

Tribhuvan University
Institute of Science and Technology
Bachelor of Science in Computer Science and Information Technology

Course Title: Digital Logic
Course No.: CSC111
Nature of the Course: Theory + Lab
Semester: I

Full Marks: 60 + 20 + 20
Pass Marks: 24 + 8 + 8
Credit Hrs: 3

Course Description: This course covers the concepts of digital logic and switching networks. The course includes the fundamental concepts of boolean algebra and its application for circuit analysis, multilevel gates networks, flip-flops, counters logic devices and synchronous and asynchronous sequential logic and digital integrated circuits.

Course Objectives: The main objective of this course is to introduce the basic tools for the design of digital circuits and introducing methods and procedures suitable for a variety of digital design applications.

Course Contents:

Units	Topics	Hours	Remarks
1. Binary systems	1. Digital systems <ul style="list-style-type: none"> Digital and analog system Block diagram of digital computer advantage/disadvantages of digital system 	1	6 hours
	2. Binary Numbers <ul style="list-style-type: none"> Number system (binary, decimal, octal, hexadecimal), importance of number system Number base conversion (binary to decimal, octal & hexadecimal and vice-versa etc.) Complements- r's, (r-1)'s Complement methods of addition/subtraction (r's & (r-1)'s) 	4	
	3. Binary Systems <ul style="list-style-type: none"> BCD codes, error-detection codes, reflected code, alphanumeric codes (ASCII, EBCDIC) 	1	
2. Boolean algebra and Logic Gates	1. Basic definition of Boolean Algebra <ul style="list-style-type: none"> Introduction Common postulates 2. Basic Theory of Boolean Algebra <ul style="list-style-type: none"> Duality theorem Basic theorems De-Morgans theorem 	1	5 hours

	<p>3. Boolean Function</p> <ul style="list-style-type: none"> • Boolean function and truth table • Algebraic manipulation and simplification of Boolean function • Complement of a function • Logic operations and Logic gates • Logic circuit, AND, OR, NOT operation • Logic Gates: Basic gates, universal gates, Ex-OR, Ex-NOR Buffer • Implementation of Boolean function using gates 	1	
	<p>4. Logic operations and Logic gates</p> <ul style="list-style-type: none"> • Logic circuit, AND, OR, NOT operation • Logic gates: Basic gates, Universal gates, Ex-OR, Ex-NOR, Buffer • Implementation of Boolean function using gates 	2	
	<p>5. Integrated Circuits</p> <ul style="list-style-type: none"> • Concept of DIP, SIMM, linear and digital ICs • RTL, TTL, MOS, CMOS, I²L • Positive and Negative Logic • Special Characteristics • Characteristics of IC logic Families 	2	
3. Simplification of Boolean Functions	<p>1. SOP and POS</p> <ul style="list-style-type: none"> • SOP, POS, min-term, max-term, standard and canonical form • Simplification of SOP and POS function using Boolean algebra 	2	5 hours
	<p>2. K-map</p> <ul style="list-style-type: none"> • Importance of k-map • Simplification of SOP and POS form • 2 and 3 variable k-map • 4 variable k-map • Don't care combination 	2	
	<p>3. NAND and NOR implementation</p> <ul style="list-style-type: none"> • NAND and NOR conversion • Rules for NAND and NOR implementation • Implementation of SOP and POS logic expressions using NAND, NOR and basic gates 	1	
4. Combinational Logic	<p>1. Design Procedure</p> <ul style="list-style-type: none"> • Definition of combinational logic circuit • Design procedure • Realization / Implementation 	1	5 hours
	<p>2. Adders/Subtractors</p> <ul style="list-style-type: none"> • Half Adder - definition, truth table, logic diagram, implementation 	1	

	<ul style="list-style-type: none"> • Full Adder - definition, truth table, logic diagram, implementation • Half sub-tractor • Full sub-tractor 		
	3. Code Conversion <ul style="list-style-type: none"> • General Concept • Code conversion – BCD to Excess-3 	1	
	4. Analysis Procedure <ul style="list-style-type: none"> • General concept • Steps in analysis • Obtaining Boolean functions from logic diagram • Obtaining truth table from logic diagram 	1	
	5. NAND, NOR, Ex-OR circuits <ul style="list-style-type: none"> • Concept of multi-level NAND and NOR circuits • Implementation of basic operations using universal gates • Block diagram method of Boolean function implementation • Realization of Ex-OR using basic gates and universal gates • Parity generator, Parity checker 	1	
5. Combinational Logic with MSI and LSI	1. Adders <ul style="list-style-type: none"> • 4-bit parallel binary adder • Decimal Adder – BCD Adder 	1	8 hours
	2. Magnitude Comparator <ul style="list-style-type: none"> • Definition • 4-bit Magnitude Comparator 	2	
	3. Decoder <ul style="list-style-type: none"> • Definition of Encoder and Decoder • 3-to-8 line decoder 		
	4. Multiplexers <ul style="list-style-type: none"> • Meaning of multiplexing and de-multiplexing • 4-to-1 line multiplexer 	1	
	5. Read-Only-Memory (ROM) <ul style="list-style-type: none"> • Types of ROM • Combinational logic implementation of ROM 	1	
	6. Programmable Logic Array (PLA) <ul style="list-style-type: none"> • Difference between ROM and PLA • Block diagram of PLA • PLA Program Table • Implementation of PLA 	1.5	
	7. Programmable Array Logic (PAL) <ul style="list-style-type: none"> • PAL programming table • Circuit design 	1.5	

