

Department of CSIT

Class: B.SC **Semester:** II **Year:** 2013 **Paper Title:** Introduction to logics of Computer **Max Marks:** 30

Section A: (All 10 questions compulsory)

10X1=10

Very Short Answer Questions: Write Very short answers to following questions

Q1. What is Gate? Explain in brief.

ANS: Electronic digital circuits are also called *logic circuits* because, with the proper input, they establish logical manipulation paths. Any desired information for computing or control can be operated upon by passing binary signals through various combinations of logic circuits, each signal representing a variable and carrying one bit of information. Logic circuits that perform the logical operations of AND, OR, and NOT. These circuits, called *gates*, are blocks of hardware that produce a logic-lor logic-O output signal if input logic requirements are satisfied.

Q2. Write advantages of Binary coded decimal?

ANS:

1. One advantage of **BCD** over binary representations is that there is *no limit to the size of a number*. To add another digit, just add a new 4-bit sequence.

2. Numbers represented in pure binary format are limited to the *largest number* that can be represented by 8, 16, 32 or 64 bits.

3. It is *easier to convert decimal numbers to and from BCD* than binary and, though BCD is often converted to binary for arithmetic processing, it is possible to *build hardware that operates directly on BCD*.

Q3. How SOP of any boolean function is creates?

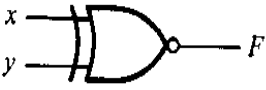
ANS: The *sum of products* is a Boolean expression containing AND terms, called *product terms*, of one or more literals each. The *sum* denotes the ORing of these terms. An example of a function expressed in sum of products is

$$F = y' + xy + x'yz'$$

The expression has three product terms of one, two, and three literals each, respectively. Their sum is in effect an OR operation

Q4. Represent Exclusive–NOR Gate with its truth table.

ANS:

Exclusive-NOR or equivalence		$F = xy + x'y'$ $= x \odot y$	x	y	F
			0	0	1
			0	1	0
			1	0	0
			1	1	1

Q5. Describe Standard Sum of Boolean variables?

ANS: The n Binary variables forming an OR term, with each variable being primed if the corresponding bit of the binary number is 1 or unprimed if the corresponding bit of the binary number is 0, provide 2^n possible combinations, called *maxterms*, or *standard sums*.

For e.g.

Maxterms	
Term	Designation
$x + y + z$	M_0
$x + y + z'$	M_1
$x + y' + z$	M_2
$x + y' + z'$	M_3
$x' + y + z$	M_4
$x' + y + z'$	M_5
$x' + y' + z$	M_6
$x' + y' + z'$	M_7

Q6. Demonstrate associative Law

ANS: *Associative law*. A binary operator $*$ on a set S is said to be associative whenever

$$(x * y) * z = x * (y * z) \text{ for all } x, y, z, \in S$$

Q7. Explain asynchronous sequential circuit system

ANS : The digital circuit are mainly categorised into two types:

- (i) Combinational circuit and,
- (ii) Sequential circuit

every digital system is likely to have combinational circuits, most systems encountered in practice also include memory elements, which require that the system be described in terms of *sequential Logic*. There are two main types of sequential circuits. Their classification depends on the timing of their signals, they are: **Synchronous and asynchronous sequential circuit**.

The behavior of an *asynchronous* sequential circuit depends upon the order in which its input signals change and can be affected at any instant of time. The memory elements commonly used in asynchronous sequential circuits are time-delay devices. The memory capability of a time-delay device is due to the finite time it takes for the signal to propagate through the device.

Q8. Define Shift Registers.

Ans: A register capable of shifting its binary information either to the right or to the left is called a *shift register*. The logical configuration of a shift register consists of a chain of flip-flops connected in cascade, with the output of one flip-flop connected to the input of the next flip-flop. All flip-flops receive a common clock pulse that causes the shift from one stage to the next.

Q9. Represent in minterm form $f(x,y,z)=\Sigma(1,3,5,7)$

Ans: $f(x,y,z) = m_1 + m_3 + m_5 + m_7$

Q10. Prove $x \cdot x = x$ by using Boolean algebra postulates.

