KINGDOM OF SAUDI ARABIA | JAZAN UNIVERSITY
COLLEGE OF COMPUTER SCIENCE & INFORMATION TECHNOLOGY

ASSIGNMENT 1

Academic Year	2022-2023	Semester	Second
Course with code	DIGITAL DESIGN AND COMPUTER ARCHITECTURE ITEC 252	Section	
Type of Assignment	Assignment 1	Marks	20
Date of Announcement		Deadline	10/2/2023
Student Name		Student ID	

ASSIGNMENT 1

Answer All Questions

1. **Find the result of the following step by step :**
   a. Binary addition $110011 + 10011$
   b. Binary subtraction $101001 - 1011$

Binary Addition:

The binary addition of 110011 and 10011 is as follows:

110011
+
10011
1001110

Starting from the rightmost digit (the least significant bit), we add the two digits and carry over if necessary.

1 + 1 = 10 (in binary), so we write 0 and carry over the 1. 0 + 0 + 1 = 1. 0 + 1 + 1 = 10 (in binary), so we write 0 and carry over the 1. 1 + 1 + 1 = 11 (in binary), so we write 1 and carry over the 1. 1 + 1 = 10 (in binary), so we write 0 and carry over the 1. 1 + 1 = 10 (in binary), so we write 0 and carry over the 1.

So, the result of the binary addition of 110011 and 10011 is 1001110.

Binary Subtraction:

The binary subtraction of 101001 and 1011 is as follows:

101001

+

1011

100110

Starting from the rightmost digit (the least significant bit), we subtract the two digits and borrow if necessary.

1 - 1 = 0. 0 - 1 = 1 (in binary), so we write 1 and borrow 1 from the next digit. 0 - 1 + 1 = 0. 1 - 0 = 1. 0 - 1 = 1 (in binary), so we write 1 and borrow 1 from the next digit. 1 - 1 = 0.

So, the result of the binary subtraction of 101001 and 1011 is 100110.

2. **Define the following terms:**

   a. Digital age

   b. Digital systems with examples

   c. Digital computers

   d. ASCII Character Codes with one example

   e. Binary cell

   f. Register

a. Digital age refers to the era in human history characterized by the widespread use of digital technology, such as computers, the internet, and other electronic devices. It is often seen as the period following the analog era and is characterized by the rapid growth of digital systems and services.

b. Digital systems are systems that operate using digital signals, which are signals that represent binary data (1s and 0s) as opposed to analog signals, which represent continuous data. Examples of digital systems include computers, smartphones, televisions, and home security systems.

c. Digital computers are computers that operate using digital signals. These computers use binary data to perform operations, store and process information, and perform calculations. Examples of digital computers include personal computers, laptops, and servers.

d. ASCII (American Standard Code for Information Interchange) Character Codes are standardized codes used to represent text characters, such as letters, numbers, and symbols, as binary data. For example, the ASCII code for the letter "A" is 65.

e. A binary cell is a single unit of information in a computer system that can have only two possible values: 1 or 0. These cells are used to represent binary data in digital systems.

f. A register is a high-speed memory unit in a computer's central processing unit (CPU) used to temporarily store data and instructions. Registers are used by the CPU to perform arithmetic and logical operations and to control the flow of data within the system.

3. Convert the following from decimal system to binary system:

a. 48
b. 65
c. 32
d. 19
e. 0.25

a. The binary equivalent of the decimal number 48 is 110000.

b. The binary equivalent of the decimal number 65 is 1000001.

c. The binary equivalent of the decimal number 32 is 100000.

d. The binary equivalent of the decimal number 19 is 10011.

e. The binary equivalent of the decimal number 0.25 is 0.01 in binary. Please note that this is an approximation and there is no exact binary representation for most decimal numbers.

4. Convert the following from binary system to decimal system:

a. 1111
b. 10011
c. 1010101
d. 11010

a. The decimal equivalent of the binary number 1111 is 15.

b. The decimal equivalent of the binary number 10011 is 19.

c. The decimal equivalent of the binary number 1010101 is 85.

d. The decimal equivalent of the binary number 11010 is 26.

5. Find 1's and 2's complements 1000110011

1's complement:

1. Invert each bit of the binary number, so that 0s become 1s and vice versa. Original binary number: 1000110011 1's complement: 01110011000

2's complement:

1. Invert each bit of the binary number, so that 0s become 1s and vice versa. Original binary number: 1000110011 1's complement: 01110011000
2. Add 1 to the 1's complement. 2's complement: 01110011001

The 2's complement is commonly used in digital computer systems to represent negative binary numbers.

