Name Answers

CE-1901-11 – Dr. Durant – Quiz 4
Fall 2016, Week 4

Note: These quiz problems are in 4 groups: problems 1-2, 3-5, 6, and 7-10.

1. (1 point) **Write** the canonical product-of-sums (POS) equation for F(ABC) which is on for all minterms except 2 and 5. Write the equation explicitly (in terms of the input variables) as opposed to using minterm or maxterm abbreviations.

$F(ABC) = M_2 \cdot M_5 = (A+\bar{B}+C)(\bar{A}+B+\bar{C})$

2. (1 point) **Calculate** how many CMOS transistors are needed to implement your canonical POS equation. **Include each type** of gate needed and the transistor count associated with that gate type.

NOT : 3 × 2T = 6 (Okay to use 4OR3 = 4×6 = 24)
AND2 : 1 × 6T = 6
OR3 : 2 × 8T = 16
28

3. (0.5 point) **Which** of the standard forms is F = a(c' + b') in? (POS) **or** SOP

4. (1 point) **Apply** Boolean algebra, specifically the distributive property, to write the equation in the **other** standard form.

$F = a\bar{c} + a\bar{b}$

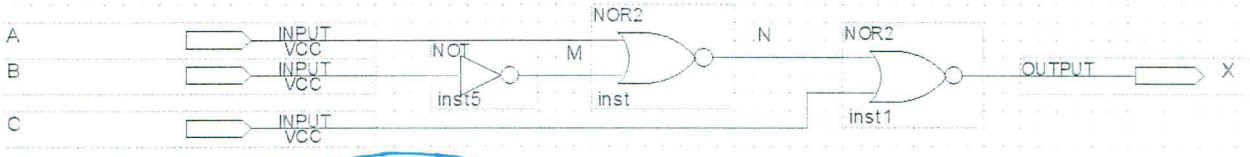
5. (0.5 point) **Is** the equation in problem 3 in **canonical** form? Yes **or** (No)

6. (1 point) **Prove** that (B+C)(B+C')=B (Book reference: T10' combining theorem) using perfect induction. That is, evaluate both expressions in a truth table and confirm that they agree in all rows. Be sure to include all intermediate terms as columns, including NOTs.

B	C	T1 B+C	$\bar{C}$	T2 B+$\bar{C}$	T1·T2
0	0	0	1	1	0
0	1	1	0	0	0
1	0	1	1	1	1
1	1	1	0	1	1

= B col. ∴ equation is true

7. (2 points) **Complete** the truth table for the following schematic. **Include** columns for each intermediate term (all gate outputs); there are more columns than you need in the given table.



A	B	C	M	N	X			
0	0	0	1	0	1			
0	0	1	1	0	0			
0	1	0	0	1	0			
0	1	1	0	1	0			
1	0	0	1	0	1			
1	0	1	1	0	0			
1	1	0	0	0	1			
1	1	1	0	0	0			

8. (1 point) **Write** the equation **directly** from the **schematic** above.

$$X = \overline{\overline{B+A}+C} = \overline{\overline{A+\bar{B}}+C}$$

9. (1 point) **Explain** which type canonical equation (SOP/POS) will be simpler based on your truth table above. Hint: Consider how many 1s/0s are in the output column.

There are only 3 1's (out of 8, so < ½ of total), ∴ it is easier/shorter to write the SOP equation.

10. (1 point) **Write** the simpler of the 2 canonical equations.

$$X = \bar{A}\bar{B}C + A\bar{B}\bar{C} + AB\bar{C}$$

Name Answers

CE-1901-12 – Dr. Durant – Quiz 4
Fall 2016, Week 4

Note: These quiz problems are in 4 groups: problems 1-2, 3-5, 6, and 7-10.

1. (1 point) **Write** the canonical product-of-sums (POS) equation for F(ABC) which is on for all minterms except 1 and 3. Write the equation explicitly (in terms of the input variables) as opposed to using minterm or maxterm abbreviations.

$F(ABC) = M_1 M_3 = (A+B+\bar{C})(A+\bar{B}+\bar{C})$

2. (1 point) **Calculate** how many CMOS transistors are needed to implement your canonical POS equation. **Include each type** of gate needed and the transistor count associated with that gate type.

2 NOT × 2T = 4 T
2 OR3 × 8T = 16 T
1 AND2 × 6T = 6 T
26

(4 OR2 × 6 = 24 also ok)
(3 OR2 ok if you explain how it works)

3. (0.5 point) **Which** of the standard forms is F = (a+b)(a+c') in? (POS) **or** SOP

4. (1 point) **Apply** Boolean algebra, specifically the distributive property, to write the equation in the **other** standard form.

$F = (a+b)(a+\bar{c}) = a + b\bar{c}$ (doesn't work for algebra over real numbers, though)

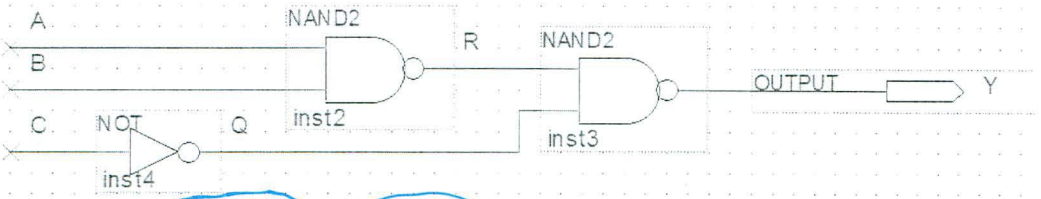
5. (0.5 point) **Is** the equation in problem 3 in **canonical** form? Yes **or** (No)

6. (1 point) **Prove** that B(B+C) =B (Book reference: T9 covering theorem) using perfect induction. That is, evaluate both expressions in a truth table and confirm that they agree in all rows. Be sure to include all intermediate terms as columns, including NOTs.

B	C	B+C	LHS = B(B+C)
0	0	0	0
0	1	1	0
1	0	1	1
1	1	1	1

= B col. ∴ equation is true

7. (2 points) **Complete** the truth table for the following schematic. **Include** columns for each intermediate term (all gate outputs); there are more columns than you need in the given table.



A	B	C	R	Q	Y			
0	0	0	1	1	0			
0	0	1	1	0	1			
0	1	0	1	1	0			
0	1	1	1	0	1			
1	0	0	1	1	0			
1	0	1	1	0	1			
1	1	0	0	1	1			
1	1	1	0	0	1			

8. (1 point) **Write** the equation **directly** from the **schematic** above.

$Y = \overline{\overline{AB}\,\overline{C}}$

9. (1 point) **Explain** which type canonical equation (SOP/POS) will be simpler based on your truth table above. Hint: Consider how many 1s/0s are in the output column.

POS is simpler since it only requires 3 of 8 ($< 1/2$) of the terms.

10. (1 point) **Write** the simpler of the 2 canonical equations.

$Y = (A+B+C)(A+\overline{B}+C)(\overline{A}+B+C)$

$= M_0 \quad M_2 \quad M_4$