
Indian Institute of Technology Jodhpur



॥ त्वं ज्ञानमयो विज्ञानमयोऽसि ॥

M. Tech. Program in Intelligent VLSI Systems

**Curriculum Structure
for AY 2023-24 Onwards**

Introduction

The proposed M.Tech program in Intelligent VLSI Systems is designed to provide training to graduate students with the state of the art knowledge in the domain of VLSI Systems, including semiconductor fundamentals, emerging devices and compact modelling, advanced circuits and systems, system on chip design, signal processing, on-chip machine learning algorithms, VLSI for communication and others. The proposed M. Tech programme for Intelligent VLSI Systems of IIT Jodhpur includes state of the art analog and digital VLSI circuits and systems, mixed signal circuits, testing and verification algorithms, issues with system integration for performance considerations, covering wide aspects of embedded and computing systems, and emerging applications. It will cover a wide aspect of fundamentals, design skills, hands on through experiential learning consisting of lab exercises, assignments, case studies and current trends in the semiconductor industry.

Objectives

Main objective of this program is to train students by imparting them skills related to the current era of VLSI systems with a deeper understanding of its various components: from devices to hardware design. By imparting extensive knowledge and research experience, the program focuses on novel approaches to processing and computation for energy- and memory-efficient hardware. With the availability of massive data acquisition and data processing, the current research and trend in future computing systems is oriented towards memory-driven and edge computing AI architectures.

The graduates will eventually be contributing to all-encompassing areas of Intelligent VLSI Systems which include emerging semiconductor devices and modelling, analog & mixed-signal circuits, RF integrated circuits (ICs), ASIC and SoC Design, embedded intelligence, self-adaptive systems, flexible electronics, neuromorphic computing, hardware for AI, state of the art non-volatile memories, machine learning, 5G communication, Internet of things (IoT) and others. The course will rigorously train the graduate students so as to enable them to take up new challenges and solve the problems in the domain of the current and future VLSI systems. The knowledge of theoretical concepts with in depth analysis and understanding of practical design issues will make their understanding more refined and result oriented in the areas of next generation VLSI systems.

Various state of the art computational facilities are available in the institute like NVIDIA DGX2 which will help the candidates to learn high performance computing, to implement machine learning algorithms and learn the concepts of data analysis. The students will have access to various design/EDA tools like Cadence Virtuoso, Mentor Graphics, Synopsys tool suite etc.

The objectives of this program are summarised as follows:

- Insight of semiconductor device physics, modelling and fabrication.
- Theoretical as well as practical knowledge of circuits and systems
- System Design issues and challenges
- Embedded Intelligence
- Machine learning algorithms, signal processing and data acquisition

- Algorithm level and architectural level optimization and implementation
- State-of-the art system design methodologies as well as current trends in the semiconductor industry
- Brain-Inspired Technologies
- Novel approaches to processing and computation for energy and memory-efficient hardware
- Development of testing and verification skills through state of the art algorithms
- Exposure to layout, floorplanning, placement and routing techniques
- High speed system design issues and performance considerations

