EEM16 Quiz #1

YICHEN LYU

TOTAL POINTS

20 / 20

QUESTION 1

1 (a)-(c) 7.5 / 7.5

- ✓ **- 0 pts (a) Correct**
- ✓ **- 0 pts (b) Correct**
  - **- 1 pts** (b) incorrect literals
  - **- 1 pts** (b) not fully
- ✓ **- 0 pts (c) Correct**
  - **- 1 pts** (c) N instead of ~N
  - **- 1 pts** (c) not fully
  - **- 1 pts** (c) not conjunctive
  - **- 0.5 pts** (c) error in literals

QUESTION 2

2 (d)-(h) 12.5 / 12.5

- ✓ **- 0 pts (d) Correct**
  - **- 1 pts** (d) missing/incorrect prime implicant
  - **- 1.5 pts** (d) incorrect Kmap
  - **- 1 pts** (d) missing or incorrect essential
- ✓ **- 0 pts (e) Correct**
  - **- 0.5 pts** (e) too many terms
  - **- 1.5 pts** (e) incorrect term
- ✓ **- 0 pts (f) Correct**
  - **- 2.5 pts** (f) incorrect factoring
- ✓ **- 0 pts (g) Correct**
  - **- 0.5 pts** (g) excess or lack of factoring
  - **- 0.5 pts** (g) partial application of DeMorgan
  - **- 2.5 pts** (g) incorrect DeMorgan
- ✓ **- 0 pts (h) Correct**
  - **- 1 pts** (h) missing or extra input/internal inversions
  - **- 1.5 pts** (h) incomplete erroneous design
  - **- 0.5 pts** (h) missing output inversion
  - **- 0.5 pts** (h) too many inversions (not optimized)
  - **- 2 pts** (h) not NAND
  - **- 2.5 pts** (h) incorrect

Quiz #1

Name (Last, First): Lyu, Yichen

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Do not start working until instructed to do so.

1. *You must answer in the **space provided** for answers after every question. We will ignore answers written anywhere else in the booklet. **All pages in this booklet must be accounted** for otherwise it will not be graded.*
2. *This quiz is closed book/notes.*
3. *You may not use any electronic device.*

Following table to be filled by course staff only

	Maximum Score	Your Score
TOTAL	20	

<intentionally blank – you may use this for scratch work>

Recall from Homework #1 where we have the 4 DNA nucleotides of G, C, T, and A. Let us represent them using 4-bit thermometer code, *t[3:0]*, where G=4'b0001, C=4'b0011, T=4'b0111, and A=4'b1111. A logic is used to indicate whether the input t[3:0] corresponds to a nucleotide. The output of this logic is *N*.

(a) Complete the truth table for N.

T[3]	T[2]	T[1]	T[0]	N
1	1	1	1	1
1	1	1	0	0
1	1	0	1	0
1	1	0	0	0
1	0	1	1	0
1	0	1	0	0
1	0	0	1	0
1	0	0	0	0
0	1	1	1	1
0	1	1	0	0
0	1	0	1	0
0	1	0	0	0
0	0	1	1	1
0	0	1	0	0
0	0	0	1	1
0	0	0	0	0

(b) Write the expression for N in Fully-Disjunctive Normal Form.

$N = (T[3]\,T[2]\,T[1]\,T[0]) \vee (\overline{T[3]}\,T[2]\,T[1]\,T[0]) \vee (\overline{T[3]}\,\overline{T[2]}\,T[1]\,T[0]) \vee (\overline{T[3]}\,\overline{T[2]}\,\overline{T[1]}\,T[0])$

(c) Write the expression for ~N in Fully-Conjunctive Normal Form

$\sim N = \overline{(\overline{T[3]}\,T[2]\,T[1]\,T[0]) \vee (\overline{T[3]}\,T[2]\,T[1]\,T[0]) \wedge (\overline{T[3]}\,\overline{T[2]}\,T[1]\,T[0]) \vee (\overline{T[3]}\,\overline{T[2]}\,\overline{T[1]}\,T[0])}$

