

**Chapter 1 : Fundamentals of Digital Logic 1-1 to 1-70**

1.1	Introduction to Logic Gates	1-1	1.10.1	Other Important Rules.....	1-7
1.1.1	NOT Operator (Inversion).....	1-1	1.11	De-Morgan's Theorems.....	1-7
1.1.2	AND Operator.....	1-1	1.12	Boolean Expression and Boolean Function.....	1-8
1.1.3	OR Operator	1-1	1.13	Truth Table Formation from a Given Boolean Equation.....	1-8
1.1.4	Logic Gates.....	1-1	1.13.1	Writing Boolean Expression from a Logic Diagram.....	1-9
1.1.5	Classification of Logic Gates.....	1-2	1.13.2	To Draw a Logic Circuit from Boolean Equation ...	1-9
1.2	NOT Gate or Inverter	1-2	1.13.3	To Write a Boolean Expression for a Logic Circuit.....	1-10
1.3	AND Gate.....	1-2	1.13.4	To Write the Boolean Expression from the Truth Table	1-10
1.4	The OR Gate.....	1-3	1.14	Universal Gates.....	1-11
1.5	The NAND Gate.....	1-3	1.14.1	NAND Gate as a Universal Gate	1-11
1.6	The NOR Gate	1-3	1.14.2	NOR Gate as a Universal Gate.....	1-12
1.7	EX-OR and EX-NOR Gates	1-4	1.15	Logic Circuits.....	1-14
1.7.1	The EX-OR Gate	1-4	1.15.1	Comparison of Combinational and Sequential Circuits.....	1-15
1.7.2	The EX-NOR Gate	1-4	1.15.2	Combinational Circuit Design.....	1-15
1.7.3	Examples of IC Gates.....	1-5	1.16	Standard Representations for Logical Functions.....	1-15
1.8	Boolean (Binary) Algebra.....	1-5	1.16.1	Sum-of-Products (SOP) Form.....	1-16
1.9	Basic Theorems and Properties of Boolean Algebra.....	1-5	1.16.2	Product of the Sums Form (POS).....	1-16
1.9.1	Duality.....	1-5			
1.10	Boolean Laws	1-6			



1.16.3	Standard or Canonical SOP and POS Forms 1-16	1.20	Simplification of Boolean Expressions using K-map 1-25
1.16.4	Conversion of a Logic Expression to Standard SOP or POS Form 1-17	1.20.1	How does Simplification Takes Place ? 1-26
1.17	Concepts of Minterm and Maxterm 1-18	1.20.2	Way of Grouping (Pairs, Quads and Octets) 1-26
1.17.1	Representation of Logical Expressions using Minterms and Maxterms 1-19	1.20.3	Grouping Two Adjacent One's (Pairs) 1-26
1.17.2	Writing SOP and POS Forms for a Given Truth Table 1-19	1.20.4	Grouping Four Adjacent Ones (Quad) 1-27
1.17.3	To Write Standard SOP Expression for a Given Truth Table 1-19	1.20.5	Grouping Eight Adjacent Ones (Octet) 1-29
1.17.4	To Write a Standard POS Expression for a Given Truth Table 1-20	1.20.6	Summary of Rules Followed for K-Map Simplification 1-30
1.17.5	Conversion from SOP to POS and Vice Versa 1-20	1.21	Minimization of SOP Expressions (K Map Simplification) 1-30
1.18	Methods to Simplify the Boolean Functions 1-22	1.21.1	Elimination of a Redundant Group 1-31
1.18.1	Algebraic Simplification 1-22	1.21.2	Minimization of Logic Functions not Specified in Standard SOP Form 1-32
1.19	Karnaugh-Map Simplification (The Map Method) 1-22	1.21.3	Don't Care Conditions 1-34
1.19.1	K-map Structure 1-23	1.22	Product of Sum (POS) Simplification 1-35
1.19.2	K-map Boxes and Associated Product Terms 1-23	1.22.1	K-map Representation of POS Form 1-35
1.19.3	Alternative Way to Label the K-map 1-24	1.22.2	Representation of Standard POS form on K-map 1-35
1.19.4	Truth Table to K-map 1-24	1.22.3	Simplification of Standard POS Form using K-map 1-36
1.19.5	Representation of Standard SOP Form on K-map 1-25	1.23	Adders 1-37
		1.23.1	Half Adder 1-38



