. Electronic-Science Entrance Examination, June 2022

Section A : **General Aptitude**

Aptitude, Reasoning , Ratios and Proportions, Progressions, Series, Age, Sets, Permutations, Combinations, Probability, height, distance , basics of geometry.

Section B :

Unit I : **Mathematical Methods**

Basic of MATLAB, Types of Window, Types of File, Basic Operations, Matrix Operation, Array Design, Array Operation, Multidimensional Array, Plotting, Multiple Plot, 2-D Plot, 3-d Plot, Subplot, Symbols, Design Formula, Differentiation, Integration, Arithmetic Operator, Logical Relational, If statement, If-else statement, Else-if statement, Identifiers in C, Variables and Data Types, Constants, Printf and Scanf, Unformatted IO Functions, Expressions and Arithmetic Operators, Relational and Logical Operators, Bitwise Operator, If Statement, Switch Statement, Unconditional Branching using goto statement, While Loop, Do While Loop, For Loop, Break and Continue, Special Cases, Introduction and Writing Functions, Scope of Variables, Storage Classes, Pass by Value and reference, Recursion, Arrays Declaration and Initialization, Sample Programs using Arrays, Arrays as Function Parameters, 2-Dimensional Array

Unit II : **Analog Electronics**

Diodes, diode equation, Graphical/Load line analysis, Diode models- Ideal, Piecewise linear AC, Other diode types, Zener diodes, Diode applications, Peak sample, power rectifier, clamps, regulator, Bipolar transistors-Definitions, V-I characteristics, breakdown, Common-emitter large signal model, graphical analysis, Common-collector, Common-emitter, Applications: current source, DC power supply regulator, Bipolar transistors, Transistor biasing, Hybrid-pi equivalent circuit, High-frequency hybrid-pi, H-parameters, Common-emitter amplifier, AC load line, Common-collector (emitter-follower) amplifier, Junction field-effect transistors, Operation, Background and V-I characteristics: JFET, FET switch, chopper, MUX, Low frequency incremental model, Biasing, JFET current source, Two-transistor amplifiers, Differential emitter-coupled pair, Current mirror, Complementary emitter-follower (Class B, AB), Amplifier classes, Power amplifiers, Operational amplifiers, Overview, Basic linear op-amp circuits, Inverting, non-inverting, addition, subtraction, AC amplifiers, inverting, and non-inverting, Cascading; Ideal impedances, I-V conv, V-I conv, difference amp, instrument amp, Integrator, differentiator, Lossy integrator, Negative feedback, Operational amplifiers, Limitations, Effect of finite open-loop gain, Differential and common mode input voltage limits, Common-mode rejection ration, Input resistance, Input bias current, input offset current, Non-zero output resistance, Frequency response, gain-bandwidth product, Output voltage swing, saturation, Output current limit, Compensation, Slew rate, Offset voltage and drift, Op-amp selection considerations, Operational amplifiers, Non-linear op-amp circuits, Precision $\frac{1}{2}$ wave rectifier, log and antilog amps, Comparator, Schmitt-trigger, Schmitt-trigger oscillator [astable multivibrator]. 555 IC timer

Unit III: **Semiconductor and power electronics**

P-N junction fundamentals, diffusion current, drift current, junction capacitance, light emitting diode, varactor diode, schottky diode, tunnel diode, PIN diode, photodiode, n-p-n/p-n-p transistor basics, operating point, amplification using BJT, power devices fundamentals, MOSFET, DIAC, TRIAC, SCR, Power BJT, Relays, Thyristor, IGBT, Inverters, SMPS.

Unit IV: **Digital Electronics**

TTL Logic, CMOS logic, fan in , fan out, propagation delay, noise margin, combinational circuits, Logic gates based on TTL , AND, OR, NOR, EXOR, NAND, mathematical circuits:

Adder, Subtractor, half adder, half subtractor, full adder, full subtractor, comparator, parity generator, odd parity, even parity, number systems, binary, decimal, hexadecimal, octal systems, sequential circuits, shift registers, counters, memory cells, flip flops, multiplexer, demultiplexers, Analog to digital converter, digital to analog converter.

Unit V : Microcontrollers

Introduction to Microcontroller, Architectural block diagram of microcontroller, functions of each block, microcontroller features, functional pin diagram and pin description, Application of microcontroller.

Classification of instructions, the syntax of instructions, instruction cycle, machine cycle, instruction set, addressing modes, and Types of instruction (Data transfer instruction, Arithmetic instruction, logical instruction, Boolean Instruction, Program branching instructions).

Special function registers, Timer and counter, interrupts in the microcontroller, a priority of interrupts, stack pointer, stack memory and stack operations.

Memories, Latches, shift registers, Ram, NVRAM, ROM, PROM, UVROM, EEPROM, FLASH, SRAM, DRAM, serial EEPROMS, Serial RAM.

What is a compiler, and why the compiler is needed?, Interfacing of ADC (Analog to Digital Converter) and DAC (Digital to analog converter), communication protocols (UART, USART, I2C, SPI, USB, CAN). Basics of Motor, Working Principle of DC and Stepper moto, Interfacing of DC motor and Stepper motor, PWM, Speed control of DC motor using PWM, interfacing of Relay.

