



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Electronics And Communication (VLSI Design)

Subject Code: ME02096011

Subject Name: Multi Gate Transistors Modelling

WEF Academic Year	2025-26
Semester	02
Category of the Course	PCC

Prerequisite:	Physics of MOS transistor
Rationale:	Alternative devices are required to study due to the CMOS's scaling limits and 'end-of-roadmap' for semiconductor chips. It is required to study physics, technology and circuit applications of advanced transistor devices as the alternative of MOSFET and planar-CMOS. In this course, the students will learn concepts of multi-gate MOS transistor, FinFETs device technology, large and small geometries of FinFETs, and various performance effects of FinFETs.

Course Outcome:

After completion of the Course, Students will be able to:

No	Course Outcomes	RBT Level*
01	Appreciate the need of multigate transistors.	UN
02	Model multi-gate MOS capacitor.	AP
03	Analyze fabrication of FinFET device.	AN
04	Model FinFET device current and other small-geometry effects.	AP
05	Analyse leakage currents in FinFET device.	AN

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Course Scheme:

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Practical		
				ESE (E)	PA(M)	ESE (V)	PA (I)	
03	00	02	04	70	30	30	20	150



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Course Content:

U. No	Course Content	No of Hours	% weightage
1	Introduction: Fin Field-Effect transistor, overview of MOSFET devices for integrated circuit manufacturing, alternative device concepts, FinFET devices for VLSI circuits and systems, history of FinFET devices.	02	05
2	Multiple-Gate Metal-Oxide-Semiconductor (MOS) System: Introduction, multigate MOS capacitors at equilibrium, oxide charges, MOS capacitors under applied bias, multigate MOS capacitor systems: mathematical analysis, quantum mechanical effect.	06	15
3	Overview of FinFET Device Technology: Introduction, FinFET manufacturing technology, Bulk-FinFET fabrication, SOI-FinFET process flow.	06	15
4	Large Geometry FinFET Device Operation: Introduction, basic features of FinFET devices, FinFET device operation, drain current formulation.	12	25
5	Small Geometry FinFETs: Physical Effects on Device Performance: Introduction, short-channel effects on threshold voltage, quantum mechanical effects, surface mobility, high field effects, output resistances.	08	20
6	Leakage Currents in FinFETs: Introduction, sub-threshold leakage currents, gate-induced drain and source leakage currents, Impact ionization current, source-drain pn-junction leakage current, gate oxide tunneling leakage currents.	08	20
		42	100

Reference Book:

- Samar K. Saha, FinFET Devices for VLSI Circuits and Systems, CRC Press, 1st Edition, 2021
- Jean-Pierre Colinge, FinFETS and Other Multi-Gate Transistors, Springer, 2008

Suggested Course Practical List:

- The practical work will be carried out based on the content covered during the academic sessions.

List of Laboratory/Learning Resources Required:

- List of Hardware: FPGA Boards



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- List of Software/Open Source Tools/Simulator: Cadence, Synopsis, ANSYS EDA Tools
- List of Useful websites/MOOCs
- Course-related online MOOCs on NPTEL/SWAYAM platform
- Recent publications in reputed journal/conferences