1.23.2	Full Adder.....	1-38	1.27.6	Implementing a Standard POS Expression using Multiplexer	1-47
1.23.3	Full Adder using Half Adders.....	1-39	1.28	Demultiplexers	1-48
1.24	Multiplexer (Data Selector)	1-40	1.28.1	Demultiplexer Principle.....	1-48
1.24.1	Necessity of Multiplexers	1-41	1.28.2	Types of Demultiplexers.....	1-48
1.24.2	Advantages of Multiplexers.....	1-41	1.28.3	1 : 2 Demultiplexer	1-49
1.25	Types of Multiplexers	1-41	1.28.4	1 : 4 Demultiplexer	1-49
1.25.1	2 : 1 Multiplexer	1-41	1.28.5	1 : 8 Demultiplexer	1-49
1.25.2	A 4 : 1 Multiplexer.....	1-42	1.29	Demultiplexer Tree	1-50
1.25.3	8 : 1 Multiplexer	1-42	1.29.1	Use of DEMUX in Combinational Logic Design	1-50
1.25.4	Applications of a Multiplexer.....	1-42	1.30	Sequential Circuits.....	1-51
1.26	Multiplexer Tree / Cascading of Multiplexer	1-43	1.30.1	Clock Signal	1-52
1.27	Use of Multiplexers in Combinational Logic Design.....	1-43	1.30.2	Latches and Flip-flop	1-52
1.27.1	Implementation of a Logical Expression in the Standard SOP Form	1-43	1.30.3	S-R Flip-flop using NAND Gates	1-52
1.27.2	Use of 4 : 1 MUX to Realize a 4 Variable Function	1-44	1.31	Triggering Methods.....	1-53
1.27.3	Use of 8 : 1 MUX to Realize a 4 Variable Function	1-45	1.31.1	Concept of Level Triggering.....	1-54
1.27.4	Implementation of a Logical Expression in the Non- standard SOP Form.....	1-46	1.31.2	Concept of Edge Triggering.....	1-54
1.27.5	Implementation of Boolean SOP Expression with Don't Care Conditions	1-46	1.31.3	Types of Edge Triggered Flip Flops.....	1-54
			1.32	Edge Triggered SR Flip Flop	1-54
			1.32.1	Positive Edge Triggered S-R Flip Flop.....	1-54
			1.32.2	Negative Edge Triggered S-R Flip Flop.....	1-56



1.33	Edge Triggered D Flip Flop.....	1-56	1.38.1	Two Bit Asynchronous Up Counter using JK Flip-Flops.....	1-65
1.33.1	Positive Edge Triggered D Flip Flop.....	1-56	1.38.2	3 Bit Asynchronous Up Counter.....	1-65
1.33.2	Negative Edge Triggered D Flip Flop.....	1-57	1.38.4	State Diagram of a Counter.....	1-66
1.33.3	Applications of D Flip-flop.....	1-57	1.39	Modulus of the Counter (MOD-N Counter).....	1-66
1.34	Edge Triggered J-K Flip Flop.....	1-57	1.40	Synchronous Counters.....	1-67
1.34.1	Positive Edge Triggered JK Flip Flop.....	1-57	1.40.1	2-Bit Synchronous up Counter.....	1-67
1.34.2	Negative Edge Triggered JK flip-flop.....	1-59	1.40.2	3-Bit Synchronous Binary up Counter.....	1-68
1.35	Toggle Flip Flop (T Flip Flop).....	1-59	1.40.3	Advantages of Synchronous Counter.....	1-69
1.35.1	Positive Edge Triggered T-FF.....	1-59	1.40.4	Comparison of Synchronous and Asynchronous Counters.....	1-69 1-36
1.35.2	Negative Edge Triggered T Flip Flop.....	1-61			
1.36	Excitation Table of Flip-Flop.....	1-61	<hr/>		
1.36.1	Excitation Table of SR Flip Flops.....	1-61	Chapter 2 : Computer System		
1.36.2	Excitation Table of D Flip Flop.....	1-62	2-1 to 2-23		
1.36.3	Excitation Table of JK Flip Flop.....	1-62	2.1	Introduction to Computer Organization.....	2-1
1.36.4	Excitation Table of T Flip Flop.....	1-62	2.2	Basic Organization of Computer and Block Level Description of Functional Units.....	2-1
1.36.5	Applications of Flip Flops.....	1-62	2.2.1	Structural Components of a Computer.....	2-1
1.37	Introduction to Counters.....	1-62	2.2.2	Functional View of a Computer.....	2-2
1.37.1	Types of Counters.....	1-63	2.3	Evolution of Computers.....	2-3
1.37.2	Classification of Counters.....	1-63	2.3.1	Mechanical Era (1600s-1940s).....	2-3
1.38	Asynchronous / Ripple Up Counters.....	1-63	2.3.2	The Electronic Era.....	2-3
			2.4	Von Neumann and Harvard Architecture.....	2-5
			2.4.1	Von Neumann Architecture.....	2-5
			2.4.2	Harvard Architecture.....	2-8
			2.5	Introduction to Buses.....	2-8