6. Convert 173 to binary code BCD.

Binary Coded Decimal (BCD) is a method of representing decimal numbers in binary form, with each digit of the decimal number represented by its own 4-bit binary code.

To convert the decimal number 173 to BCD, we need to convert each decimal digit of the number into its binary representation.

1. The first decimal digit, 1, can be represented in binary as 0001.
2. The second decimal digit, 7, can be represented in binary as 0111.
3. The third decimal digit, 3, can be represented in binary as 0011.

Putting the binary representations of the decimal digits together, we get the BCD representation of the decimal number 173: 0001 0111 0011.

7. Use DeMorgan's Theorem to complement $f = x'(y + z') + xy'z'$

DeMorgan's Theorem states that the complement of a logical expression formed by taking the complement of each term within the expression and then swapping the AND (•) operator with the OR (+) operator, and vice versa.

Given the logical expression f = x'(y + z') + xy'z', we can find its complement as follows:

1. Take the complement of each term within the expression: x'(y + z') becomes x(y'z) xy'z' becomes x' + yz
2. Swap the AND (•) operator with the OR (+) operator, and vice versa: x(y'z) becomes x + y'z x' + yz becomes x(y'z)

Therefore, the complement of the expression f = x'(y + z') + xy'z' is given by x + y'z.

8. Show the Truth table for $f = xy' + yx'$

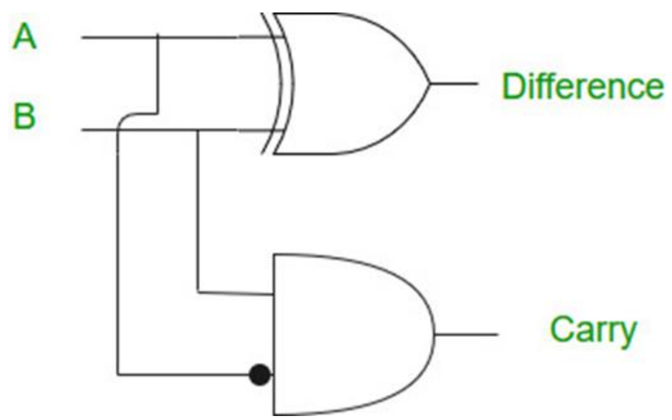
Here is the truth table for the expression f = xy' + yx':

x	**y**	**x'**	**y'**	**xy'**	**yx'**	**xy' + yx'**

0	0	1	1	0	0	0
0	1	1	0	0	1	1
1	0	0	1	1	0	1
1	1	0	0	0	0	0

In this truth table, x and y are binary inputs and f is the output of the expression. The values of x' and y' are the complements of x and y, respectively. The column for xy' shows the result of x AND y', and the column for yx' shows the result of y AND x'. The last column shows the result of the expression xy' + yx', which is the output f.

9. **What are the logic expressions of $Differnce$ and $Carry$?**



The logic expressions for the difference and carry outputs in a binary subtraction operation can be obtained using Boolean algebra.

Difference: The difference output in binary subtraction is obtained by subtracting the second binary number from the first binary number. It can be represented as a logical expression as follows:

diff = A xor B

Carry: The carry output in binary subtraction is obtained by checking if there is a carry-out from the previous stage of the subtraction operation, or if the first binary input is less than the second binary input. It can be represented as a logical expression as follows:

carry = not(A) and B

10. Find the Minterms and Maxterms for the following table:

x	y	z	index	Minterm	Maxterm
0	0	0	0	0	1
0	0	1	1	1	0
0	1	0	2	0	1
0	1	1	3	1	0
1	0	0	4	0	1
1	0	1	5	1	0
1	1	0	6	0	1
1	1	1	7	1	0

11. By using Karnaugh Map simplify the Boolean Function $\boldsymbol{f(x,y,z) = \sum(0,1,2,4,5,6)}$

	00	**01**	**11**	**10**
0	**1**	**1**	**0**	**1**
1	**1**	**1**	**0**	**1**

So, the Boolean function f(x,y,z) = ∑(0,1,2,4,5,6) can be simplified to f(x,y,z) = y' + yz'.

12. Compare between Combinational and Sequential circuit.

Combinational and Sequential circuits are two different types of digital circuits.

Combinational circuit:

- A combinational circuit consists of a combination of logic gates that perform a specific logical operation.
- The output of a combinational circuit is solely dependent on the present input values and not on any previous inputs.
- Combinational circuits are used for arithmetic and logical operations.

