Nanoelectronics: Devices and Materials - Video course

COURSE OUTLINE

The objective of this course is to present the state of the art in the areas of semiconductor device physics and materials technology to enable the Nanoelectronics.

The fundamentals of classical CMOS technology will be discussed and the issue in scaling MOSFET in the sub-100nm regime will be elaborated.

In this context the need for non classical transistors with new device structure and nano materials will be elucidated.

The issues in realizing Germanium and compound semiconductor MOSFET will be presented.

Extensive materials characterization techniques will also be discussed, which help in engineering high performance transistors.

COURSE DETAIL

Sl.No.	Topic(s)	Instructor	No.of Hours
1.	Overview: Nano devices, Nano materials, Nano characterization.	NB	1
2.	Definition of Technology node, Basic CMOS Process flow.	NB	2
3.	MOS Scaling theory, Issues in scaling MOS transistors : Short channel effects, Description of a typical 65 nm CMOS technology.		3
4.	Requirements for Non classical MOS transistor.	NB	1
5.	MOS capacitor, Role of interface quality and related process techniques, Gate oxide thickness scaling trend, SiO2 vs High-k gate dielectrics. Integration	NB	5

NP-TEL

NPTEL

http://nptel.iitm.ac.in

Electronics & Communication Engineering

Pre-requisites:

1. Basic understanding of semiconductor devices.

Hyperlinks:

1. http://ece.iisc.ernet.in/~navakant/nano/2007/course.html.

Coordinators:

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	issues of high-k . Interface states, bulk charge, band offset, stability, reliability - Qbd high field, possible candidates, CV and IV techniques.		
6.	Metal gate transistor : Motivation, requirements, Integration Issues.	NB	2
7.	Transport in Nano MOSFET, velocity saturation, ballistic transport, injection velocity, velocity overshoot.	KNB	2
8.	SOI - PDSOI and FDSOI.	KNB	1
9.	Ultrathin body SOI - double gate transistors, integration issues.	KNB	2
10.	Vertical transistors - FinFET and Surround gate FET.	KNB	1
11.	Metal source/drain junctions - Properties of schotky junctions on Silicon, Germanium and compound semiconductors -Workfunction pinning.	KNB	2
12.	Germanium Nano MOSFETs : strain , quantization , Advantages of Germanium over Silicon , PMOS versus NMOS. Compound semiconductors - material properties, MESFETs Compound semicocnductors MOSFETs in the context of channel quantization and strain , Hetero structure MOSFETs exploiting novel materials, strain, quantization.	KNB KNB	5
13.	Synthesis of Nanomaterials : CVD, Nucleation and Growth, ALD, Epitaxy, MBE.	SAS	4
14.	Compound semiconductor	SAS	2

	hetero-structure growth and characterization : Quantum wells and		
15.	Thickness measurement techniques: Contact - step height, Optical - reflectance and ellipsometry. AFM.	SAS	1
16.	Characterization techniques for nanomaterials: FTIR, XRD, AFM, SEM, TEM, EDAX etc. Applications and interpretation of results.	SAS	4
17.	Emerging nano materials : Nanotubes, nanorods and other nano structures, LB technique, Soft lithography etc. Microwave assisted synthesis, Self assembly etc.	SAS	2
	Total		40

References:

1. Fundamentals of Modern VLSI Devices, Y. Taur and T. Ning, Cambridge University Press.
2. Silicon VLSI Technology, Plummer, Deal , Griffin , Pearson Education India.
3. Encyclopedia of Materials Characterization, Edited by: Brundle, C.Richard; Evans, Charles A. Jr.; Wilson, Shaun ; Elsevier.