Training Course on Semiconductor Device Physics and Fabrication

Professional Development Training Course Outline

Category	Engineering	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Introduction

Training Course on Semiconductor Device Physics and Fabrication offers a deep and structured understanding of the principles, physics, and manufacturing technologies behind modern semiconductor devices. In a world powered by nanoelectronics, integrated circuits, and microfabrication, this course equips participants with essential knowledge of carrier transport, PN junctions, MOSFETs, BJTs, CMOS technologies, and semiconductor materials science. Through a combination of theory, simulation, and real-world case studies, the course covers semiconductor processing steps including oxidation, diffusion, photolithography, etching, doping, and thin-film deposition.

Designed for engineers, researchers, and technologists working in semiconductor R&D, cleanroom fabrication, device modeling, and failure analysis, this course also includes insights into advanced fabrication methods such as FinFETs, SOI, quantum devices, and 2D materials. Participants gain hands-on skills in device simulation using TCAD tools, process integration techniques, yield enhancement, and cleanroom protocols, all essential for building reliable high-performance semiconductor devices.

Programme Curriculum

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Course Objectives

1. Understand the fundamentals of semiconductor physics and band theory
2. Explore charge carrier dynamics, mobility, and recombination mechanisms
3. Analyze PN junctions, diodes, and their I-V characteristics
4. Design and evaluate MOSFET and BJT architectures
5. Examine CMOS process flow and fabrication techniques
6. Apply photolithography, etching, and doping in device making
7. Learn oxidation, CVD, PVD, and epitaxy methods for material growth
8. Model devices using industry-standard TCAD simulation tools
9. Understand cleanroom classifications, contamination control, and safety
10. Explore scaling challenges in FinFETs and beyond CMOS technologies
11. Investigate wide bandgap materials like GaN and SiC
12. Analyze yield, reliability, and failure mechanisms
13. Review case studies from advanced node fabrication and 2D electronics

Organizational Benefits

1. Build in-house capability for semiconductor innovation
2. Equip R&D teams with fabrication and process integration knowledge
3. Accelerate new product development in chip design and nanotech
4. Reduce reliance on external fabrication services
5. Improve fabrication process efficiency and yield
6. Train engineers in ISO cleanroom and ESD-compliant operations
7. Enhance product reliability through device physics understanding
8. Strengthen failure analysis and quality control expertise
9. Prepare teams for emerging markets in GaN, SiC, and 2D materials
10. Increase competitiveness in the global semiconductor ecosystem

Target Participants

- Semiconductor Engineers
- Device Physicists and Technologists
- Process Integration Engineers
- Nanotechnology and Microelectronics Researchers

- Electrical and Materials Science Students
- Cleanroom and Fab Operators
- Failure Analysis and QA Teams

Course Outline

Module 1: Introduction to Semiconductor Physics

- Band theory and semiconductors vs insulators
- Intrinsic and extrinsic materials
- Fermi level and carrier concentration
- Carrier generation and recombination
- Case Study: Silicon vs GaAs properties

Module 2: Charge Transport Mechanisms

- Drift and diffusion currents
- Mobility and scattering mechanisms
- Continuity and Poisson’s equations
- High-field effects and carrier saturation
- Case Study: Carrier mobility in advanced CMOS

Module 3: PN Junction and Diode Characteristics

- Depletion region and built-in potential
- Forward and reverse bias behavior
- Zener, Schottky, and tunnel diodes
- Breakdown mechanisms and capacitance
- Case Study: Zener diodes in voltage regulation

Module 4: Bipolar Junction Transistors (BJT)

- Structure and operation modes
- Ebers-Moll model and charge control
- Small signal analysis
- BJT fabrication steps
- Case Study: BJT vs CMOS in analog ICs

Module 5: MOSFET Device Physics

- MOS capacitor fundamentals
- Threshold voltage and channel formation
- Scaling and short channel effects
- Subthreshold conduction and leakage
- Case Study: NMOS vs PMOS in logic gates

Module 6: CMOS Technology and Fabrication Flow

- CMOS inverter and logic design
- Twin-well and LOCOS isolation
- Self-aligned gates and silicide processes
- Latch-up prevention and layout rules
- Case Study: CMOS scaling from 65nm to 5nm

Module 7: Oxidation and Thin Film Deposition

- Thermal oxidation and dry/wet growth
- CVD (LPCVD, PECVD) and PVD techniques
- Epitaxy for single crystal growth
- Film thickness control and measurement
- Case Study: Gate oxide reliability in MOS

Module 8: Lithography and Patterning

- Photolithography process flow
- Photoresists, masks, and aligners
- Resolution limits and EUV lithography
- Etch processes: dry vs wet
- Case Study: Patterning at 7nm node

Module 9: Doping and Junction Formation

- Ion implantation and diffusion
- Annealing and activation
- Doping profiles and sheet resistance
- SIMS characterization
- Case Study: Halo implants in modern transistors

Module 10: Etching and Cleaning Techniques

- Reactive Ion Etching (RIE) and DRIE
- Isotropic vs anisotropic etching
- Post-etch cleaning and damage removal
- Selectivity and endpoint detection
- Case Study: Via etching in DRAM

Module 11: Process Integration and Yield Engineering

- Process control and parameter interactions
- Integration of front-end and back-end steps
- Yield calculation and enhancement techniques
- Design for manufacturability (DFM)
- Case Study: Yield loss in sub-20nm technologies

Module 12: Reliability and Failure Mechanisms

- Time-Dependent Dielectric Breakdown (TDDB)
- Hot Carrier Injection (HCI)
- Electromigration and ESD
- Burn-in and life testing
- Case Study: Failure analysis of FinFET devices

Module 13: Wide Bandgap and Emerging Materials

- GaN and SiC properties and applications
- 2D materials: MoS2, graphene
- Thermal management in high-power devices
- Defect and dislocation control

- Case Study: SiC in EV power modules

Module 14: FinFET and Advanced Transistor Structures

- Tri-gate and nanowire transistors
- Process flow and challenges
- Quantum tunneling and leakage control
- Device modeling considerations
- Case Study: Intel 14nm FinFET design

Module 15: TCAD Simulation and Process Modeling

- Introduction to Synopsys Sentaurus/Silvaco Atlas
- Process simulation (oxidation, diffusion)
- Device simulation (IV, CV, breakdown)
- Calibration and parameter extraction
- Case Study: TCAD modeling of a CMOS inverter

Training Methodology

This course employs a participatory and hands-on approach to ensure practical learning, including:

- Interactive lectures and presentations.
- Group discussions and brainstorming sessions.
- Hands-on exercises using real-world datasets.
- Role-playing and scenario-based simulations.
- Analysis of case studies to bridge theory and practice.
- Peer-to-peer learning and networking.
- Expert-led Q&A sessions.
- Continuous feedback and personalized guidance.

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call *+254769199797*

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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