Adventist University of Central Africa
P.O. Box 2461 Kigali, Rwanda | www.auca.ac.rw | info@auca.ac.rw

Faculty: IT

Course Name: Digital Computer Fundamentals

Course Code: MATH 8127

Lecturer: Kundan Kumar

Student Name: MUTANGANA Joseph

Student ID: 29061

Report: Individual Assignment

Adventist University of Central Africa (AUCA)

Faculty: IT

Department: Software Engineering

Course Name: Digital Computer fundamental

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Report: Number system, Digital Logic and Boolean Algebra

Individual Assignment.

Question 1 Binary substraction and 2's Complement Concept

a) Essential of 2's Complement in binary substruction with signed number:

- 2's Complement is a method we use in Computers to show a negative numbers in binary, because Computers can only add easily, they are not good at substructing directly.

So instead of substruction, we turn it into addition using 2'complement

Example with 4 digits

A = 0110
B = 1110

If you try to substruct directly, your logic will break down. and Lose a focus.

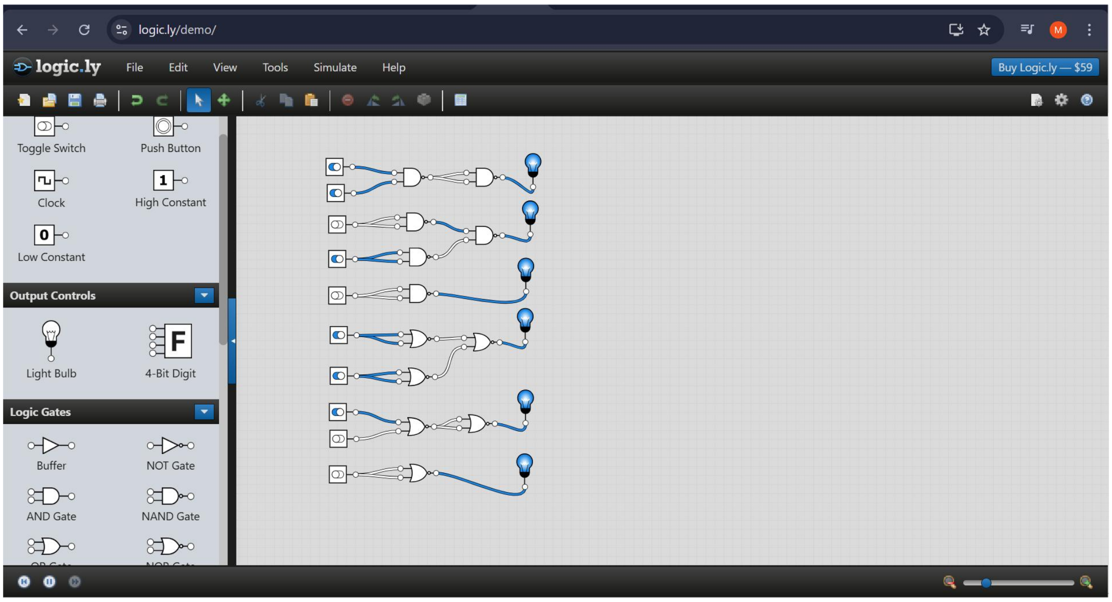
here is best way to do it!

Step 1 turn B variable into 1's Complement, which is inversion of B values

B = [0001] 1's Complement, again add 1 on 1's comp of B to get two's com

0001 + 1 = 0010

$$\boxed{\begin{array}{r} 0001 \\ +\quad 1 \\ \hline 0010 \end{array}}$$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Low Constant
Output Controls
Light Bulb
4-Bit Digit
F
Logic Gates
Buffer
NOT Gate
AND Gate
NAND Gate

Now, in own example we have A-B and be is Large

So if we turn it into addition, It will be A+(-B) when (-B) is B. 2's complement

and 2's Complement of B is 0010

So now we take value of A and Add to 2's Complement of B

A=0110

$B_{2's}$ com = 0010

$$\begin{array}{r} 0110 \\ +\,0010 \\ \hline 1000 \end{array}$$

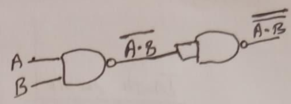
Now $A-(-B) = 1000$

Question 2: a) Design AND using NAND gate:

Truth table

A	B	$\bar{A}$	$\bar{B}$	$\overline{\bar{A}\cdot\bar{B}}$
1	0	0	1	0
1	1	0	0	0
0	0	1	1	1
0	1	1	0	0

Logic gates

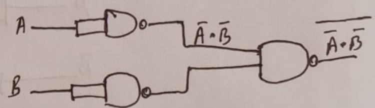


b) Design OR gate using only NAND gates:

Truth table.