2.5.1	Single-Bus Structure	2-8	3.2	Memory Hierarchy : Classifications of Primary and Secondary Memories	3-3
2.6	Bus Contentions	2-9	3.3	Types of Memory.....	3-3
2.6.1	Multiple-Bus Hierarchies.....	2-9	3.3.1	Types of RAM and ROM.....	3-3
2.7	Bus Arbitration.....	2-10	3.3.2	Memory Map, Structure and its Requirements.....	3-4
2.8	Input / Output System	2-11	3.3.3	Memory Chip Size and Numbers	3-5
2.8.1	Parallel vs. Serial Interface	2-12	3.3.4	ROM (Read Only Memory).....	3-12
2.8.2	Types of Communication Systems	2-13	3.3.5	Types of ROM	3-12
2.9	I/O Modules and 8089 IO Processor.....	2-13	3.3.6	Magnetic Memory	3-12
2.9.1	I/O Module.....	2-14	3.3.7	Optical Memory.....	3-14
2.10	Types of Data Transfer Techniques : Programmed I/O, Interrupt driven I/O and DMA	2-14	3.4	Allocation Policies.....	3-15
2.10.1	Programmed I/O.....	2-14	3.5	Cache Memory : Concept, Architecture (L1, L2, L3) and Cache Consistency.....	3-16
2.10.1(A)	Input/Output Addressing.....	2-15	3.5.1	Cache Operation.....	3-16
2.10.2	Interrupt Driven I/O	2-16	3.5.2	Principles of Locality	3-17
2.10.2(A)	Comparison between Programmed and Interrupt Driven Input/Output.....	2-17	3.5.3	Cache Performance	3-17
2.10.2(B)	Interrupt Processing.....	2-17	3.5.4	Cache Architectures	3-18
2.10.2(C)	Interrupt Selection (Multiple Interrupts).....	2-18	3.5.5	Cache Consistency (Cache Coherency)	3-19
2.10.2(D)	Difference between Subroutine and Interrupt Service Routine.....	2-20	3.5.6	Write Policy.....	3-19
2.10.2(E)	Types of Interrupts.....	2-20	3.5.7	Bus Master/Cache Interaction.....	3-20
2.10.3	DMA.....	2-21	3.5.8	Bus Snooping/Snarfing	3-21
2.10.4	DMA Transfer Modes.....	2-22	3.5.9	Replacement Algorithms	3-22
<hr/>			3.5.10	Performance Characteristics of Two Level Memory.....	3-25
Chapter 3 : Memory System Organization 3-1 to 3-34			3.6	Cache Mapping Techniques.....	3-26
3.1	Introduction to Memory and Memory Parameters.....	3-1	3.6.1	Direct Mapping Technique	3-26
3.1.1	Bytes and Bits.....	3-2	3.6.2	Fully Associative Mapping	3-27



