20VL024 - Nano Electronic Devices

Course Outcomes:

CO 1. To understand the basic concepts involve in this technology for device architecture and interface engineering at atomic.

CO2. Give a general introduction to different types of conventional and novel nanoelectronic devices for different applications

CO3. Understand the underlying physical processes governing the operation of spintronic devices.

CO4. Demonstrate how simulation can facilitate learning of fabrication process and device designing.

UNIT - I

QUANTUM DEVICES Charge and spin in single quantum dots- Coulomb blockade– Electrons in mesoscopic structures - single electron transfer devices (SETs) – Electron spin transistor – resonant tunnel diodes, tunnel FETs - quantum interference transistors (QUITs) - quantum dot cellular automata (QCAs) - quantum bits (qubits).

UNIT - II

NANOELECTRONIC DEVICES Electronic transport in 1,2 and 3 dimensions- Quantum confinement - energy subbands - Effective mass - Drude conduction - mean free path in 3D - ballistic conduction - phase coherence length - quantized conductance - Buttiker-Landauer formula- electron transport in pn junctions - short channel NanoTransistor –MOSFETs - Advanced MOSFETs - Trigate FETs, FinFETs - CMOS.

UNIT – III

MOLECULAR NANOELECTRONICS Electronic and optoelectronic properties of molecular materials - Electrodes & contacts – functions – molecular electronic devices - elementary circuits using organic molecules- Organic materials based rectifying diode switches – TFTs- OLEDs- OTFTs – logic switches.

UNIT – IV

SPINTRONICS Spin tunneling devices - Magnetic tunnel junctions- Tunneling spin polarization - Giant tunneling using MgO tunnel barriers - Tunnel-based spin injectors - Spin injection and spin transport in hybrid nanostructures - spin filters -spin diodes - Magnetic tunnel transistor - Memory devices and sensors - ferroelectric random access memory-MRAMS -Field Sensors - Multiferro electric sensors- Spintronic Biosensors.

UNIT – V

NANOELECTRONIC ARCHITECTURES AND COMPUTATIONS Architecture Principles: Mono and Multi processor systems – Parallel data processing – Power Dissipation and Parallelism – Classic systolic arrays - Molecular devices-properties - Self-organization – Size dependent - limitations. Computation: Monte Carlo Simulations- Computational methods and Simulations from ab initio to multiscale Modeling- Modeling of Nanodevices.

References:

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3. Karl Goser, Peter Glosekotter, Jan Dienstuhl, ―Nanoelectronics and Nanosystems‖, Springer (2004).

4. Sadamichi Maekawa, ―Concepts in Spin Electronics‖, Oxford University Press (2006).

5. L. Banyai and S.W.Koch, ―Semiconductor Quantum Dots‖, World Scientific (1993).

6. Edward L. Wolf, ―Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience‖, Wiley-VCH (2006).