Sequential circuit:

- A sequential circuit consists of both combinational logic and memory elements such as flip-flops.
- The output of a sequential circuit depends on both present inputs and previous inputs stored in memory elements.
- Sequential circuits are used in applications such as counters, state machines, and memory elements.

In summary, the main difference between the two is that a combinational circuit's output is only a function of its current inputs, while a sequential circuit's output is dependent on both its current inputs and its past inputs stored in memory elements.

13. **Explain Half adder, Full adder, Half subtractor, Full subtractor, Multiplexer and give example of uses.**

Half Adder:

- A half adder is a simple digital circuit that performs addition of two binary numbers.
- It has two inputs, A and B, and two outputs, sum (S) and carry (C).
- The sum output is the XOR of inputs A and B and the carry output is the AND of inputs A and B.

Example of use: A half adder can be used to add two bits of a larger binary number.

Full Adder:

- A full adder is a digital circuit that performs the addition of three binary numbers.
- It has three inputs, A, B, and Cin, and two outputs, sum (S) and carry (Cout).
- The sum output is the XOR of inputs A, B and Cin and the carry output is the OR of the AND of A, B and the AND of A and Cin, B and Cin.

Example of use: A full adder can be used to add two n-bit binary numbers by cascading n full adders.

Half Subtractor:

- A half subtractor is a digital circuit that performs subtraction of two binary numbers.
- It has two inputs, A and B, and two outputs, difference (D) and borrow (B).
- The difference output is the XOR of inputs A and B and the borrow output is the AND of A and the complement of B.

Example of use: A half subtractor can be used to subtract two bits of a larger binary number.

Full Subtractor:

- A full subtractor is a digital circuit that performs subtraction of three binary numbers.
- It has three inputs, A, B, and Borrow-In, and two outputs, difference (D) and borrow-out

(Bout).

- The difference output is the XOR of inputs A, B and the Borrow-In and the borrow-out output is the OR of the AND of A and the complement of B and the AND of the Borrow-In and the complement of B.

Example of use: A full subtractor can be used to subtract two n-bit binary numbers by cascading n full subtractors.

Multiplexer (MUX):

- A multiplexer is a digital circuit that selects one output from several inputs.
- It has several data inputs and a single output, along with a set of select inputs that determine which of the data inputs is connected to the output.

Example of use: A multiplexer can be used to select one of several inputs to be transmitted or to select one of several memory locations to be accessed.

14. Discuss SR-Latches, D-Latches, D flip flop Flip Flop.

SR-Latch:

- SR (Set-Reset) latch is a basic type of bistable circuit that has two inputs, S (set) and R (reset), and two complementary outputs, Q and not-Q.
- The inputs S and R control the state of the latch and the outputs Q and not-Q represent the stored binary value.
- When S is 1 and R is 0, the output Q becomes 1 and not-Q becomes 0, meaning the latch is set to 1.
- When S is 0 and R is 1, the output Q becomes 0 and not-Q becomes 1, meaning the latch is reset to 0.
- When both S and R are 1, the circuit is in an unstable state and the outputs can be either 0 or 1, meaning the circuit is not predictable.
- The SR-latch is considered a basic memory element in digital systems, as it can store a binary value as long as the inputs S and R do not change.

D-Latch:

- D (Data) latch is a type of SR-latch where the inputs are replaced by a single data input, D, and a clock input, C.
- The clock input C determines when the data input D should be transferred to the output Q.
- When the clock input is 1, the output Q takes the value of the data input D and holds it until the next clock edge.
- When the clock input is 0, the output Q holds its previous value.
- The D-latch is considered a synchronous memory element as it transfers the data input only on

the clock edge.

D Flip-Flop:

- A D flip-flop is a type of clocked latch that samples the value of the data input at the rising edge of the clock and holds the value until the next clock edge.
- It has two inputs, data input (D) and clock input (C), and two complementary outputs, Q and not-Q.
- The data input D represents the value to be stored and the clock input C determines when the data should be stored.
- At the rising edge of the clock, the value of the data input is stored in the flip-flop and held until the next rising edge.
- The D flip-flop is considered a synchronous memory element as it transfers the data input only on the clock edge.
- The D flip-flop is widely used in digital systems for storing binary values, synchronizing signals and implementing sequential logic.

In summary, SR-latches and D-latches are basic building blocks of sequential circuits that can store binary values. The D flip-flop is a specific type of D-latch that is commonly used for storing and transferring binary data in digital systems.

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