ANS:

$$x \cdot x = x.$$

$$x \cdot x = xx + 0 \quad \text{by postulate:} \quad 2(a)$$

$$= xx + xx' \quad 5(b)$$

$$= x(x + x') \quad 4(a)$$

$$= x \cdot 1 \quad 5(a)$$

$$= x \quad 2(b)$$

Section B: (Attempt any 4 questions out of 6 questions)

4X5=20

Descriptive Questions:

Q11. Perform the subtraction of decimal numbers using (1) 10's (2) 9's

Complement: 753-864.

ANS:

Q2
Ans-2: Given $M = 753$, $S = 864$,

i) Using 10's complement :- $r = 10$, $N = 864$, $n = 3$

Step(a) \rightarrow Complement of subtrahend $N = 864$

$$= r^n - N$$

$$= 10^3 - 864$$

$$= 1000 - 864 = 136$$

Step(b) Add complement of S with M

$$\begin{array}{r} 753 \\ + 136 \\ \hline 889 \end{array}$$

\rightarrow as carry does not occur

\therefore Step(c) take the 8's complement of Step(b)

$$N = 889, r = 10, n = 3$$

$$(10^3 - 889)$$

$$= 1000 - 889$$

$$= 111 = -(111)_{10} \rightarrow \underline{\text{Ans.}}$$

(ii) Using 9's complement :- $r = 10$, $N = 864$, $n = 3, m = 0$

Step(a) $(r^n - r^m) - N = (10^3 - 10^0) - 864 = (10^3 - 1) - 864$

$$999 - 864$$

$$= 135$$

Step(b) Add 135 to Minuend (M)

$$\begin{array}{r} 753 \\ + 135 \\ \hline 888 \end{array}$$

\rightarrow \therefore No carry occur

\therefore Step(c) \rightarrow Take the $(r-1)$'s complement of Step(b) ~~where~~ where,

$$N = 888, r = 10, n = 3$$

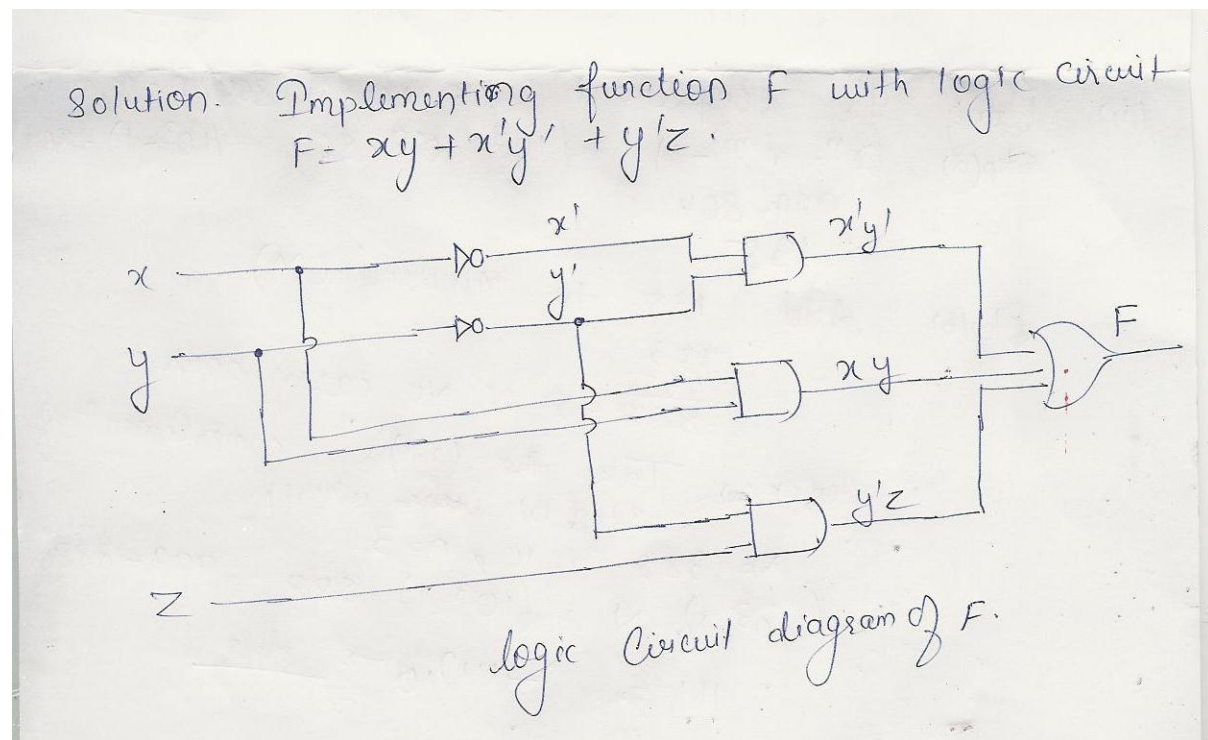
$$(10^3 - 1) - N = (10^3 - 1) - 888 = 999 - 888$$

