INDRAPRASTHA INSTITUTE OF INFORMATION TECHNOLGY DELHI

ECE111: Digital Circuits

Quiz 1 Solution (10 points)

Exam Date: February 6, 2022

Note:

1. The exam will start at 12:00 p.m.
2. After 12:20 p.m, start submitting the same on the classroom.
3. Any submission after 12:30 p.m will be counted under late submission, with 1 mark as penalty for each minute till 12:35 p.m.
4. All submission after 12:35 p.m will be graded zero.

Rubrics:

1. **Both parts carry 5 points each.**
2. **Solving expression carry 3 points and the circuit carry 2 points.**

Penalties:

1. **Point 3 & 4 from 'Note' part.**
2. **If you have drawn the correct circuit without solving the expression, then you will get only 1 point for that particular question, as it is not possible to draw the circuit without expression.**
3. **We are not giving penalty for naming convention/not submitting PDF file this time, but make sure to read and follow the instructions carefully for future submissions.**
4. **These are final remarks and no email regarding the same will be entertained.**

SOLUTIONS

1. Implement the following functions using minimum number of 2-input NOR gates. You can use axioms, , postulates and expression mentioned below and the DeMorgan's law and any other Theorem to simplify the expression. You can also use associativity of XOR operation.

Solutions

a) $f(x,y,z) = (x \cdot z)\oplus[(x+y)\cdot z]\oplus[(x+y)\cdot(x+\bar{y})\cdot(\overline{x\cdot\bar{z}})]$

$f(x,y,z) = (x \cdot z)\oplus[(x+y)\cdot z]\oplus[x\cdot(\overline{x\cdot\bar{z}})]$ used $x+(y\cdot z) = (x+y)\cdot(x+z)$ and $x\cdot\bar{x} = 0$

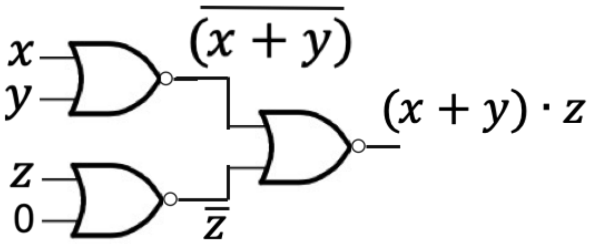
$f(x,y,z) = (x \cdot z)\oplus[(x+y)\cdot z]\oplus[x\cdot(\bar{x}+z)]$ used De Morgan's Law

$f(x,y,z) = (x \cdot z)\oplus[(x+y)\cdot z]\oplus[x\cdot z]$ used $x\cdot(y+z) = x\cdot y + x\cdot z$ and $x\cdot\bar{x} = 0$

$f(x,y,z) = (x \cdot z)\oplus(x\cdot z)\oplus[(x+y)\cdot z]$ used $A\oplus B = B\oplus A$

$f(x,y,z) = 0\oplus[(x+y)\cdot z]$ used $A\oplus A = 0$

$f(x,y,z) = [(x+y)\cdot z]$ used $0\oplus A = A$



b) $f(x,y,z) = z\cdot\bar{y} \oplus x\cdot\bar{y} \oplus(\bar{x}+y) \oplus y\cdot\bar{x} \oplus \bar{z}\cdot\bar{y}$

$f(x,y,z) = z\cdot\bar{y} \oplus x\cdot\bar{y}\oplus\overline{\overline{(\bar{x}+y)}}\oplus y\cdot\bar{x}\oplus\bar{z}\cdot\bar{y}$

$f(x,y,z) = z\cdot\bar{y} \oplus x\cdot\bar{y}\oplus\overline{(x.\bar{y})}\oplus y\cdot\bar{x}\oplus\bar{z}\cdot\bar{y}$ used $A\oplus\bar{A} = 1$

$f(x,y,z) = z\cdot\bar{y} \oplus 1\oplus y\cdot\bar{x}\oplus\bar{z}\cdot\bar{y}$

$f(x,y,z) = \overline{z\cdot\bar{y}}\oplus y\cdot\bar{x}\oplus\bar{z}\cdot\bar{y}$ used $A\oplus 1 = \bar{A}$

$f(x,y,z) = \overline{z\cdot\bar{y}}\oplus\bar{z}\cdot\bar{y}\oplus y\cdot\bar{x}$ used $A\oplus B = B\oplus A$

$f(x,y,z) = \overline{\overline{z\cdot\bar{y}}}.(\bar{z}\cdot\bar{y}) + \overline{(z\cdot\bar{y})}.(\overline{\bar{z}\cdot\bar{y}})\oplus y\cdot\bar{x}$ used $x\oplus y = \bar{x}\cdot y + x\cdot\bar{y}$

$f(x,y,z) = (z\cdot\bar{y}).(\bar{z}\cdot\bar{y}) + (\bar{z}+y).(z+y)\oplus y\cdot\bar{x}$

$f(x,y,z) = (\bar{z}+y).(z+y)\oplus y\cdot\bar{x}$ used $x\cdot\bar{x} = 0$ and $x\cdot y = y\cdot x$

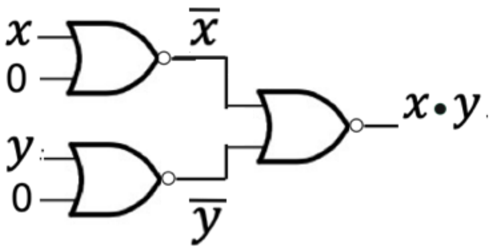
$f(x,y,z) = (y+z.\bar{z})\oplus y\cdot\bar{x}$ used $x+y = y+x$ *and* $(x+y)\cdot(x+z) = (x+yz)$

$f(x,y,z) = y\oplus y\cdot\bar{x}$ used $x\cdot\bar{x} = 0$

$f(x,y,z) = y.\overline{y\cdot\bar{x}} + \bar{y}.(y\cdot\bar{x})$ used $x\oplus y = \bar{x}\cdot y + x\cdot\bar{y}$

$f(x,y,z) = y.(\bar{y}+x)$ used $x\cdot\bar{x} = 0$

$f(x,y,z) = xy = \overline{\overline{xy}} = \overline{(\bar{x}+\bar{y})}$ used $x\cdot\bar{x} = 0$



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Axioms, Postulates and Logical Expression:

- $0\cdot 0 = 0,\ 1\cdot 1 = 1,\ 0\cdot 1 = 1\cdot 0 = 0$
- $0+0 = 0,\ 1+1 = 1,\ 0+1 = 1+0 = 1$
- $x+0 = x,\ x\cdot 1 = x$
- $x\cdot y = y\cdot x,\ x+y = y+x$
- $x\cdot(y+z) = x\cdot y + x\cdot z$

- $x + (y \cdot x) = (x + y) \cdot (x + z)$
- $x \cdot \bar{x} = 0, \;\; x + \bar{x} = 1$
- $x \oplus y = \bar{x} \cdot y + x \cdot \bar{y}$