COURSE CODE	COURSE TITLE	L	T	P	C
1154EC108	NANO ELECTRONICS	3	0	0	3

Course Category:

Program Elective (2).

Preamble:

The Purpose of the course is to provide students with the basic knowledge in nanoelectronics. This course emphasize on nano materials, types, synthesis, interconnects and fabrication.

a. Prerequisite Courses:

Engineering Physics-II

b. Related Courses:

NIL

c. Course Educational Objectives :

Students undergoing this course are exposed to:

- Know the types of nanotechnology, atomic structure, molecular technology and preparation of nano materials.
- Understand the fundamentals of nano electronics and its properties.
- Know the Silicon MOSFET's, QTD and carbon nano tubes.
- Understand the fundamentals of molecular electronics.

d. Course Outcomes :

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Discuss the types of nanotechnology, molecular technology and the preparation of nano materials.	K2
CO2	Explains the fundamental of the devices such as logic devices, field effect devices, and spintronics.	K2
CO3	Describe the concepts of silicon MOSFET and Quantum Transport Devices.	K2
CO4	Summarize the types, synthesis, interconnects and applications of carbon nano tubes.	K2
CO5	Explain the concepts, functions, fabrications and applications of molecular electronics.	K2

e. Correlation of COs with POs :

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	H									
CO2	M											
CO3	M		H									
CO4	M											
CO5	L		M									

H- High; M-Medium; L-Low

f. Course Content :

UNIT I INTRODUCTION TO NANOTECHNOLOGY L-9

Introduction: Discussion of the International Technology Roadmap characteristics: Need for new concepts in electronics From microelectronics towards biomolecule electronics
Background to nanotechnology: Types of nanotechnology and nanomachines – periodic table – atomic structure – molecules and phases – energy – molecular and atomic size – surface and dimensional space – top down and bottom up.
Molecular Nanotechnology:
Electron Microscope – Scanning Electron Microscope – Atomic Force Microscope –Scanning Tunneling Microscope.
Nanomaterials:
Preparation –Plasma Arcing – Chemical Vapor Deposition – Sol-Gels – Electrode Position – Ball Milling –Applications Of Nanomaterials.

UNIT II FUNDAMENTALS OF NANOELECTRONICS L-9

Fundamentals of logic devices:- Requirements – dynamic properties – threshold gates; physical limits to computations; concepts of logic devices:- classifications – two terminal devices – field effect devices – coulomb blockade devices – spintronics – quantum cellular automata – quantum computing – DNA computer; performance of information processing systems;- basic binary operations, measure of performance processing capability of biological neurons – performance estimation for the human brain. Ultimate computation:- power dissipation limit – dissipation in reversible computation – the ultimate computer.

UNIT III SILICON MOSFETs & QUANTUM TRANSPORT DEVICES L-9

Silicon MOSFETS - Novel materials and alternate concepts:- fundamentals of MOSFET Devices- scaling rules – silicon-dioxide based gate dielectrics – metal gates – junctions & contacts – advanced MOSFET concepts.
Quantum transport devices based on resonant tunneling: Electron tunneling – resonant tunneling diodes – resonant tunneling devices; Single electron devices for logic applications- Single electron devices – applications of single electron devices to logic circuits.

UNIT IV CARBON NANOTUBES L-9

Carbon Nanotube: Fullerenes - types of nanotubes – formation of nanotubes – assemblies – purification of carbon nanotubes – electronic properties – synthesis of carbon nanotubes – carbon nanotube interconnects – carbon nanotube FETs – Nanotube for memory applications – prospects of all carbon nanotube nanoelectronics.

UNIT V MOLECULAR ELECTRONICS L-9

Electrodes & contacts – functions – molecular electronic devices – first test systems – simulation and circuit design – fabrication; Future applications: MEMS – robots – random access memory – mass storage devices.

Total: 45 Periods

g. Learning Resources

i.Text Books:

1. Michael Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons and Burkhard
2. Raguse, Nanotechnology: Basic Science and Emerging Technologies, Chapman & Hall / CRC, 2002.
3. Rainer Waser (Ed.), Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices, Wiley-VCH, 2003.
4. T. Pradeep, NANO: The Essentials – Understanding Nanoscience and Nanotechnology, TMH, 2007.

ii.Reference:

1. M.Ziese and M.J Thornton(Eds.)"Spin Electronics ", Springer-verlag 2001.
2. M.Dutta and M.A Stroscio Edited by "Quantum Based Electronic Devices and systems", world Scientific, 2000.

iii. Online resources

1. https://www.edx.org/course/fundamentals-nanoelectronics-part-b-purduex-nano521x.