$$111 = -(111)_{10} \rightarrow \underline{\text{Ans.}}$$

Q12. Implement the Boolean function with AND, OR and NOT gates

$$F = xy + x'y' + y'z.$$

ANS:



Q13. Show that dual of the X-OR gate is equal to its complement.

ANS:



XOR - Gate can be represented as ..



Truth table of X-OR Gate is

x	y	$x \oplus y$
0	0	0
0	1	1
1	0	1
1	1	0

Dual of X-OR Gate is $x \oplus y = x'y + xy'$ (i)
 $= (x' + y)(x + y')$ as,

in Dual (.) operator changes into (+) and (+) converts into (.)

where as: Complement of x-OR gate is

$$\begin{aligned}
 x \oplus y &= (x'y + xy')' \rightarrow \text{Applying De Morgan's Law} \\
 &= (x'y)' \cdot (xy')' \Rightarrow ((x')' + y) \cdot ((x)' + (y')') \\
 &= (x + y') \cdot (x' + y) \quad \text{--- (ii)}
 \end{aligned}$$

Representing eqⁿ (i) & (ii) in the form of Truth table.

Dual - Eqn (1)

X	Y	$X \oplus Y$	Dual - Eqn (1)					Complement				
			X'	Y'	$X+Y$	$X+Y'$	Y	X'	Y'	$(X+Y)$	$(X'+Y)$	$(X'+Y')$
0	0	0	1	1	1	1	1	1	1	1	1	
0	1	1	1	0	1	0	0	1	0	0	0	
1	0	1	0	1	0	1	0	0	1	0	0	
1	1	1	0	0	1	1	1	0	0	1	1	

Both outputs are equal.

Hence Proved.

Q14. Simplify the Boolean function using MAP method:

$$F = A'C + A'B + AB'C + BC$$

ANS:

Solution 5 $F = A'C + A'B + AB'C + BC$, implementing with K-Map of Three variables A, B, C .

	BC	00	01	11	10
A	0		1	1	1
	1		1	1	

$g_1 = C$
 $g_2 = A'B$
 $\therefore g_1 + g_2 = F(A, B, C)$
 $\therefore F(A, B, C) = C + A'B$

Q15. Design the combinational circuit that accepts a 3-bit number and generates an output binary number equal to the square of the input number.

