Advanced Digital System Design
Course Code: EE823

Course Description

The course provides an in-depth coverage of systematic development, simulation, and synthesis of advanced Digital System Design with emphasis on FPGA (Field Programmable Gate Array) technology. FPGA-based digital design using VHDL or Verilog is fundamental for many engineering applications. In this course, the students will study digital design, Verilog, VLSI, and FPGA, and get exposure to the complete hardware design flow, Verilog programming and hands-on experiences in FPGA design and debugging. The course focuses on understanding and applying techniques for modelling complex digital systems at different levels of abstraction.

Text Book:

1. Advanced Digital System Design, A Practical Guide to Verilog Based FPGA and ASIC Implementation. By: Shirshendu Roy, Springer 2024.
2. Introduction to Digital Systems Design by Giuliano Donzellini, Domenico Ponta, Luca Oneto, Davide Anguita, Springer, 2019.

Reference Book:

1. Digital Design of Signal Processing Systems, A Practical Approach By: Shoab Ahmed Khan, Springer 2011.

ASSESSMENT SYSTEM

Quizzes	10%
Research Project/Labs	20%
Mid Terms	30%
ESE	40%

Teaching Plan

Week No	Topics / Learning Outcomes
1	Introduction to Digital System Design High-Level Design Methodology Boolean logic
2	Logic Optimization Hardware Description language (Verilog) Verilog Operators
3	Procedural Statements Blocking and Non-Blocking Coding Understanding the Simulation Cycle
4	Functions and Tasks Synthesis Process RTL for Synthesis

5	Finite State Machines Avoiding Simulation Mismatches Coding and Synthesizing an Example Verilog Design
6	Using Verification Constructs Generating Test Stimulus Developing a Testbench
7	Example Verilog Testbench
8	FPGA Architecture Static Timing Analysis Third-party IP Integration
9	**Mid Semester Exams**
10	Floating Point Implementation in FPGAs Fixed Point Implementation in FPGAs Architectural optimization in FPGAs
11	Pipelining Time-Shared Architecture Parallel Processing
12	Design Space Exploration (Area, Power, and Performance)
13	Arithmetic Adders Arithmetic Multipliers Arithmetic Dividers
14	1553 Bus Protocol AXI Protocol SoC Design Methodologies
15	Hardware Accelerators Approximate Computing for Error-Tolerant Applications
16	High-Level Synthesis Emerging Topics in Digital System Design
17	Research Project Presentations
18	**End Semester Exams**