A	B	$\bar{A}$	$\bar{B}$	$\bar{A}\cdot\bar{B}$	$\overline{\bar{A}\cdot\bar{B}}$
0	1	1	0	0	1
0	0	1	1	1	0
1	1	0	0	0	1
1	0	0	1	0	1

Logic gate with NAND



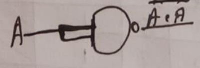
c) Design NOT gate using only NAND gate.

Truth table

A	$\bar{A}$	$\bar{A}\cdot\bar{A}$
1	0	0
0	1	1

A	$\bar{A}$	$\bar{A}\cdot\bar{A}$
0	1	1
1	0	0

Logic gate

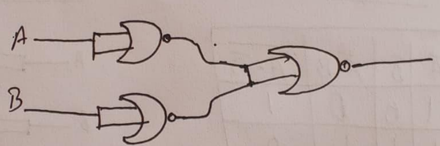


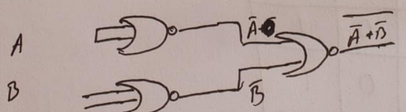
d) Design an AND gate using NOR gat

Truth table

A	B	$\bar{A}$	$\bar{B}$	$\overline{\bar{A}+\bar{A}}$	$\overline{\bar{B}+\bar{B}}$	$(\overline{\bar{A}+\bar{A}})+(\overline{\bar{B}+\bar{B}})$	$\overline{(\overline{\bar{A}+\bar{A}})+(\overline{\bar{B}+\bar{B}})}$
0	0	1	1	1	1	1	0
0	1	1	0	1	0	1	0
1	0	0	1	0	1	1	0
1	1	0	0	0	0	0	1

Logic gate





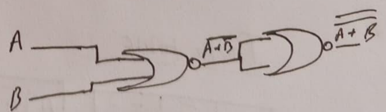
(this one is connect) what I stands for!

c) Design OR Gate usin NOR gates

Truth table

A	B	$\bar{A}$	$\bar{B}$	$\bar{A}+\bar{B}$	$\overline{\bar{A}+\bar{B}}$
0	0	1	1	1	0
0	1	1	0	1	1
1	0	0	1	1	1
1	1	0	0	0	1

Logic gates



Truth table

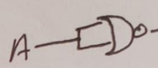
A	B	A+B	$\overline{A+B}$	$\overline{\overline{A+B}}$
0	0	0	1	0
0	1	1	0	1
1	0	1	0	1
1	1	1		

f) Design ~~and~~ NOT gate using only NOR

Truth table

A	$\bar{A}$	$\overline{A+A}$
0	1	1
1	0	0

Logic gate.



$\overline{A+A} = \bar{A}$

Question 3 Boolean Algebra - Simplifying expression

a) $AB + A\bar{B} + \bar{A}B$

$\Rightarrow A(B+\bar{B}) + \bar{A}B$ [by factoring A as common factor]

$= A(1) + \bar{A}B$ [by $B+\bar{B} = 1$]

$= A + \bar{A}B$ [by $A \cdot 1 = A$ Identity Law]

$= A + B(A+A')$ [by Complement]

$= A + B(1)$ [by $A + A' = 1$]

$= \boxed{A+B}$ [by $B(1) = B$], $\boxed{AB + A\bar{B} + \bar{A}B = A+B}$

b) $(A+B)(A+\bar{B})(\bar{A}+B) =$

$(AA + A\bar{B} + BA + B\bar{B})(\bar{A}+B)$ [by Distributive Law]

$(A + A\bar{B} + BA + 0)(\bar{A}+B)$ [by Complement Law, where $A \cdot A = A$, $B \cdot \bar{B} = 0$]

$A(\bar{B}+B)(\bar{A}+B)$ [by distributive Law]

$A(1)(\bar{A}+B)$ [Complement law $\bar{B}+B = 1$]

$A(\bar{A}+B)$ [by identity Law $A \cdot 1 = A$]

$A\bar{A} + AB$ [by distributive Law]

$0 + AB$ [by identity Law] $A \cdot \bar{A} = 0$

AB [by identity Law $0 + AB = AB$]

