

# DETAILED SYLLABUS FOR THE POST OF ASSISTANT PROFESSOR IN ELECTRONICS (COLLEGIATE EDUCATION)

(CAT.NO.: 52/2021)

**TOTAL MARKS: 100**

## Module 1

### Electronic Devices [10 Marks]

Energy bands in solids, concept of effective mass, density of states, Semiconductors- Intrinsic and extrinsic. Carrier Concentration-Fermi-Dirac distribution function, Carrier transport in semiconductors - mobility and conductivity, Fermi levels. PN junction under thermal equilibrium, Diode equation and diode equivalent circuit, Breakdown in diodes, Zener diode, Tunnel diode, Metal semiconductor junction - Ohmic and Schottky contacts.

Characteristics and equivalent circuits of JFET, MOSFET. Low dimensional semiconductor devices - quantum wells, quantum wires, quantum dots. High Electron Mobility Transistor (HEMT), Solar cells - I-V characteristics, fill factor and efficiency, LED, LCD and flexible display devices.

Emerging materials for future Devices: Graphene, Carbon Nanotubes (CNT), ZnO, SiC and GaN.

## Module 2

### Device Fabrication and Characterization Techniques: [10 Marks]

IC fabrication - crystal growth, epitaxy, oxidation, lithography, doping, etching, isolation methods, metallization, bonding.

Thin film deposition and characterization Techniques: XRD, TEM, SEM, EDX, Thin film active and passive devices, MOS technology and VLSI, scaling of MOS devices, NMOS and CMOS structures and fabrication, NMOS and CMOS inverters,

Charge-Coupled Device (CCD) - structure, storage and transfer of charge.

## Module 3

### Circuits and Networks: (10 Marks)

Network Elements, Circuit theorems: Superposition, Thevenin, Norton and Maximum Power Transfer Theorems, Network graphs, Nodal and Mesh analysis. AC steady-state (phasor) circuit analysis, Transient analysis, Time and frequency domain response, Passive filters, Two-port Network Parameters: Z, Y, ABCD and h parameters, Network Functions, Transfer functions, State variable method of circuit analysis, Zeros and Poles.

## Signal Processing

Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, DFT and FFT, z-transform. Sampling theorem. Linear Time Invariant (LTI) Systems: definitions and properties; causality, stability, impulse response, convolution, parallel and cascade structure, frequency response, group delay, phase delay. Signal transmission through LTI systems. Basic concepts of digital signal processing, digital filters - IIR, FIR.

## Module 4

### Analogue Electronic Circuits [10 Marks]

Rectifiers, Voltage regulated ICs and regulated power supply, Biasing of Bipolar junction transistors and FETs, operating point and stability, Amplifiers, Classification of amplifiers, Concept of feedback, Hartley, Colpitts and Phase Shift oscillators.

Operational amplifiers (OPAMP) - characteristics, computational applications, comparators, Schmitt trigger, Instrumentation amplifiers, wave shaping circuits, Phase locked loops, Oscillators using Op-amps, Active filters, Multivibrators, Voltage to frequency converters (V/F), frequency to voltage converters (F/V).

## Module 5

### Digital Electronics [10 Marks]

Logic Families, Logic Gates, Boolean algebra and K-Map based minimization techniques up to 4 variables, Combinational circuits, Sequential Circuits: flip-flops, Counters: Ring, Ripple, Synchronous, Asynchronous, Shift registers, multiplexers and demultiplexers.

A/D and D/A converters: Flash, SAR ADCs, Binary weighted, R-2R ladder DACs.

Analysis and Design of fundamental mode state machines: State variables, State table and State diagram.

Programmable Logic Devices (PLD), CPLD, Sequential PLD, FPGA, Basic ideas of VHDL based design.

## Module 6

### Microprocessors and Microcontrollers [10 Marks]

Introduction of Microprocessor 8085: Architecture, addressing modes, instruction set, interrupts, Programming, Memory and I/O interfacing.

Introduction of Microcontrollers - 8051 for embedded systems, Architecture and register set of Microcontroller 8051, Addressing modes, Instruction set of 8051 - Data transfer instructions, Arithmetic instructions, Logic instructions, bit level and byte level control transfer instructions, 8051 assembly programming - stack operations, subroutines, interrupts, 8051 programming as timer/counter, 8051 serial communications, 8051 interfacing RS232, LED/LCD display, Keyboard, Stepper motor.

## Module 7

### Electromagnetics [10 Marks]

Electrostatics - vector calculus, Gauss's Law and its applications, Laplace and Poisson's equations, boundary value problems, Magnetostatics - Biot-Savart's law, Ampere's law and electromagnetic induction, Maxwell's equations and wave equations, Plane wave propagation in free space, dielectrics and conductors, Poynting theorem, Reflection and refraction, polarization, interference, coherence and diffraction, Transmission lines and waveguides - line equations, impedance, reflections and voltage standing wave ratio, rectangular waveguides. Antennas - retarded potential and Hertzian dipole, half wave antenna, antenna patterns, radiation intensity, gain, effective area and Friis' free space receiver power equation.

Microwave Sources and Devices: Reflex Klystron, Magnetron, TWT, Gunn diode, IMPATT diode, Crystal Detector and PIN diode. Radar - block diagram of Radar, frequencies and power used, Radar range equation.

## Module 8 (10 Marks)

### Communication Systems

Analog modulation and demodulation - AM, FM and PM, Principle of superheterodyne receiver, Random signals, noise, noise temperature and noise figure, Basic concepts of information theory, Error detection and correction, Digital modulation and demodulation - PCM, ASK, FSK, PSK, BPSK, QPSK and QAM, Time and Frequency-Division Multiplexing, Multiple Access techniques, Data Communications - Modems, Codes, Principles of Mobile and Satellite Communication,

### Optoelectronics and Optical Communication

Optoelectronic Devices and Components: LED, spontaneous and stimulated emission, semiconductor Lasers, Detectors - PIN photodiodes, Avalanche photodiodes (APD), Optical fibres - attenuation and dispersion characteristics, Bandwidth, Wavelength division multiplexing.

## Module 9 (10 Marks)

**Power Electronics :** Power devices - characteristics of SCR, DIAC, TRIAC, power transistors, SCR triggering -  $dv/dt$  and  $di/dt$  ratings, Single-phase Controlled Rectifiers with R and RL loads, dc-dc choppers and inverters.

**Control Systems :** Open loop and closed loop control system, Block Diagram reduction techniques, transfer function and signal flow diagram, Stability criterion: Routh-Hurwitz, Bode and Nyquist plots, Proportional (P), Proportional-Integral (PI), Proportional-Derivative (PD), PID controllers.

## Module 10

### Sensors, Transducers and Instrumentation [10 Marks]

Transducers - Resistance, Inductance, Capacitance, Piezoelectric, Thermoelectric, Hall effect, Photoelectric.

Measurement of physical variables: displacement, velocity, acceleration, force, torque, strain, temperature, pressure, flow, humidity, thickness, pH.

Measuring Equipment: Measurement of R, L and C, Bridge and Potentiometers, Measurement of voltage, current, power, energy, frequency/time, phase. Digital Multimeters, Digital Storage Oscilloscope, Spectrum Analyzer, Biomedical Instruments - ECG, EEG, Blood Pressure Measurements, MEMS and its applications.

**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.**