Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC702	**IC Technology**	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
EXC702	**IC Technology**	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXC302: Electronic Devices
- EXC303: Digital Circuits and Design
- EXC402: Discrete Electronic Circuits
- EXC502: Design With Linear Integrated Circuits
- EXC601: VLSI Design

Course Objectives:

1. To teach fundamental principles of fabrication of VLSI devices and circuits
2. To disseminate knowledge about novel VLSI devices

Course Outcomes:

After successful completion of the course student will be able to

1. demonstrate a clear understanding of CMOS fabrication flow and technology scaling
2. demonstrate a clear understanding of various MOS fabrication processes, semiconductor measurements, packaging, testing and advanced semiconductor technologies
3. discuss physical mechanism in novel devices
4. verify processes and device characteristics via simulations

Module No.	Unit No.	Topics	Hrs.
1. 0		**Environment and Crystal Growth for VLSI Technology**	8
	1.1	**Environment:** Semiconductor technology trend, Clean rooms, Wafer cleaning	
	1.2	**Semiconductor Substrate:** Phase diagram and solid solubility, Crystal structure, Crystal defects, Czochralski growth, Bridgman growth of GaAs, Float Zone growth, Wafer Preparation and specifications	
2.0		**Fabrication Processes Part 1**	10
	2.1	**Deposition:** Evaporation, Sputtering and Chemical Vapor Deposition	
	2.2	**Epitaxy:** Molecular Beam Epitaxy, Vapor Phase Epitaxy, Liquid Phase Epitaxy, Evaluation of epitaxial layers	
	2.3	**Silicon Oxidation:** Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality, high κ and low κ dielectrics	
	2.4	**Diffusion:** Nature of diffusion, Diffusion in a concentration gradient, diffusion equation, impurity behavior, diffusion systems, problems in diffusion, evaluation of diffused layers	
	2.5	**Ion Implantation:** Penetration range, ion implantation systems, process considerations, implantation damage and annealing	
3.0		**Fabrication Processess Part 2**	10
	3.1	**Etching:** Wet chemical etching, dry physical etching, dry chemical etching, reactive ion etching, ion beam techniques	
	3.2	**Lithography:** Photoreactive materials, Pattern generation and mask making, pattern transfer, Electron beam, Ion beam and X-ray lithography	
	3.3	**Device Isolation, Contacts and Metallization:** Junction and oxide isolation, LOCOS, trench isolation, Schottky contacts, Ohmic contacts, Metallization and Packaging	
	3.4	**CMOS Process Flow:** N well, P-well and Twin tub	
	3.5	Design rules, Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact	
4.0		**Measurements, Packaging and Testing**	10
	4.1	**Semiconductor Measurements:** Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility, Minority Carrier Lifetime and diffusion length	
	4.2	**Packaging:** Integrated circuit packages, Electronics package reliability	
	4.3	**Testing:** Technology trends affecting testing, VLSI testing process and test equipment, test economics and product quality	
5.0		**SOI, GaAs and Bipolar Technologies**	08
	5.1	**SOI Technology:** SOI fabrication using SIMOX, Bonded SOI and Smart Cut, PD SOI and FD SOI Device structure and their features	
	5.2	**GaAs Technologies:** MESFET Technology, Digital Technologies, MMIC technologies, MODFET and Optoelectronic Devices	
	5.3	**Silicon Bipolar Technologies:** Second order effects in bipolar transistor, Performance of BJT, Bipolar processes and BiCMOS	
6.0		**Novel Devices**	06
	6.1	**Multigate Device:** Various multigate device configurations (device structure and important features)	
	6.2	**Nanowire:** Fabrication and applications	
	6.3	**Graphene Device:** Carbon nanotube transistor fabrication, CNT applications	
		Total	52

Recommended Books:

1. James D. Plummer, Michael D. Deal and Peter B. Griffin, "*Silicon VLSI Technology*", Pearson, Indian Edition.
2. Stephen A. Campbell, "*The Science and Engineering of Microelectronic Fabrication"*, Oxford University Press, 2nd Edition.
3. Sorab K. Gandhi, "*VLSI Fabrication Principles*", Wiley, Student Edition.
4. G. S. May and S. M. Sze, "*Fundamentals of Semiconductor Fabrication*", Wiley, First Edition.
5. Kerry Bernstein and N. J. Rohrer, "*SOI Circuit Design Concepts",* Kluwer Academic Publishers, 1st edition.
6. Jean-Pierre Colinge, "*FinFETs and Other Multigate Transistors",* Springer, 1st edition
7. M. S. Tyagi, "*Introduction to Semiconductor Materials and Devices*", John Wiley and Sons, 1st edition.
8. James E. Morris and Krzysztol Iniewski, "*Nanoelectronic Device Applications Handbook*", CRC Press
9. Glenn R. Blackwell, "*The electronic packaging*", CRC Press
10. Michael L. Bushnell and Vishwani D. Agrawal, "*Essentials of Electronic Testing for digital, memory and mixed-signal VLSI circuits*", Springer

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be selected from all the modules.