$\boxed{AB} \Rightarrow \boxed{(A+B)(A+\bar{B})(\bar{A}+B) = AB}$

c) $\overline{A+\bar{B}C} + A\bar{B}$

$\bar{A}\cdot\overline{\bar{B}C} + A\bar{B}$ [by Demongon's Low]

$(\bar{A}\cdot(\bar{\bar{B}}+\bar{C})+A\bar{B}$ [by Demongon's Low]

$\bar{A}\cdot\bar{\bar{B}}+\bar{A}\bar{C}+A\bar{B}$ [by distribution]

$\bar{A}\cdot\bar{B}+A\bar{B}+\bar{A}\bar{C}$ [by Commutative Low]

$\bar{B}(\bar{A}+A)+\bar{A}\bar{C}$ [by Distributive Low]

$\bar{B}(1)+\bar{A}\bar{C}$ [by Complement $\bar{A}+A=1$]

$\bar{B}+\bar{A}\bar{C}$ [by identity $\bar{B}(1)=\bar{B}$]

$\boxed{\bar{B}+\bar{A}\bar{C}}$ $\boxed{\overline{A+BC}+A\bar{B} = \bar{B}+\bar{A}\bar{C}}$

d) $AB + A\bar{B} + \bar{A}B + A\bar{B}$

$A(B+\bar{B}) + \bar{A}B + A\bar{B}$ [by distribution]

$A(1) + \bar{A}B + AB$ [by Complement $B+\bar{B}=1$]

$A + \bar{A}B + AB$ [by identity $A(1)=A$]

$A + B(\bar{A}+A)$ [by distribution

$A+B(1)$ [by Complement $\bar{A}+A=1$]

$\boxed{A+B}$ [by identity $B\cdot 1 = B$]

e) $\overline{\overline{A+\bar{B}} + \overline{\bar{C}+D}}$

$\overline{\overline{A+\bar{B}}}\cdot\overline{\overline{\bar{C}+D}}$ [by Demongon Low]

$\bar{\bar{A}}\cdot\bar{\bar{\bar{B}}}\cdot\bar{\bar{\bar{C}}}\cdot\bar{\bar{D}}$ [by Demongon's Low]

$A\cdot\bar{B}\cdot\bar{C}\cdot D$ [Negation Cancels]

$\boxed{A\cdot\bar{B}\cdot\bar{C}\cdot D}$

f) $\overline{\overline{A+B} \cdot \overline{\overline{C}+D}}$

$\overline{\overline{A+B}} + \overline{\overline{\overline{C}+D}}$ [by Demorgan Law]

$\overline{\overline{A}}+\overline{\overline{B}} + \overline{\overline{\overline{C}}}+\overline{\overline{D}}$ [by Demorgan Law]

$\boxed{A+B+\overline{C}+D}$ [by Negation Concels]

g) $\overline{(\overline{A\cdot(\overline{B}+C)} + \overline{\overline{D}+E})}$

$\overline{\overline{A\cdot(\overline{B}+C)}} \cdot \overline{\overline{\overline{D}+E}})$ [by Demorgon's Law]

$\overline{\overline{A}} \cdot \overline{\overline{(\overline{B}+C)}} \cdot \overline{\overline{D}+E})$ [by Demorgon's Law]

$A \cdot \overline{\overline{\overline{B}}}+\overline{\overline{C}} \cdot \overline{\overline{\overline{D}}}+\overline{\overline{E}}$ [by Demorgan Law]

$A\cdot\overline{B}+C\cdot\overline{D}+E$ [by Negation Concels]

h) $\overline{\overline{(\overline{A}+B)\cdot(C+\overline{D})}+\overline{E}}$

$\overline{\overline{(\overline{A}+B)\cdot(C+\overline{D})}}\cdot\overline{\overline{E}}$ [by Demorgons Law]

$\overline{\overline{(\overline{A}+B)}}\cdot\overline{\overline{(C+\overline{D})}}\cdot\overline{\overline{E}}$ [by Demorgon's Law]

$(\overline{\overline{\overline{A}}}+\overline{\overline{B}})\cdot(\overline{\overline{C}}+\overline{\overline{\overline{D}}})\cdot\overline{\overline{E}}$ [by Demorgon's Law]

$\overline{A}+B\cdot C\cdot\overline{D}\cdot E$ [by Complement]

$\boxed{\overline{A}+B\cdot C\cdot\overline{D}\cdot E}$