جامعة الموصل / كلية الهندسة

قسم الهندسة الكهربائية

Subject Title: Digital Techniques

Subject Code: DIGT208

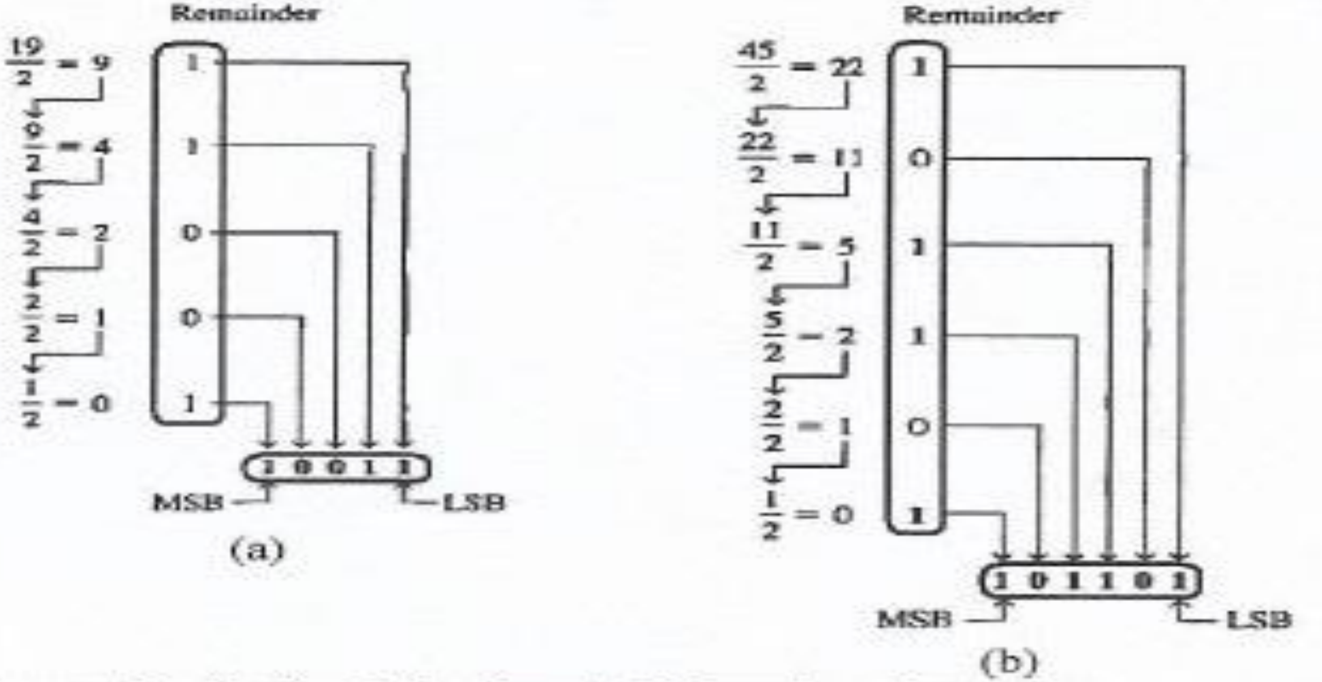
Class 2: Power and Electronics

Instructor : Yehia Rehab Hamdy

Course Description Outlines (15 weeks)

- Number Systems and Operations.
- Logic Gates.
- Boolean Algebra and Logic Simplifications.
- Combinational Logic Analysis.
- Functions of Combinational Logic.
- Basic Logic Circuits Design.

Figures, Diagrams, or Examples…. etc



2-Converting Decimal Fractions to Binary by using Repeated Multiplication by 2:

- As you have seen, decimal whole numbers can be converted to binary by repeated division by 2.
- Decimal fractions can be converted to binary by repeated multiplication by 2.
- For example, to convert the decimal fraction 0.3125 to binary, begin by multiplying 0.3125 by 2 and then multiplying each resulting fractional part of the product by 2 until the fractional product is zero or until the desired number of decimal places is reached.
- The carry digits, or carries, generated by the multiplications produce the binary number.
- The first carry produced is the MSB, and the last carry is the LSB. This procedure is illustrated as follows:

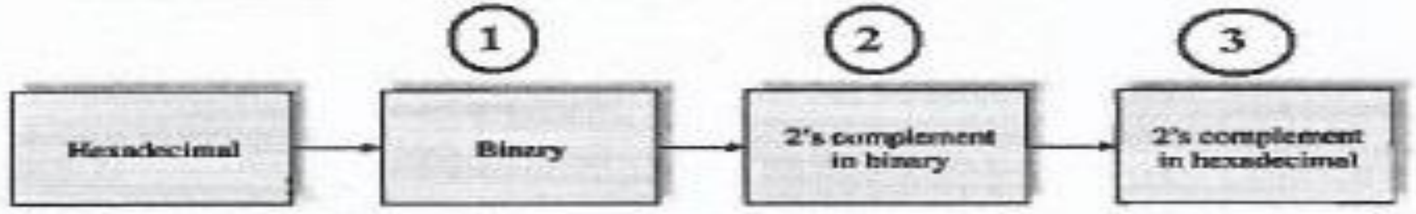
(a)	23_{16} $+16_{16}$ 39_{16}	right column: $3_{16} + 6_{16} = 3_{10} + 6_{10} = 9_{10} = 9_{16}$ left column: $2_{16} + 1_{16} = 2_{10} + 1_{10} = 3_{10} = 3_{16}$
(b)	58_{16} $+22_{16}$ $7A_{16}$	right column: $8_{16} + 2_{16} = 8_{10} + 2_{10} = 10_{10} = A$ left column: $5_{16} + 2_{16} = 5_{10} + 2_{10} = 7_{10} = 7_{1}$
(c)	$2B_{16}$ $+84_{16}$ AF_{16}	right column: $B_{16} + 4_{16} = 11_{10} + 4_{10} = 15_{10} = F_{16}$ left column: $2_{16} + 8_{16} = 2_{10} + 8_{10} = 10_{10} = A_{16}$
(d)	DF_{16} $+AC_{16}$ $18B_{16}$	right column: $F_{16} + C_{16} = 15_{10} + 12_{10} = 27_{10}$ $27_{10} - 16_{10} = 11_{10} = B_{16}$ with a 1 carry left column: $D_{16} + A_{16} + 1_{16} = 13_{10} + 10_{10} + 1_{10} = 24_{10}$ $24_{10} - 16_{10} = 8_{10} = 8_{16}$ with a 1 carry

7-Hexadecimal Subtraction.

- The 2's complement allows you to subtract by adding binary numbers.
- Since a hexadecimal number can be used to represent a binary number, it can also be used to represent the 2's complement of a binary number.

Subtraction Method.

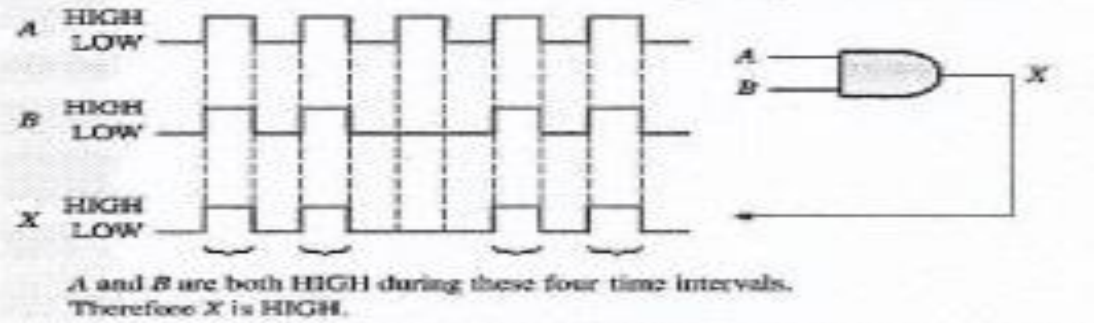
- Step1-Convert the hexadecimal number to binary.
- Step2-Take the 2's complement of the binary number.
- Step3-Convert the result to hexadecimal.



Example (24): Subtract the following hexadecimal numbers:

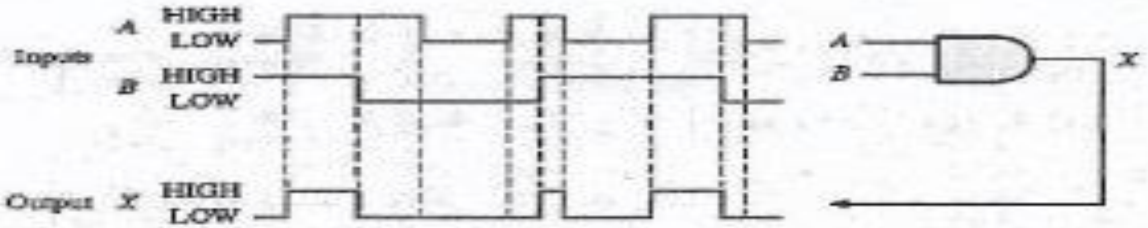
(a) $84_{16} - 2A_{16}$ (b) $C3_{16} - 0B_{16}$

Example (3): If two waveforms, A and B, are applied to the AND gate inputs as in the Figure, what is the resulting output waveform?