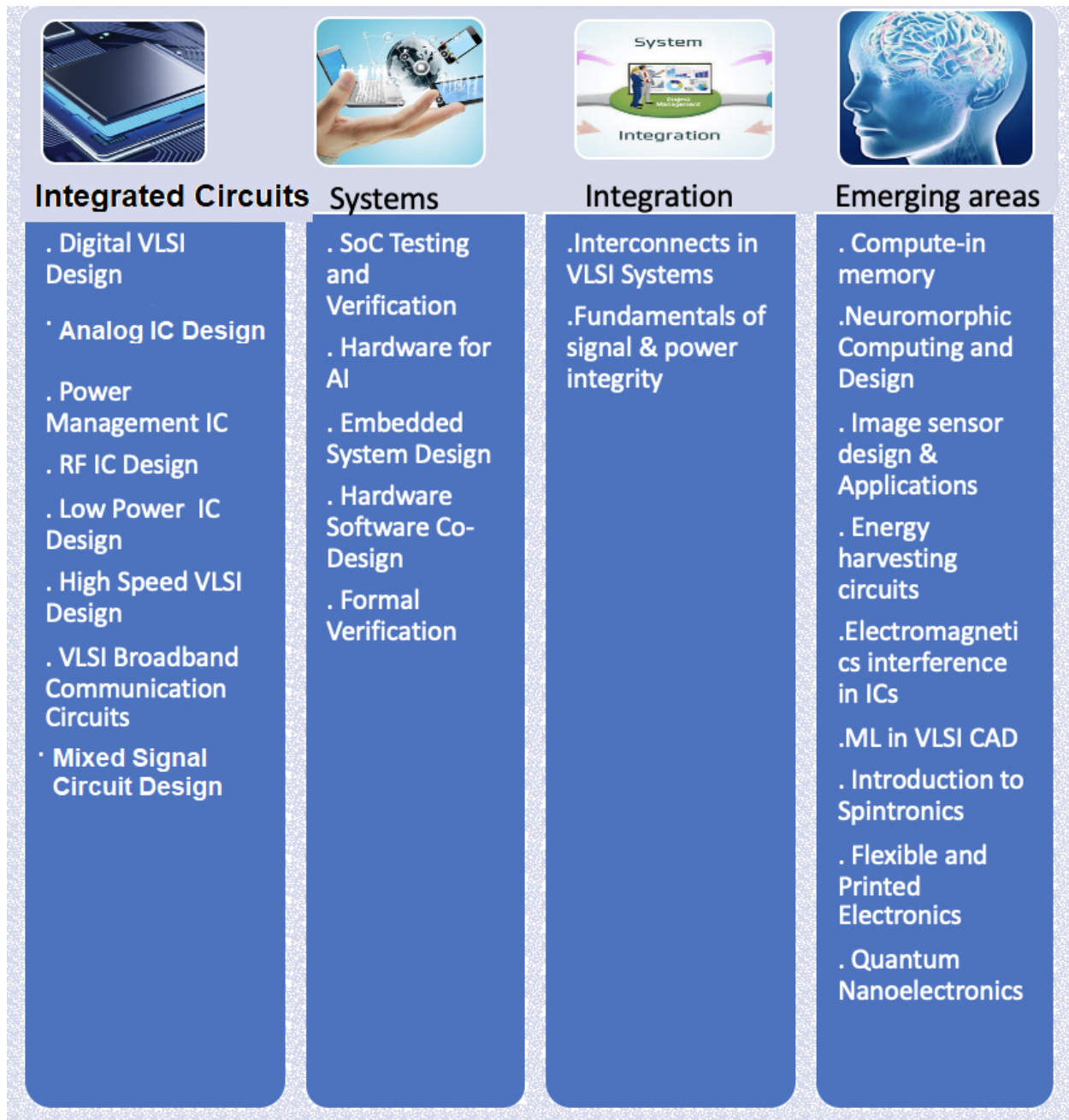
Graduate attributes

- Ability to follow a multidisciplinary approach for design and implementation of systems, involving various domains of Engineering, and Sciences.
- To learn top-to-bottom approach for IC design
- Exposure to computing for embedded intelligent systems
- To learn machine learning tool and its application in domains like VLSI for signal processing and communication
- To apply the skills and course aspects directly in the profession
- Exposure to design issues and challenges in ASIC and SoC Design
- Exposure to system level integration and challenges including packaging and PCB related issues

Learning outcomes

- Ability to design digital, analog, mixed signal circuits
- Knowledge of ASIC flow for IC fabrication and tape out
- Exposure to state-of-the-art compact models, process and IC fabrication technology
- Implementation of intelligence in traditional VLSI systems/architectures
- Knowledge of VLSI design flow covering both front end and back end.
- Knowledge of programming, algorithms and system development techniques
- Knowledge of state of the art non-volatile memories
- Able to design and implement algorithms for optimising hardware
- Knowledge of complete system integration and challenges associated with high speed designs

