NIRMA UNIVERSITY
SCHOOL OF TECHNOLOGY, INSTITUTE OF TECHNOLOGY
M. Tech. in Electronics & Communication Engineering (VLSI Design)
M.Tech Semester - I

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Course Code	6EC103CC22
Course Title	Semiconductor Device Physics and Modelling

Course Learning Outcomes (CLOs):

At the end of the course, the students will be able to -
1. Comprehend the semiconductor physics, MOSFET operation and Scaling of MOSFET
2. Design MOSFETs of different gate lengths with lambda rules using TCAD tools for VLSI circuits
3. Analyse different models of MOSFETs for VLSI circuits
4. Implement the different MOSFETs for VLSI circuits

Syllabus: **Teaching Hours: 30**

UNIT I: Semiconductor physics **03**
Semiconductors, Energy bands, Thermal equilibrium carrier concentration. Excess carriers, quasi Fermi levels; Recombination of carriers, lifetime.

UNIT II: MOS Transistor **12**
Analysis of MOS capacitor. Calculation of threshold voltage. Static I-V characteristics. The MOS structure, The MOS under external Bias, Analysis of MOS capacitor. Calculation of threshold voltage, Structure and Operation of MOS Transistor, Current-Voltage Characteristic, Scaling and Small Geometry Effects

UNIT III: Modeling of MOS Transistor **05**
Various level model equation, BSIM Model, MOS capacitance model

UNIT IV: PN Junction Diode **03**
Carrier transport by drift, mobility, Carrier transport by diffusion, Continuity equation. Diffusion length, Ballistic Transport, Radiation Effects. Quantitative theory of PN junctions, Steady state I-V characteristics under forward bias, reverse bias and illumination. Capacitances. Dynamic behaviour under small and large signals. Breakdown mechanisms.

UNIT V: Bi-Junction Transistor **03**
Quantitative theory of bipolar junction transistors having uniformly doped regions. Static characteristics in active and saturation regions. Emitter efficiency, transport factor, transit time

UNIT VI: MOSFET devices **04**
Schottky Barriers and Ohmic Contacts, Steps of Deriving a Device Model, Types of Device Model, MOSFET Models, Double Gate MOSFET, FINFET

Self-Study: The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study contents

Laboratory Work:
Laboratory work will be based on the above syllabus with a minimum of 10 experiments to be incorporated.

Suggested Readings:

1. C. Snowden, Introduction to Semiconductor Device Modeling, World Scientific
2. S. M. Sze, Modern Semiconductor Device Physics, John Wiley & Sons
3. D. Nagchoudhuri, Microelectronic Devices, Pearson Education
4. J. P. Colinge, Fin-FETs and other multigate Transistors, Springer