3.6.3	Set Associative Mapping	3-28	4.3.2	Execute Cycle.....	4-11
3.7	Interleaved and Associative Memory.....	3-29	4.3.3	Interrupt Cycle.....	4-12
3.7.1	Associative Memory.....	3-29	4.3.4	Applications of Microprogramming.....	4-13
3.7.2	Interleaved Memory	3-29	4.4	Performance Measures of Computer Architecture.....	4-13
3.8	Virtual Memory	3-30	4.4.1	Amdahl's Law	4-15
3.8.1	Paging Mechanism or the Memory Management Unit.....	3-30	4.5	Pipeline Processing.....	4-16
3.9	Flash Memories	3-31	4.5.1	Non-Pipelined System Versus Two Stage Pipelining.....	4-16
3.10	RAID Levels	3-31	4.5.2	Basic Pipelined Datapath and Control for a Six Stage CPU Instruction Pipeline.....	4-17
<hr/>			4.5.3	Linear Pipeline Processors	4-18
Chapter 4 : Processor Organization			4.5.3(A)	Asynchronous and Synchronous Linear Pipelining	4-18
4-1 to 4-26			4.5.3(B)	Clocking and Timing Control.....	4-19
4.1	Processor and Register Organization.....	4-1	4.5.3(C)	Speedup, Efficiency and Throughput.....	4-20
4.1.1	Instruction Formats.....	4-2	4.6	Instruction Pipelining and Pipelining Stages.....	4-21
4.1.2	Instruction Word Format - Number of Addresses	4-3	4.7	Instruction Level Parallelism and Superscalar Processors.....	4-23
4.1.3	Reverse Polish Notation.....	4-4	4.7.1	Pipelining in Superscalar Processors	4-23
4.1.4	Basic Instruction Cycle.....	4-4	4.8	RISC and CISC Processors	4-25
4.1.5	Interrupt Cycle.....	4-5	4.8.1	Comparison of CISC and RISC Processors	4-25
4.2	Addressing Modes.....	4-7			
4.2.1	Examples on Addressing Modes	4-9			
4.3	Instruction Interpretation and Sequencing and Micro-Operations with their Sequencing.....	4-10			
4.3.1	Fetch Cycle.....	4-11			



Chapter 5 : Control Unit		5-1 to 5-08	
5.1	Introduction	5-1	
5.1.1	Examples of Micro-operations/Microprograms	5-1	
5.1.2	Applications of Microprogramming.....	5-4	
5.2	Control Unit : Hardwired Control Unit Design Methods.....	5-5	
5.2.1	State Table Method.....	5-5	
5.2.2	Delay Element Method.....	5-5	
5.2.3	Sequence Counter Method.....	5-6	
5.2.4	PLA Method.....	5-6	
5.3	Control Unit : Soft Wired (Micro programmed) Control Unit Design Methods.....	5-6	
5.3.1	Wilkie's Microprogrammed Control Unit.....	5-7	
5.3.2	Comparison between Hardwired and Micro- programmed Control	5-8	
5.4	Concepts of Nano Programming.....	5-8	
Chapter 6 : Fundamentals of Advanced Computer Architecture		6-1 to 6-21	
6.1	Parallel Architecture	6-1	
6.1.2	Levels of Parallel Processing / Software Parallelism.....	6-2	
6.1.3	Future Trends in Parallel Processing	6-2	
6.2	Architectural Classification of Parallel Processing.....	6-2	
6.2.1	Flynn's Classification of Parallel Computing.....	6-2	
6.2.2	Feng's Classification of Parallel Computing	6-4	
6.2.3	Handler's Classification of Parallel Processing.....	6-4	
6.3	Cluster Computing.....	6-5	
6.3.1	Shared-Address Space Platform : NUMA and UMA.....	6-6	
6.4	Introduction to Array Processing.....	6-7	
6.4.1	Classification of Vector Processors.....	6-9	
6.4.2	Comparison of Array Processors and Vector Processors.....	6-9	
6.5	Interconnection Network.....	6-10	
6.5.1	Need and Types of Routing in Array (SIMD) Processors.....	6-10	
6.5.2	Linear and Ring Topologies	6-11	
6.5.3	Meshes and Torus	6-12	
6.5.3(A)	Meshes in Illiac - IV.....	6-12	
6.5.4	Hypercubes	6-13	



6.5.5	Trees and Butterflies	6-14	6.5.7(B)	Single Stage Interconnect Network.....	6-17
6.5.6	Bus Based Interconnect Network.....	6-15	6.5.7(C)	Multistage Interconnect Network.....	6-18
6.5.6(A)	Single Bus Interconnect System	6-15	6.6	Introduction and Organization of Multi-core Processors.....	6-20
6.5.6(B)	Multi Bus Interconnect System.....	6-15		<ul style="list-style-type: none">• Module Questions Papers	M-1 to M-03
6.5.7	Switch Based Interconnect Network	6-17			
6.5.7(A)	Crossbar Interconnect Network.....	6-17			