Topic Clouds and Course Mapping



Program Structure for M.Tech Intelligent VLSI Systems (IVS)

Overall Program Structure

Category	<i>M. Tech. Core (MC)</i>	<i>M. Tech. Elective (ME)</i>	<i>M. Tech. Open (MO)</i>	<i>M. Tech. Project (MP)</i>	Non-graded (NG)	Total
Credits	20	16	6	16	4	62

Semester wise distribution of credits

Cat.	Course Title	L-T-P	C	Cat.	Course Title	L-T-P	C
I Semester				II Semester			
MC	Digital VLSI Design	3-0-0	3	MC	Hardware Design for Artificial Intelligence	3-0-0	3
MC	Digital ASIC Design lab	0-0-2	1	MC	Mixed Signal Circuit Design	3-0-0	3
MC	Physics and Modelling of MOS Transistors	3-0-0	3	MC	SoC Testing and Verification	3-0-0	3
MC	Analog IC Design	3-0-2	4				
ME	Program Elective(s)		3	ME	Program Elective(s)		6
NG	Technical Communication	1-0-0	1	NG	Innovation and IP Management	1-0-0	1
Total			15	Total			16
III Semester				IV Semester			
MP	Project-1	0-0-12	6	MP	Project-2	0-0-20	10
ME	Program Elective(s)		5	MO	Open Elective-2	3-0-0	3
MO	Open Elective-1	3-0-0	3	ME	Program Elective(s)		2
NG	System Engineering and Project Management	1-0-0	1	NG	Professional Ethics	1-0-0	1
Total			15	Total			16

List of Program Electives

Course Title	L-T-P	Credits	Course Title	L-T-P	Credits
<i>VLSI Broadband Communication Circuits</i>	3-0-0	3	<i>High Speed Interfaces</i>	2-0-0	2
<i>Semiconductor Reliability</i>	3-0-0	3	<i>Network-on-Chip</i>	2-0-0	2
<i>Hardware-Software Co-design</i>	3-0-2	4	<i>Machine Learning for Device Modeling</i>	1-0-2	2
<i>Sensors and Measurement</i>	3-0-0	3	<i>RF IC Design</i>	1-0-2	2
<i>Neuromorphic Computing and Design</i>	3-0-0	3	<i>Formal Verification</i>	2-0-0	2
<i>Integrated Circuit Technology</i>	3-0-0	3	<i>Signal and Power Integrity</i>	3-0-0	3
<i>ML in VLSI CAD</i>	3-0-0	3	<i>Processor Design</i>	3-0-0	3
<i>High Level Synthesis</i>	3-0-0	3	<i>Introduction to Spintronics</i>	3-0-3	3
<i>Embedded System Design</i>	3-0-0	3	<i>Low Power IC Design</i>	2-0-0	2
<i>Machine Learning 1</i>	3-0-0	3	<i>Power Management IC</i>	2-0-0	2
<i>Deep Learning</i>	3-0-0	3	<i>Non-Volatile Memory Technologies</i>	2-0-0	2
<i>Nanosensors</i>	3-0-0	3	<i>In-memory Computing</i>	2-0-0	2
<i>Variability Analysis of Integrated Circuits</i>	1-0-0	1	<i>Optimization in VLSI Systems</i>	2-0-0	2
<i>Resource Constrained AI</i>	3-0-0	3	<i>Flexible and Printed Electronics</i>	3-0-0	3
<i>Electromagnetic Interference in ICs</i>	1-0-0	1	<i>Quantum Nanoelectronics</i>	3-0-0	3
<i>IC Fabrication lab</i>	0-0-2	1	<i>Machine Learning for Communication</i>	3-0-0	3