COURSE CODE: EEE 3131
COURSE TITLE: DIGITAL ELECTRONICS

Rationale
With general advancement in engineering, most electronic systems have become more compact and efficient in terms of resource utilization and processing speeds. All this has been made possible by the shift towards digital electronics. With this, circuits have become smaller, more power efficient, able to multi-task etc. This builds up on the analog electronics covered in earlier courses and transitions into the digital realm. It starts from number systems and finally ends with application of digital electronics in microprocessor systems, the main component in everyday systems.

Aim
The aim of this course is to provide the Electrical and Electronic Engineering students with a comprehensive understanding of how to design, analyse, and practically implement sequential digital electronic circuits

Objectives
At the end of the course the student should be able to:
1. Express signed binary numbers in sign-magnitude, 1's complement, 2's complement, and floating-point format.
2. Convert between the binary and hexadecimal, octal number systems and Gray form.
3. Construct timing diagrams, discuss the basic concepts of programming logic and write a VHDL program for simple logic.
4. Explain how the different series within the major IC technologies-CMOS and TTL families differ from each other.
5. Apply Boolean algebra, the karnaugh map method, and VHDL to a system application.
6. Explain how S-R, D, and J-K flip-flops differ. Apply flip-flop in basic applications. Use shift register in a system application.
7. Design a state machine from its state diagram or transition table.
8. Define and understand propagations delays, set-up time, hold time, maximum operating frequency, minimum clock pulse widths, power dissipation, speed-power product, and fan-out in relation to logic gates and flip-flops.
9. Discuss the characteristics, the difference of the various types of memories. Apply memory device in a system application.
10. Design, build, test, analyse, identify glitches, common bugs and simulate logical combination circuits and sequential circuits.

Course Outline
Introductory Digital Concepts.
Digital and Analog Quantities. Binary Digits, Logic Levels, and Digital Waveforms. Introduction to Logic Operations. Basic Overview of Logic Functions. Fixed-Function Integrated Circuits. Circuit Design Using Programmable Logic Basics: VHDL/Verolog.

Number Systems, Operations, and Code:
Decimal Numbers. Binary Numbers. Decimal-to-Binary Conversion. Binary Arithmetic. 1s and 2s Complements of Binary Numbers. Signed Numbers. Arithmetic Operations with Signed Numbers. Hexadecimal Numbers. Octal Numbers. Binary Coded Decimal (BCD). Digital Codes and Parity. Numeric Values in VHDL.

Logic Fundamentals:
.Logic Gates. . Fixed-Function Logic: IC Gates. Laws and Rules of Boolean Algebra.. Boolean Analysis of Logic Circuits. Simplification Using Boolean Algebra. Boolean Expressions and Truth Tables. The Karnaugh Map. Karnaugh Map SOP Minimization. Karnaugh Map POS Minimization. Boolean Expressions with VHDL. Digital System Application.

Combinational Logic Circuits and Logic functions:
Basic Combinational Logic Circuits. Implementing Combinational Logic. The Universal Property of NAND and NOR Gates. Combinational Logic Using NAND and NOR Gates. Logic Operation with Pulse Waveform Inputs . Binary adders/ subtractors. Comparators. Encoders/Multiplexers. Decoders/Demultiplexers. Code Converters, A/D and D/A Converters. Parity Generators/Checkers. Design examples using HDL.

Synchronous Sequential/ Asynchronous Logic Circuits:
S-R latch, clocked S-R flip flop, level and edge triggering. Master-slave, propagation delay, ac coupled, and capacitive storage 'edge' triggering techniques in flip flops. J-K, T, and D type flip flops. Timers and Counters. Serial/Parallel in/out Shift Registers. Truth tables and Excitations Tables; State Diagrams and State Transitions Tables; State Machines; State Reduction, Races, Hazards. Shift Registers Using VHDL. Digital System Application.

Memory and Storage :
Basics of Semiconductor Memory. Random-Access Memories (RAMs). Read-Only Memories (ROMs). Programmable ROMs (PROMs and EPROMs); PLAs . Flash Memories. Memory Expansion. Magnetic and Optical Storage. Design examples using HDL.

Integrated Circuit Technologies :.
Basic Operational Characteristics and Parameters. CMOS Circuits. TTL Circuits. Practical Considerations in the Use of TTL. Comparison of CMOS and TTL Performance. Emitter-Coupled Logic (ECL) Circuits. Application-Specific integrated Circuits (ASICs), PMOS, NMOS, and E2CMOS.

Introduction to Microprocessors, Computers, and Buses :
The Microprocessor and the Computer. Historical Review of Microprocessor Families. The 8086/8088 Microprocessor and Software Model for the Pentium Processor. Microprocessor Programming. The Central Processing Unit (CPU). The Memory. The Input/Output (I/O) Port. Interrupts. Direct Memory Access (DMA). Internal System Interfacing. Standard Buses.

Prerequisites
EEE 3571

Time Allocation
Lectures 4 hours/ week
Laboratory/Tutorials 3 hours/week

Assessment
Assignments 5 %
Laboratory 15 %
Tests 20 %
Examination 60 %

Prescribed Books:
[1] William Kleitz, 2006, Digital Electronics: A Practical Approach with VHDL, Prentice Hall ISBN-100131714902

[2] Thomas L. Floyd, 2006, Digital Fundamentals with PLD Programming, Prentice Hall ISBN-10: 0131701886.

Recommended Books

[3] Aldec, Inc. 2006, Active-HDL 6.3 Student Edition, Prentice Hall ISBN-10: 0131866974

[4] Alan C. Diixon, JamesL. Antonakos, 2000, A Practical Approach To Digital Electronics, Prentice Hall ISBN-10: 0137275 951.