

EE2000: LOGIC CIRCUIT DESIGN

Effective Term

Semester A 2024/25

Part I Course Overview

Course Title

Logic Circuit Design

Subject Code

EE - Electrical Engineering

Course Number

2000

Academic Unit

Electrical Engineering (EE)

College/School

College of Engineering (EG)

Course Duration

One Semester

Credit Units

3

Level

B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

EE1001 Foundations of Digital Techniques (only applicable to EE students)

or

EE1002 Principles of Electrical Engineering (only applicable to ITME students)

Precursors

Nil

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

The aim is to provide students with an understanding of the concepts and design of logic circuits, including (i) various devices, techniques for analyzing and designing combinational circuits and sequential circuits, circuit design and implementation techniques, and (ii) Hardware Description Language (HDL) modelling and synthesis of combinational and synchronous sequential circuit, circuit implementation with FPGA devices. The electrical characteristics of selected logic families are also covered.

Course Intended Learning Outcomes (CILOs)

CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Apply different methods to simplify combinational logic functions and sequential machines		x	
2	Analyze and design combinational and synchronous sequential circuits	x	x	
3	Identify electrical characteristics of different logic families	x	x	
4	Design logic circuit using VHDL Hardware Description Language	x	x	
5	Implement logic circuits with Xilinx FPGA	x	x	
6	Apply basic theories to practical work	x	x	

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

LTAs	Brief Description	CILO No.	Hours/week (if applicable)	
1	Lecture	Explain keys concepts such as binary code, logic circuit, combinational and sequential circuit.	1, 2, 3, 4, 5	3 hours/week
2	Tutorial	Discuss and practice how to use the lecture materials in real implementations through the tutorial questions.	1, 2, 3, 4, 5	1 hour/week

3	Laboratory	Identify, design, and apply the fundamental logic circuits to practical work using Hardware Description Language (VHDL) and Xilinx FPGA chip.	1, 2, 3, 4, 5, 6	3 hours/week for 5 weeks
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Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Tests (min.: 2)	1, 2, 3, 4, 6	25	
2	#Assignments (min.: 3)	1, 2, 3, 4, 6	10	
3	Lab Exercises/Reports	1, 2, 3, 4, 5, 6	15	

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

Remark:

To pass the course, students are required to achieve at least 30% in course work and 30% in the examination. Also, 75% laboratory attendance rate must be obtained.

may include homework, tutorial exercise, project/mini-project, presentation

Assessment Rubrics (AR)**Assessment Task**

Examination

Criterion

Achievements in CILOs

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Assessment Task

Coursework

Criterion

Achievements in CILOs

Excellent (A+, A, A-)

High

Good (B+, B, B-)

Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

Revision of Boolean algebra

Boolean algebra and switching functions; minterm and maxterm canonical forms; sum of products and products of sums; don't care conditions; minimization of Boolean algebra.

Combinational Logic Circuit Design

Minimization by Karnaugh map and Quine-McCluskey method; circuit designs; timing parameters and circuit hazards.

Circuit Design with Functional Blocks

Carry Look Ahead adder; comparators; decoders and encoders; multiplexers and demultiplexers.

Introduction to Hardware Description Language (HDL)

Introduction to Hardware Description Language (HDL); logic gates and combinational circuit modelling.

Flip-flops

Latches, RS, JK, D-type, edge-triggered and master-slave flip-flops; triggering and setting; timing parameters; HDL circuit modelling.

Synchronous Sequential Logic Circuit Design

Concept of states; Mealy and Moore Machines; redundant state elimination; sequential digital system analysis and design; HDL sequential circuit modelling.

Registers and Counter

Basic registers and counters; ripple counters and synchronous counters, and their applications; construction of registers and counters; HDL circuit modelling.

Field-Programmable Gate Array

Introduction to Look-up Table (LUT), Generic Array Logic (GAL), Programmable Array logic (PAL), simple programmable logic device, complex programmable logic device (CPLD), Field-Programmable Gate Array (FPGA), Programmable System-on-Chip (SoC).

FPGA Implementation

Combination and synchronous sequential circuit synthesis; datapath component description, debugging and validation.

Logic Families

Introduction to electrical characteristics of TTL and CMOS logic families; transfer characteristics, noise margins; fan-in and fan-out; comparison of families; interfacing between different families.

Reading List**Compulsory Readings**

Title	
1	Nil

Additional Readings

Title	
1	Alan B. Marcovitz: Introduction to Logic Design, Third Edition, ISBN 978-0-07-016490-1 (McGraw-Hill Higher Education 2010).
2	Charles H Roth, Lizy K. John: Digital Systems Design Using VHDL, Fifth Edition, ISBN 978-1-305-63514-2 (Cengage Learning 2016).
3	C V S Rao: Switching Theory & Logic Design, ISBN 81-317-0183-2 (Pearson Education 2006).
4	Victor P. Nelson, H. Troy Nagle, Bill D. Carrol, J. David Irwin: Digital Logic Circuit Analysis and Design, ISBN 0-13-463894-8 (Prentice Hall, International Edition 1995).
5	William J. Dally: Digital design using VHDL: a systems approach, ISBN 978-1107098862, (Cambridge University Press, 2016).