$= \overline{T[3]}\,T[2]\,T[1]\,T[0] \wedge (\overline{T[3]}\,T[2]\,T[1]\,T[0]) \wedge (\overline{T[3]}\,\overline{T[2]}\,T[1]\,T[0]) \wedge \overline{T[3]}\,\overline{T[2]}\,\overline{T[1]}\,T[0]$

$= (T[3] \vee \overline{T[2]} \vee \overline{T[1]} \vee \overline{T[0]}) \wedge (\overline{T[3]} \vee T[2] \vee \overline{T[1]} \vee \overline{T[0]}) \wedge (\overline{T[3]} \vee \overline{T[2]} \vee T[1] \vee \overline{T[0]})$

$\sim N = (\overline{T[3]} \vee \overline{T[2]} \vee \overline{T[1]} \vee \overline{T[0]})\,(T[3] \vee \overline{T[2]} \vee \overline{T[1]} \vee \overline{T[0]})\,(\overline{T[3]} \vee T[2] \vee \overline{T[1]} \vee \overline{T[0]})$

$(\overline{T[3]} \vee T[2] \vee T[1] \vee \overline{T[0]})$

(d) Draw the Karnaugh Map of the Truth Table. Circle the prime implicants, indicate which one(s) are essential (if any).

T[1:0] \ T[3:2]	00	01	11	10
00	0	0	0	0
01	1	0	0	0
11	1	1	1	0
10	0	0	0	0

The prime implicants are $\overline{T[3]}\,\overline{T[2]}\,T[0]$, $\overline{T[3]}\,T[1]\,T[0]$, $T[2]\,T[1]\,T[0]$

EPI: $\overline{T[3]}\,\overline{T[2]}\,T[0]$ and $T[2]T[1]T[0]$

(e) Using the K-map in (d) as the minimized 2-level logic, write the sum-of-product expression using the fewest number of terms and literals.

N = $\overline{T[3]}\,\overline{T[2]}\,T[0] \vee T[2]\,T[1]\,T[0]$

(f) Can you do better (reduce the number of literals), by using Boolean properties? If so, write the expression and indicate which property you used.

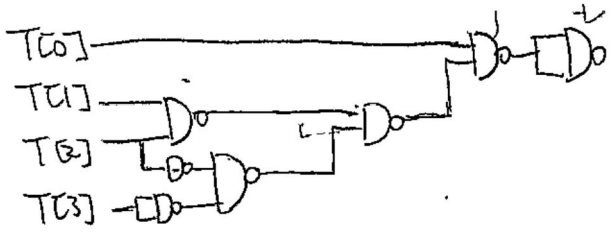
N = $T[0]\,(\overline{T[3]}\,\overline{T[2]} \vee T[2]\,T[1])$

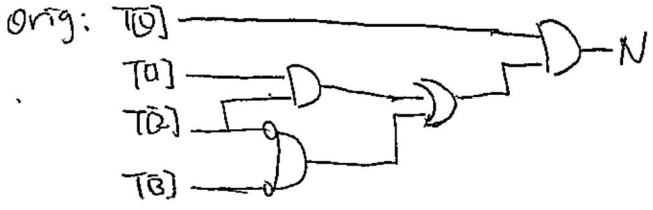
Property: associative property

(g) Use DeMorgan's theorem and write the inverse of the function in (f).

$\sim N = \overline{T[0]} \vee (\overline{\overline{T[3]}\,\overline{T[2]} \vee T[2]\,T[1]}) = \overline{T[0]} \vee (T[3] \vee T[2]) \wedge (\overline{T[2]} \vee \overline{T[1]})$

(h) Show a combinational circuit that implements N from (f) (with *T[3:0]* as inputs) using only 2-input NAND gates.





by replacing with with with