Course Code	Course Title	L	T	P	C
1152EC145	NANO SCALE TRANSISTORS	3	0	0	3

a) Course Category

Program Elective

b) Preamble

In this subject we are discussing about the essential of MOS transistor scaling and how the short-channel effects can be minimized.

c) Prerequisite

Nil

d) Course educational objectives

To understand the essential of MOS transistor scaling

To introduce the nanoscale MOS transistor concept and performance

To study and analyze the different nano scaled MOS transistors

e) Related Courses

Solid state devices

f) Course Outcomes

On successful completion of this course the student will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain about the various novel MOSFETs to tackle short channel effects	K2
CO2	Apply the physics of multigate MOS system	K2
CO3	Identify the performance of Nanowire FETs and transistors at the molecular scale	K2
CO4	Understand about the radiation effects in SOI MOSFETs	K2
CO5	Explain about the concept of circuit design using multigate devices	K2

g)	Correlation of COs with POs													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2														
CO3														
CO4														
CO5														

h) Course Content

UNIT I INTRODUCTION TO NOVEL MOSFETS 9

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 subband scattering, multigate technology – mobility – gate stack

UNIT II PHYSICS OF MULTIGATE MOS SYSTEM 9

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 9

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 nanotubes – Carbon nanotube FETs – Electronic conduction in molecules – General model for ballistic nanotransistors – MOSFETs with 0D, 1D, and 2D channels – Molecular transistors

UNIT IV RADIATION EFFECTS 9

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 9

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

Total 45 Hrs

i) Learning Resources

Text Books

1. J P Colinge, FINFETs and other multi-gate transistors, Springer – Series on integrated circuitsand systems, 2008
2. Mark Lundstrom Jing Guo, Nanoscale Transistors: Device Physics, Modeling and Simulation,Springer,2006

Reference Books

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