6. Synchronous and Asynchronous Sequential Logic	1. Flip-Flop <ul style="list-style-type: none"> • Definition of sequential circuit • RS flip-flop, clocked RS FF • D flip-flop, J-K flip-flop, T flip-flop, J-K Master Slave flip-flop 	3	10 hours
	2. Triggering of flip-flop <ul style="list-style-type: none"> • Clock pulse • Positive and negative edge triggering • Clocked J-K FF, edge triggered D FF • Direct inputs 	2	
	3. Design with state equations and state reduction table <ul style="list-style-type: none"> • State table • State diagram • State equation • State reduction and assignment 4. Design procedure <ul style="list-style-type: none"> • Design procedure of sequential circuits 	3	
	5. Introduction to Asynchronous circuits <ul style="list-style-type: none"> • Basic definition • Difference between Synchronous and Asynchronous circuit • State table • State diagram • State equation • Circuits with latches. 	2	
7. Registers and Counters	1. Registers <ul style="list-style-type: none"> • Introduction to register • Shift registers – serial-in serial-out, parallel-in parallel-out, serial-in parallel-out, parallel-in serial-out 	1	6 hours
	2. Ripple Counters <ul style="list-style-type: none"> • Definition of counter, ripple and synchronous counter • Asynchronous counter – BCD ripple counter, Binary ripple counter 3. Synchronous Counters <ul style="list-style-type: none"> • Binary counter • Binary up/down counter • BCD counter 	3	
	4. Timing sequences <ul style="list-style-type: none"> • Word time generation • Timing signals • Johnson's counter 	1	
	5. Memory Unit <ul style="list-style-type: none"> • Introduction to memory unit • Block diagram • Read/Write operation 	1	

	<ul style="list-style-type: none">• Integrated circuit memory		
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Text Books:

1. M. Morris Mano, “Digital Logic & Computer Design”

Reference Books:

1. Brain Holdsworth, “Digital Logic Design”, Elsevier Science.
2. John Patrick Hayes, “Introduction to Digital Logic Design”, Addison-Wesley.
3. M. Morris Mano and Charles Kime, “Logic and Computer Design Fundamentals”, Pearson New International.

Laboratory works:

Introduction to logic gates with IC pin details and verify the truth table using bread board.

1. Use any one simulator to simulate the basic logic circuits functions.
2. Design of half adder, full adder, subtractor using basic logic gates.
3. Study and verification of 3-8 decoder using IC.
4. Study and verification of 8-3 encoder using IC
5. Implementation of 4-1 Mux using IC
6. Implementation of 1-4 DeMux using IC
7. Implementation of 7 Segment Display
8. Verification of Flip flop
9. Design and verification of Up counter/Down counter
10. Design and verification of Shift Register

Required devices:

1. Bread board
2. Multimeters
3. IC's/Logic Gates

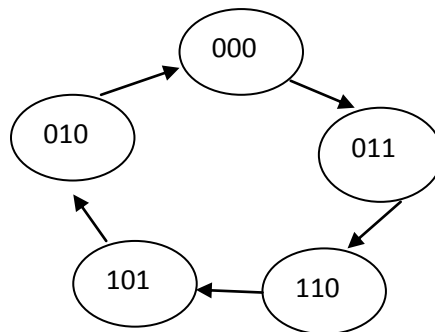
Model Question:

Group A (Long Answer Question Section)

Attempt any TWO questions.

(2x10=20)

1. Implement the following function $F = \Sigma(0,1,3,4,7)$ using
 - a) Decoder
 - b) Multiplexer
 - c) PLA
2. Differentiate between synchronous and asynchronous sequential circuit. Design a counter as shown in the state diagram below



3. Explain different types of shift registers with necessary diagrams.

Group B (Short Answer Question Section)

Attempt any EIGHT questions.

(8x5=40)

4. Convert $(2AC5)_{16}$ to decimal, octal and binary.
5. What do you mean by encoder? Design 3 to 8 line encoder.
6. Design a combinational circuit that multiplies 2-bit numbers, a_1a_0 and b_1b_0 to produce a 4-bit product, $c_3c_2c_1c_0$. Use AND gates and half-adders.
7. Design a circuit which produces 2's complement of the given four bit binary digit.
8. Implement full adder using decoder with truth table and logic diagram.
9. Design a circuit that produces the square of three bit number using ROM?
10. Use K-map to simplify the given function in POS. Implement the simplified function using 2-input NOR-NOR gate only.

$$F = \prod M (0,1,2,9,10,11,14) \text{ And with don't care conditions}$$

$$D = \prod M (7,8,12)$$

11. Discuss race condition in J-K Flip flop and methods to overcome it.
12. Write Short notes on (Any two)
 - a) Coding system in logic design
 - b) Error-detection code
 - c) Universal Gates