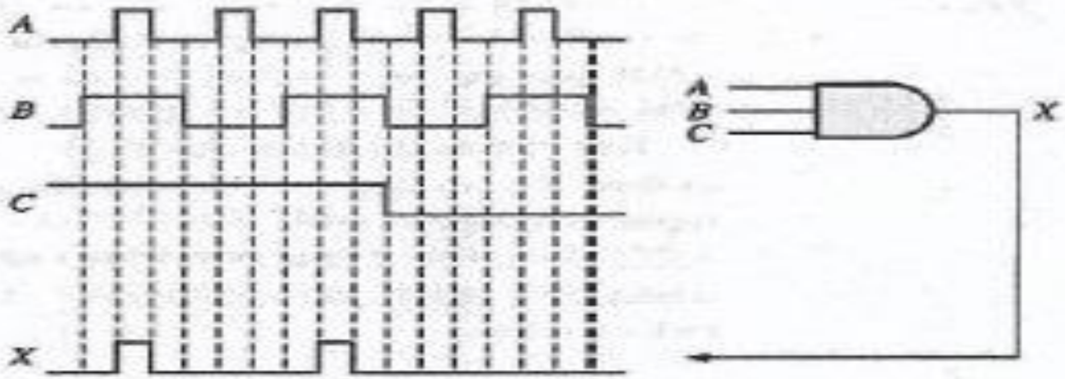
Solution: The output waveform X is HIGH only when both A and B waveforms are HIGH as shown in the timing diagram in the Figure.

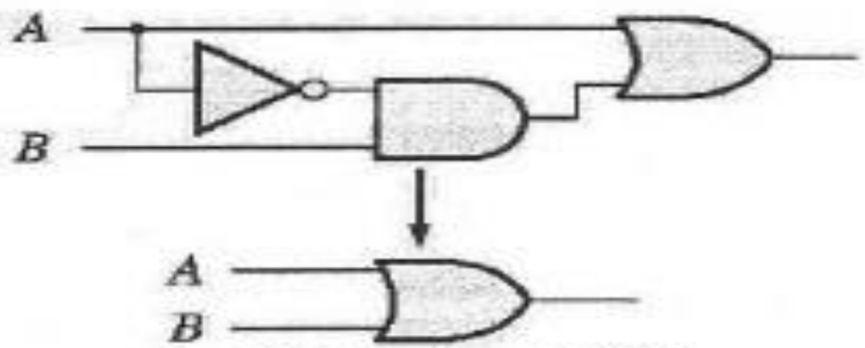
Example (4): For the two input waveforms, A and B, in the Figure, show the output waveform with its proper relation to the inputs.



Solution: The output waveform is HIGH only when both of the input waveforms are HIGH as shown in the timing diagram.

Example (5): For the 3-input AND gate in the Figure, determine the output waveform in relation to the inputs.





Rule 12: (A + B)(A + C) = A + BC

- This rule can be proved as follows:

(A + B)(A + C) = AA + AC + AB + BC   Distributive law
= A + AC + AB + BC   Rule 7: AA = A
= A(1 + C) + AB + BC   Factoring (distributive law)
= A. 1 + AB + BC   Rule 2: 1 + C = 1
= A(1 + B) + BC   Factoring (distributive law)
= A. 1 + BC   Rule 2: 1 + B = 1
= A + BC   Rule 4: A x 1 = A

- The proof is shown in the Table, which shows the truth table and the resulting logic circuit simplification.

A	B	C	A + B	A + C	(A + B)(A + C)	BC	A + BC
0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0
0	1	0	1	0	0	0	0
0	1	1	1	1	1	1	1
1	0	0	1	1	1	0	1
1	0	1	1	1	1	0	1
1	1	0	1	1	1	0	1
1	1	1	1	1	1	1	1

(A + B)(A + C) and A + BC: equal

- This means that the SOP expression in the previous example and the POS expression in this example are equivalent.