Unit VI: Electromagnetics

Sources and effects of electromagnetic fields, Coordinate Systems, Coulomb's Law – Electric field intensity – Field due to discrete and continuous charges – Gauss's law and applications. Poisson's Equation, Lorentz force, magnetic field intensity (H) – Biot-Savart's Law – Ampere's Circuit Law, Faraday's law, Maxwell's equations (differential and integral form) Electromagnetic wave generation and equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors- skin depth – Poynting vector – Plane wave reflection and refraction. Transmission lines, Decibels, Attenuation, noise, Radio waves, transmission losses: conductor losses, dielectric losses, , Electromagnetic spectrum

Unit VII: Communication

Basics of Communication Systems, Block diagram of communication system, types of communication system: simplex, duplex, analog and digital communication, base band and broad band communication. Wave propagation: permeability, permittivity, noise concept and types, signal to noise ratio, noise figure, noise temperature, Need of modulation, concept of modulation, Amplitude Modulation, frequency Modulation, AM waveform, mathematical expression of AM power, concept of sideband, modulation index, power distribution. Demodulation principles, demodulator circuit using diode, super-heterodyne receiver, characteristics of receiver: selectivity, sensitivity, Image frequency and dynamic range, Square law modulator, Digital Communication Systems, advantages of digital communication system, bit rate, baud rate and bandwidth. Serial and parallel communication, concept of sampling, Sampling theorem, concept of ASK, PSK, FSK, PAM, PWM, PPM, PCM, Concept of FDM and TDM, Antenna

Unit VIII: Nano Technology and sensors

Basics of nanostructures, Characterization of nanostructures, Electronic transport in nanostructures, Materials for nano electronics and Devices, Coulomb Blockade, Single-Electron Transistor, Carbon Nanotube, Semiconductor Nanowire, Quantum well laser, quantum dot LED, quantum dot laser, MOSFETS.

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Physics (40 %)

Motion and Friction, Work, Energy and Power, Heat, Fundamental properties of wave, Angular Momentum, Newton's Laws, Specific Heat Capacity, Thermal Expansion, Gravitational Force, Energy, Conduction, Convection, Occurrence of Superconductivity, Critical magnetic field, Elastic and inelastic scattering, Diffraction, Fibre optics, LASER, Coulomb's law, Gauss law, Electric field, Electrostatic Potential, Statement of Poisson's equation, Polarization, Electric displacement, Electric susceptibility and dielectric constant, Electric field at an exterior and interior point of dielectric, Concepts of magnetic induction, magnetic flux and magnetic field, Relationship between B, H and M, Biot-Savart's law, Ampere's law for force between two current carrying loops, Ampere's circuital law, Equation of continuity, Magnetic susceptibility and permeability, Hysteresis loss, B-H curve. Faradays law of induction, Lenz's law, Simple Harmonic Motion, Waves, Inertia, Temperature, Thermal conduction, Geometric Optics, Wave Optics, Quantum Optics, Electromagnetism, Electromagnetic induction, Elasticity, Force, mass, Velocity, Density, Energy, Hall effect, Sound waves, Diamagnetism, Langevin theory of Diamagnetism, Application of diamagnetic material, Occurrence of Superconductivity, Critical magnetic field and Meissner effect, Paramagnetism, Langevin theory of Para magnetism, ferromagnetism, ferromagnetic domains, Hysteresis, Curie temperature, Ferromagnetism, Conventional and non-conventional sources of energy, Photovoltaic principle solar cells.

Electronics (40 %)

P-N junction diode, Applications of diode, Rectifiers, clippers, clampers, Zener diode voltage regulators. Construction, characteristics and configurations of BJT, biasing of BJT, BJT amplifiers Construction and Characteristics of JFETs, Transfer Characteristics, Depletion type MOSFET, Enhancement type MOSFET Feedback concepts, types of Feedback connection, Oscillators, Number System, Logic gates, Combinational Circuits, Sequential Circuits, Analog to Digital Converter, Digital to Analog Converter. Introduction to Microcontrollers, 8051 Microcontroller Architecture, Addressing modes and instruction set. Introduction, Elements of Communication Systems, Types of Modulation Ideal OP-AMP characteristics, frequency response of OP-AMP; Basic applications of op-amp, Summing amplifier, Integrator, Differentiator, etc. Basic thyristor family like SCR, IGBT, TRIAC, etc. Rectifiers: Single-phase and three-phase controlled & uncontrolled rectifiers, choppers, cycloconverters and inverters.

Computer architecture and C Programming (10 %)

Data Types, operators, identifiers and keywords, constants, types of operators, variable declaration, Input and Output, Control statement, conditional, case and switch statement, loop- statements, Function definition, Arrays Notation and declaration, multidimensional arrays, pointers, Declarations, Pointer arithmetic, Pre-processors, structures. CPU organisations – ALU & control circuit, Introduction to input devices, computer output: output fundamentals, hardcopy output devices, Computer system characterization & capabilities. Speed, Memory types

Instrumentation (10 %)

Definition, Classification, Static and Dynamic characteristics. Typical Sensors: Principle, Construction, Working and specifications of- Thermal Sensors, Optical Sensors, Mechanical and electromechanical transducers. Measurement principles: Measurement of physical parameters, measurement system block diagram, Measurement characteristics. Test and Measuring instruments: Working principle, specification and operating procedure for: Voltmeter, Ammeter, Multirange meter, Analog Multimeter, Electronic Voltmeter, True RMS Meter, DMM, DFM, CRO. Types of CRO. Signal Sources: Signal and function generators, Sweep generator.

General Aptitude Syllabus

Quantitative Aptitude (Number Systems, HCF and LCM, Ratio and Proportion, Percentage, Simple and Compound Interest, Time and Work, Time and Distance, Volume and Surface Area, Problems on Ages, Blood Relation, Boats and Streams, Problems on Trains, etc.) B. Verbal Ability