VL5004 NANO SCALE DEVICES

DETAILED SYLLABUS

UNIT I INTRODUCTION TO NOVEL MOSFETS

MOSFET scaling, short channel effects - channel engineering - source/drain engineering - high k dielectric - copper interconnects - strain engineering, SOI MOSFET, multigate transistors – single gate – double gate – triple gate – surround gate, quantum effects – volume inversion – mobility – threshold voltage – inter sub band scattering, multigate technology – mobility – gate stack

UNIT II PHYSICS OF MULTIGATE MOS SYSTEMS

MOS Electrostatics – 1D – 2D MOS Electrostatics, MOSFET Current-Voltage Characteristics – CMOS Technology – Ultimate limits, double gate MOS system – gate voltage effect – semiconductor thickness effect – asymmetry effect – oxide thickness effect – electron tunnel current – two-dimensional confinement, scattering – mobility

UNIT III NANOWIRE FETS AND TRANSISTORS AT THE MOLECULAR SCALE

Silicon nanowire MOSFETs – Evaluvation of I-V characteristics – The I-V characteristics for nondegenerate carrier statistics – The I-V characteristics for degenerate carrier statistics – Carbon nanotube – Band structure of carbon nanotube – Band structure of graphene – Physical structure of nanotube – Band structure of nanotube – Carbon nanotube FETs – Carbon nanotube MOSFETs – Schottky barrier carbon nanotube FETs – Electronic conduction in molecules – General model for ballistic nano transistors – MOSFETs with 0D, 1D, and 2D channels – Molecular transistors – Single electron charging – Single electron transistors

UNIT IV RADIATION EFFECTS

Radiation effects in SOI MOSFETs, total ionizing dose effects – single gate SOI – multigate devices, single event effect, scaling effects

UNIT V CIRCUIT DESIGN USING MULTIGATE DEVICES

Digital circuits – impact of device performance on digital circuits – leakage performance trade off – multi VT devices and circuits – SRAM design, analog circuit design – transconductance - intrinsic gain – flicker noise – self heating –band gap voltage reference – operational amplifier – comparator designs, mixed signal – successive approximation DAC, RF circuits.

OBJECTIVES

- To introduce novel MOSFET devices and understand the advantages of multi-gate devices
- To introduce the concepts of nanoscale MOS transistor and their performance characteristics
- To study the various nano scaled MOS transistors

REFERENCES:

1. J P Colinge, "FINFETs and other multi-gate transistors", Springer – Series on integrated circuits and systems, 2008

2. Mark Lundstrom, Jing Guo, "Nanoscale Transistors: Device Physics, Modeling and Simulation", Springer, 2006

3. M S Lundstorm, "Fundamentals of Carrier Transport", 2nd Ed., Cambridge University Press, Cambridge UK, 2000