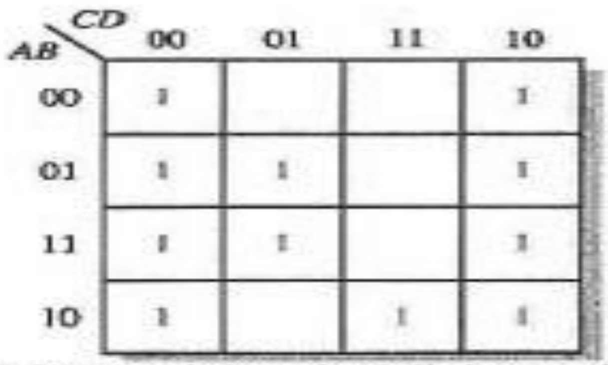
Example (13): From the truth table in shown, determine the standard SOP expression and the equivalent standard POS expression.

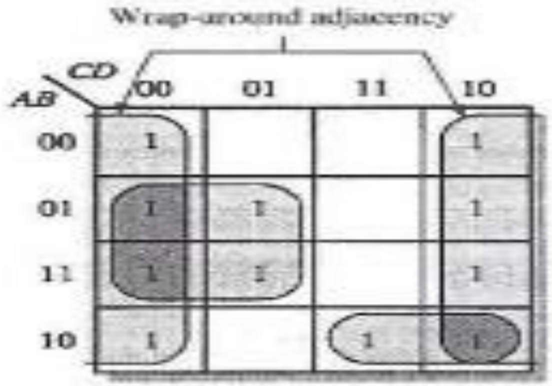
INPUT			OUTPUT
A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

Solution:

INPUT			OUTPUT	SOP	POS
A	B	C	X		
0	0	0	0		$(A+B+C)$
0	0	1	0		$(A+B+\overline{C})$
0	1	0	0		$(A+\overline{B}+C)$
0	1	1	1	$\overline{A}BC$	
1	0	0	1	$A\overline{B}\overline{C}$	
1	0	1	0		$(\overline{A}+B+\overline{C})$
1	1	0	1	$AB\overline{C}$	
1	1	1	1	ABC	

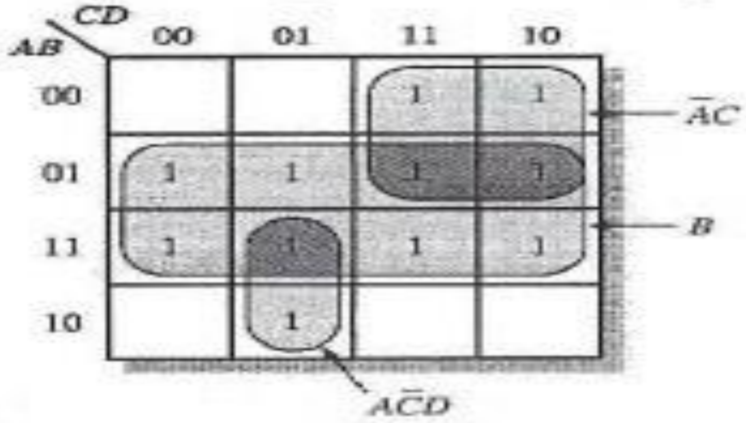
- The resulting standard SOP expression for the output X is: $\overline{A}BC + A\overline{B}\overline{C} + AB\overline{C} + ABC$.
- The resulting standard POS expression for the output X is: $(A+B+C)+(A+B+\overline{C})+(A+\overline{B}+C)+(\overline{A}+B+\overline{C})+(\overline{A}+B+\overline{C})$





4-Determining the Minimum SOP Expression from the Map

Example (17): Determine the product terms for the Karnaugh map in the Figure and write the resulting minimum SOP expression.



Solution: The SOP terms are:

$X = \bar{A}\bar{B}CD + \bar{A}\bar{B}C\bar{D} + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D + \bar{A}BCD + \bar{A}B\bar{C}\bar{D}$
$+ AB\bar{C}\bar{D} + AB\bar{C}D + ABCD + ABC\bar{D} + A\bar{B}\bar{C}D$

- Eliminate variables that are in a grouping in both complemented and uncomplemented forms.
- In the Figure, the product term for the 8-cell group is B because the cells within that group contain both A and $\bar{A}$, C and $\bar{C}$, and D and $\bar{D}$, which are eliminated.
- The 4-cell group contains B, $\bar{B}$, D, and $\bar{D}$, leaving the variables $\bar{A}$ and C, which form the product term $\bar{A}C$.

TEXTBOOK OR REFERENCES

- Digital Fundamentals (11th Edition) by Thomas L. Floyd.
- Digital Systems Principles and Applications (8th Edition) by Ronald J. Tocci and Neal S. Widmer.
- Digital Design and Computer Architecture (2nd Edition) by David Money Harris and Sarah L. Harris.