Course Title: Introduction to VLSI Circuits
Credit Structure (L-T-P-Cr): (3-0-2-4)
Prerequisites (if any)/Desired Skill Set: Basic Electronics
Course Code: EL421
Semester: Autumn, 2020
Instructor: Prof. Tapas Kumar Maiti

Course Objective: The goal of this course is to give the students an understanding and practical implementation of different VLSI circuits, required to carry out the complete design of modern Chips, such as AI/ML ICs, CPU/GPU processor, etc. The students will acquire key concepts and skills to become a good AI/ML IC designers.

Course Content: This course is an introduction to VLSI with focuses on AI/ML architectures and circuits. It will start with VLSI devices where MOS transistor functioned as core, basic logic and memory circuits. The course consists of three parts: (i) online class lectures, (ii) online practical exercises using software tools, and (iii) online project. The course will cover following topics.

Online Class Lecture: Google Meet complemented with Google Classroom
1. Introduction to VLSI
   ▪ VLSI Market and Trends ▪ Modern Processors ▪ VLSI Design Methodologies
2. Basic of MOS Transistors
   ▪ Semiconductor Device Physics ▪ CMOS Transistor
3. Logic Design with CMOS Transistor
   ▪ Static and Dynamic CMOS Logic ▪ Combinational and Sequential Logic Circuits
4. Memory Elements and Arrays
   ▪ Latches ▪ Registers ▪ Random-Access Memory (RAM) ▪ SRAM ▪ DRAM
5. Arithmetic Circuits in VLSI
   ▪ Full-Adder ▪ Half-Adder ▪ Adder Circuits ▪ Subtractor Logic Circuits ▪ Multiplication Circuits
6. Basic of AI/ML Architecture
   ▪ Nearest Neighbors Search ▪ SVM Classification ▪ Neural Network Architecture
7. Processor Design
   ▪ Introduction to TinyCPU ▪ VLSI Aspects of Computer Architecture ▪ Concept of Parallel Computing ▪ VLSI Sub-blocks of GPU

Lab: Software Based Online
1. Design of Memory System
2. Design of Nearest-Neighborhood Processor
3. Design of Motion Processing Elements (PE’s)

Course Project: VLSI Aspects of High-Performance AI/ML Architecture
Lab Information: VLSI architectures and circuit design shall be carried out with the following software. Please download and install the software on your computer/laptop.

1. VLSI Circuit Simulation Software

2. Intel-FPGA Edition Software for AI/ML Architecture Design
   ModelSim: [https://fpgasoftware.intel.com/?product=modelsim_ae#tabs-2](https://fpgasoftware.intel.com/?product=modelsim_ae#tabs-2)

Suggested Textbook:

Related resources:
Books, journals, conferences, Web sites, simulators, etc.

Course Evaluation Policy:
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<td>II In-Semester Examination</td>
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<td>End-Semester Examination</td>
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