Ans: The First Step in the design is to drive the truth table of combinational circuit. Firstly we design the truth table with three input and six output are needed to accommodate all possible combinations of binary numbers. Truth

table and circuit diagram are described as follows: where, A_0, A_1, A_2 are act as input and $B_0, B_1, B_2, B_3, B_4, B_5$ are act as output

Inputs			Outputs						Decimal	
A_2	A_1	A_0	B_5	B_4	B_3	B_2	B_1	B_0		
0	0	0	0	0	0	0	0	0	0	$B_5 = \sum m(6, 7)$
0	0	1	0	0	0	0	0	1	1	$B_4 = \sum m(4, 5, 7)$
0	1	0	0	0	0	1	0	0	4	$B_3 = \sum m(3, 5)$
0	1	1	0	0	1	0	0	1	9	$B_2 = \sum m(2, 6)$
1	0	0	0	1	0	0	0	0	16	$B_1 = 0$
1	0	1	0	1	1	0	0	1	25	$B_0 = \sum m(1, 3, 5, 7) = A_0$
1	1	0	1	0	0	1	0	0	36	
1	1	1	1	1	0	0	0	1	49	

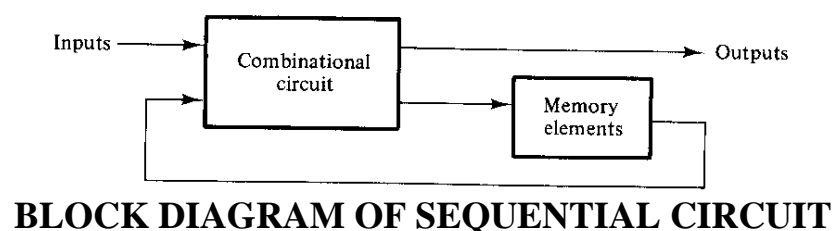
A_2	A_1	A_0	B_5	B_4	B_3	B_2
0	0	0	0	0	0	0
0	0	1	0	0	0	0
0	1	0	0	0	0	1
0	1	1	0	0	1	0
1	0	0	0	1	0	0
1	0	1	0	1	1	0
1	1	0	1	0	0	1
1	1	1	1	1	0	0

Q16. What is sequential circuit? Compare Combinational and sequential circuit.

Ans: The digital circuit are mainly categorised into two types:

- Combinational circuit and,
- Sequential circuit

every digital system is likely to have combinational circuits, most systems encountered in practice also include memory elements, which require that the system be described in terms of *sequential Logic*. The memory elements are devices capable of storing binary information within them. The binary information stored in the memory elements at any given time defines the *state* of **the sequential circuit**. **The sequential circuit receives binary information from external inputs**. These inputs, together with the present state of the memory elements, determine the binary value at the output terminals. They also determine the condition for changing the state in the memory elements.



The block diagram demonstrates that the external outputs in a sequential circuit are a function not only of external inputs, but also of the present state of the memory elements. The next state of the memory elements is also a function of

external inputs and the present state. Thus, a sequential circuit is specified by a time sequence of inputs, outputs, and internal states.

Comparison of Combinational and Sequential circuit

S.NO	Combinational Cicuit	Sequential Circuit
1.	A combinational circuit can be defined as a circuit whose output is dependent only on the inputs at the same instant of time	a sequential circuit can be defined as a circuit whose output depends not only on the present inputs but also on the past history of inputs.
2.	For a combinational circuit, the values of the variable are usually specified over the whole continuous time.	For a sequential circuit, the values of the variable are usually specified at certain discrete time instants
3.	It contains no memory elements	It contains memory elements
4.	The present value of it's outputs are determined solely by the present values of it's inputs	The present value of it's outputs are determined by the present value of it's inputs and it's past state
5.	It's behavior is described by the set of output functions	It's behavior is described by the set of next-state(memory) functions and the set of output functions
6.	HalfAdder , FullAdder , Half Subtractor , Full Subtractor are examples of combinational circuits	Flip-Flops , Counters form the sequential circuit.

Q17. What is Synchronous Counter? Explain in brief.

Ans: A sequential circuit that goes through a prescribed sequence of states upon the application of input pulses is called a *counter*. The input pulses, called *count pulses*, may be clock pulses or they may originate from an external source and may *occur* at prescribed intervals of time or at random. **In** a counter, the sequence of states may follow a binary count or any other sequence of states. Counters are found in almost all equipment containing digital logic. They are used for counting the number of occurrences of an event and are useful for generating timing sequences to control operations in a digital system.

