



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

DIGITAL SYSTEM DESIGN LABORATORY								
III Semester: ECE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P		C	CIA	SEE
AECD07	Core	-	-	2	1	40	60	100
		Contact Classes: Nil		Tutorial Classes: Nil		Practical Classes: 45		Total Classes: 45
Prerequisite:								

I. COURSE OVERVIEW:

The digital system design laboratory introduces the hardware description language for the design and development of digital integrated circuits and field programmable devices. It provides VHDL language elements, synthesizable register transfer logic models in structural, dataflow, behavioral modeling of combinational and sequential circuits. Includes applications in the area of VLSI system design.

II. COURSES OBJECTIVES:

The students will try to learn

- I. The fundamental principles of the VHDL and its constructs used in design implementation of digital logic systems.
- II. The concepts of behavioral, dataflow and structural modeling of fundamental digital logic circuits using VHDL.
- III. The exposure to various stages of a typical state of the art CAD VLSI tool for simulation, synthesis, place and route, layout and power and clock routing module.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

- CO 1 Utilize the concept of Boolean algebra to verify the truth table of Boolean expressions using logic gates in Hardware Description Language.
- CO 2 Make use of dataflow, structural and behavioral modelling styles of HDL for simulating the combinational logic circuits.
- CO 3 Analyze the truth tables and characteristic equations of flip flops for the functional simulation and timing analysis of sequential circuits.
- CO 4 Construct the synchronous and asynchronous sequential circuits using the flip flops.
- CO 5 Model a finite state machine with mealy and moore machines a finite state machine with mealy and moore machines for detecting a given sequence.
- CO 6 Examine the functionality of real time traffic light controller, chess clock controller FSM, elevator operations using HDL code.

IV. LIST OF EXPERIMENTS:

WEEK-1: GETTING STARTED EXERCISES

To be proficient in VHDL programming, you need to be able to operate on basic gates:

- 1 Basic gates realization.
- 2 Realization of AND-OR-INVERT, OR-AND-INVERT LOGIC.
- 3 Realization of Product of Sum (POS) Boolean expression.
- 4 Realization of Sum of Product (SOP) Boolean expression.
- 5 Implementation of code conversions (gray to Boolean, Boolean to gray code).

WEEK-2: EXERCISES ON GATE REALIZATION

To be skillful in VHDL programming, you need to be able to realize Boolean expressions using gates

- 1 Basic gates realization using NAND gate.
- 2 Basic gates realization using NOR gate.
- 3 XOR, XNOR gates realization using minimum number of NAND gates.
- 4 Three input NAND gate using min no of 2 input NAND Gate.
- 5 User defined logic gate.

WEEK-3: EXERCISES ON MULTIPLEXERS AND DEMULTIPLEXERS

To be proficient in programming, you need implement the following data selector circuits:

- 1 Implementation of 2x1, 4x1 multiplexers, demultiplexers.
- 2 Realization of higher order multiplexers using lower order multiplexers.
- 3 Realization of basic gates using 2x1 multiplexer.

WEEK-4: EXERCISES ON DECODERS

To be proficient in programming, you need implement the following digital circuits

- 1 Implementation of 2 to 4 and 3 to 8 decoders.
- 2 Realization of higher order decoders using lower order decoders.
- 3 Develop a functional model of a BCD-to-seven-segment decoder for a light emitting diode (LED) display.

WEEK-5: EXERCISES ON ENCODERS AND PRIORITY ENCODERS

To be proficient in programming, you need implement the following digital circuits

- 1 Implementation of 4 to 2 encoders.
- 2 Implementation of 8 to 3 encoders.
- 3 Build 8 to 3 priority encoder.
- 4 Realization of 8 to 3 priority encoder using 2x1 multiplexer.

WEEK -6: EXERCISES ON ADDERS AND SUBTRACTORS

To be proficient in programming, you need implement the following digital circuits

- 1 Implementation of half adder.
- 2 Implementation of full adder.
- 3 Realization of full adder using half adder.
- 4 Design and implement 4-bit ripple carry adder.
- 5 Implementation of half subtractor.
- 6 Implementation of full subtractor.
- 7 Realization of full subtractor using half subtractor.
- 8 Realization of full subtractor using full adder.

WEEK -7: EXERCISES ON BARREL SHIFTER AND ALU

To be proficient in programming, you need implement the following digital circuits

- 1 Design a 4- bit barrel shifter with four select lines for supporting 16- functionalities.
- 2 Implementation 8-bit ALU to perform the arithmetic, logical operations.

WEEK -8: EXERCISES ON LATCHES AND FLIP-FLOPS.

To be proficient in programming, you need implement the following sequential logic circuits

- 1 Implementation of SR latch, JK latch, D latch and T latch.
- 2 Implementation of JK flip-flop, D flip-flop and T flip-flop.
- 3 Realization of D flip-flop using D latch.
- 4 Realization of D flip-flop using JK flip-flop.
- 5 Realization of T flip-flop using JK flip-flop.
- 6 Realization of T flip-flop using D flip-flop.

WEEK -9: EXERCISES ON COUNTERS AND SHIFT REGISTERS

To be proficient in programming, you need implement the following sequential logic circuits

- 1 4-bit synchronous counter with synchronous reset
- 2 Decade counter
- 3 4-bit serial in serial out shift register (SISO)

WEEK -10: EXERCISES ON FINITE STATE MACHINE

To be proficient in programming, you need implement the following finite state machines

- 1 Design 4-bit sequence detector with finite state machine
- 2 Design 5-bit sequence detector with finite state machine

WEEK -11: EXERCISES ON CASE STUDY: PSEUDO RANDOM GENERATOR

To be proficient in programming, you need implement the following finite state machines

- 1 Pseudo random number generator using LFSR
- 2 Pseudo random number generator for CRC logic

WEEK -12: EXERCISES ON CASE STUDY: CARRY-LOOK AHEAD ADDER

Develop a functional model of a 4-bit carry-look-ahead adder.

WEEK -13: EXERCISES ON CASE STUDY: VENDING MACHINE CONTROLLER

Design this circuit using the FSM approach.

WEEK -14: EXERCISES ON CASE STUDY: ROM DESIGN

Write an entity declaration for a lookup table ROM modeled at an abstract level.

V. TEXT BOOKS:

- 1 Hdl Chip Design: A Practical Guide for Designing, Synthesizing & Simulating Asics &Fpgas Using Vhdlor Verilog Douglas J. Smith.
- 2 Design for Embedded Image Processing on FPGAs Donald G. Bailey.
- 3 FPGA Prototyping by VHDL Examples Pong P. Chu.

VI. REFERENCE BOOKS:

- 1 Salivahanan S. Arivazhagan “Digital Circuits and Design”, 2nd edition, 2016.
- 2 M. Morris Mano, “Digital Logic & Computer Design” 1st edition, 2009.

VII. ELECTRONICS RESOURCES:

- 1 <https://www.dsdwebworks.com/resources.php>
- 2 <https://github.com/kevinwlu/dsd>

VIII. MATERIALS ONLINE

- 1 Course template
- 2 Lab Manual