Syllabus for Nanoelectronics / Material Sciences (MTQP09)

Note:

i. There will be one Question Paper which will have 75 questions.

ii. All questions will be complulsory.

iii. All 75 questions will be based on Subject-Specific Knowledge.

iv. The medium of the question paper will be English only.

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Unit-I

Electronic Transport in semiconductor, PN Junction, Diode equation and diode equivalent circuit. Breakdown in diodes, Zener diodes, Tunnel diode, Semiconductor diodes, characteristics and equivalent circuits of BJT, JFET, MOSFET, IC fabrication-crystal growth, doping, bonding, Thin film active and passive devices. Rectifiers, Voltage regulated ICs and regulated power supply, Biasing of Bipolar junction transistors and JFET. Single stage amplifiers, Multi stage amplifiers, Feedback in amplifiers, oscillators, function generators, multi vibrators, Operational Amplifiers (OP AMP): Characteristics and Applications, Computational Applications, Integrator, Differentiator.

Unit-II

Network theorems, Network graphs, Nodal and Mesh analysis. Time and frequency domain responses. Image impedance and passive filters. Two-port Network Parameters. Transfer functions, Signal representation. State variable method of circuit analysis, AC circuit analysis, Transient analysis. Logic families, flip-flops, Gates, Boolean algebra and minimization techniques, Multi vibrators and clock circuits, Counters-Ring, Ripple. Synchronous, Asynchronous, Up and down shift registers, multiplexers and demultiplexers, Arithmetic circuits, Memories, A/D and D/A converters. Modulation index, frequency spectrum, generation of AM (balanced modulator, collector modulator), Amplitude Demodulation (diode detector Other forms of AM: Double side band suppressed carrier, DSBSC generation (balanced modulator), Single side band suppressed carrier, SSBSC generation and Phase modulation, modulation index.

Unit-III

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magneto statics: Biot-Savart law, Ampere's theorem. Electromagnetic induction.
Maxwell equations. Reflection and refraction, polarization.

Unit-IV

Microprocessor: Introduction to 8085, Basic Concepts of Microprocessors, Central Processing Unit: CPU, I/O devices, clock, memory, bussed architecture, tristate logic, address bus, data bus and control bus. Development of semiconductor memory, internal structure and decoding, memory read and write timing diagrams, MROM, ROM, EPROM, EEPROM, DRAM: Intel 8085 microprocessor.

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Unit V:

Introduction to nanotechnology, Mesoscopic physics, trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence, Schrodinger's Equation, wave function, Low dimensional structures Quantum wells, Basic properties of two dimensional semiconductor nanostructures, Quantum wires and quantum dots, carbon nano tube, grapheme, Introduction to methods of fabrication of nano-layers, Introduction to characterization of nanostructures, Principle of operation of Scanning Tunnelling Microscope, X-Ray Diffraction analysis, MOSFET structures, Quantum wells, modulation doped quantum wells, multiple quantum wells, The concept of super lattices, Transport of charge in Nanostructures under Electric field, Transport of charge in magnetic field, Nanoelectonic devices, principle of NEMS

Unit VI:

Nanotechnology Enabled Sensors, Sensor Characteristics and Terminology, Potentiometric Sensors, Selectivity of Potentiometric Sensor, the IonSelective Field Effect Transistor (ISFET), Measurement with Potentiometric Sensors, Amperometric Sen sors Selectivity of Amperometric Sensors, Electrode Design and Examples, Measurement with Amperom etric Sensors, Sensors Based on Other Electrochemical Methods, Electrochemical Biosensors, Classes of Electrochemical Biosensors.Sensors with Thermistors and Pellistors, Pyroelectric Sensors, Sensors Based on Other Thermal Effects, Optical Fibres as a Basis for Optical Sensors.