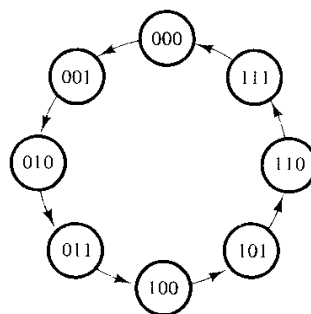
In general there are two types of counter, asynchronous counter and Synchronous counter.

In asynchronous counter, the flip-flop output transition serves as a source for triggering other flipflops. **In** other words, the *CP* inputs of all flip-flops (except the first) are triggered not by the incoming pulses, but rather by the transition that occurs in other flip-flops.

In synchronous counter, the input pulses are applied to all *CP* inputs of all flip-flops. The change of state of a particular flip-flop is dependent on the present state of other flipflops.

Designing of Synchronous counter:

The most simplest synchronous counter is Binary counter: A counter that follows the binary sequence is called a *binary counter*. An n -bit binary counter consists of n flip-flops and can count in binary from 0 to $2^n - 1$. The state transitions in clocked sequential circuits occur during a clock pulse; the flip-flops remain in their present states if no pulse occurs. The next state of a counter depends entirely on its present state, and the state transition occurs every time the pulse occurs. For example:



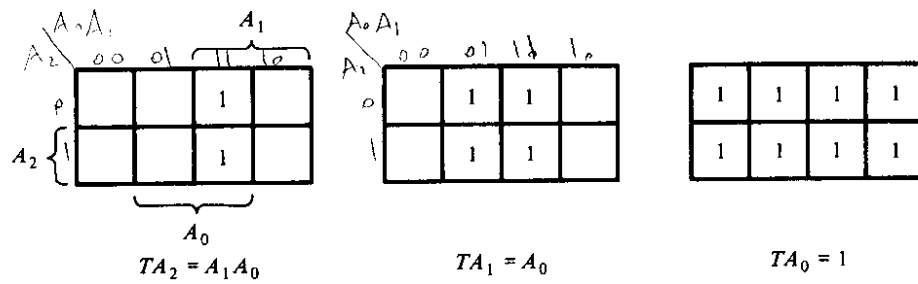
State Diagram of 3-bit binary counter

The three flip-flops are given variable designations A_2 , A_1 and A_0 . Binary counters are most efficiently constructed with T flip-flops (or JK flip-flops with J and K tied together). The flip-flop excitation for the T inputs is derived from the excitation table of the T flip-flop and from inspection of the state transition of the present state to the next state. Consider the flip-flop input entries for row 001. The present state here is 001 and the next state is 010, which is the next count in the sequence. Comparing these two counts, we note that A_2 goes from 0 to 0; so TA_2 is marked with a 0 because flip-flop A_2 must remain unchanged when a clock pulse occurs. A_1 goes from 0 to 1; so TA_1 is marked with a 1 because this flip-flop must be complemented in the next clock pulse. Similarly, A_0 goes from 1 to 0, indicating that it must be complemented; so TA_0 is marked with a 1. The last row with present state 111 is compared with the first count 000, which is its next state. Going from all 1's to all 0's requires that all three flip-flops be complemented.

Excitation Table for 3-Bit Counter

Present State			Next State			Flip-Flop Inputs		
A_2	A_1	A_0	A_2	A_1	A_0	TA_2	TA_1	TA_0
0	0	0	0	0	1	0	0	1
0	0	1	0	1	0	0	1	1
0	1	0	0	1	1	0	0	1
0	1	1	1	0	0	1	1	1
1	0	0	1	0	1	0	0	1
1	0	1	1	1	0	0	1	1
1	1	0	1	1	1	0	0	1
1	1	1	0	0	0	1	1	1

MAPS for 3-bit Binary Counter



The flip-flop input functions from the excitation tables are simplified in the maps. The Boolean functions listed under each map specify the combinational circuit part of the counter. Including these functions with the three flip-flops, we obtain the logic diagram of the binary synchronous counter.