University of Washington – Computer Science & Engineering

Spring 2020 Instructor: Clarice Larson 2020-04-28

CSE 369 QUIZ 1

Name: _Molly_Model_____

UWNetID: _model_____

Please do not turn the page until 11:30.

Instructions

- This quiz contains 3 pages, including this cover page. You may use the backs of the pages for scratch work.
- Please clearly indicate (box, circle) your final answer.
- The quiz is open book and open notes.
- Please silence and put away all cell phones and other mobile or noise-making devices.
- You have 20 minutes to complete this quiz.

Advice

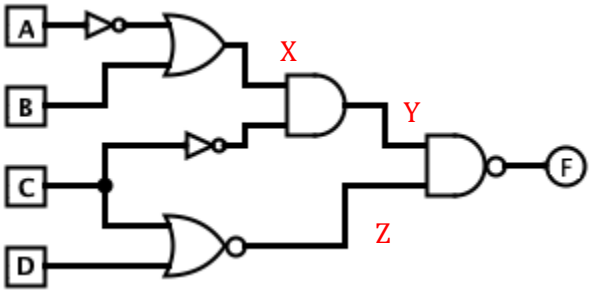
- Read questions carefully before starting. Read *all* questions first and start where you feel the most confident to maximize the use of your time.
- There may be partial credit for incomplete answers; please show your work.
- Relax. You are here to learn.

Question	Points	Score
(1) CL Gates	8	8
(2) K-map	5	5
(3) Waveforms & Verilog	11	11
Total:	**24**	**24**

Question 1: Combinational Logic Gates [8 pts]

(A) Write out a Boolean expression for the circuit diagram below. *No need to simplify.* Remember to use + (OR), · (AND), and ¯ (NOT) as well as any necessary parentheses to make your answer unambiguous. [2 pts]

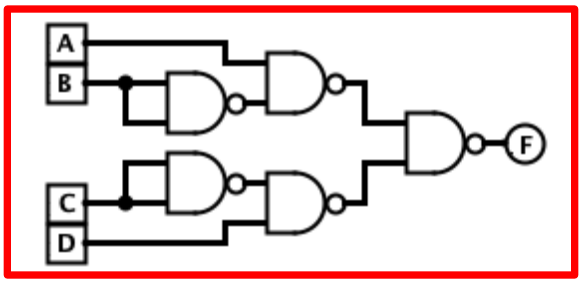
$\mathbf{F = \overline{((\bar{A} + B) \cdot \bar{C}) \cdot (\overline{C + D})}}$



$X = \bar{A} + B$ [0.5 pt]
$Y = X \cdot \bar{C}$ [0.5 pt]
$Z = \overline{C + D}$ [0.5 pt]
$F = \overline{Y \cdot Z}$ [0.5 pt]

(B) Find a minimal implementation of the function below using only **2-input NAND gates**. *We will only accept circuit diagrams.* [6 pts]

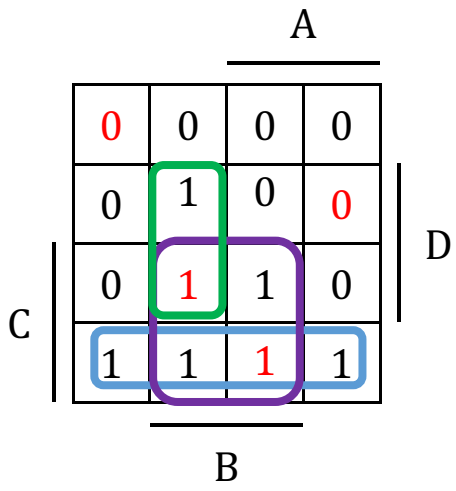
$$F = \left(\overline{\bar{A} + B}\right) + \bar{C}D$$



[2 pt] Valid gate conversion from expression
[2 pt] DeMorgan's applications (either in expression or gates)
[2 pt] Conversion of extra NOTs to NANDs

Question 2: Karnaugh Maps [5 pts]

Find the *minimum sum-of-products solution* for the K-map shown below.



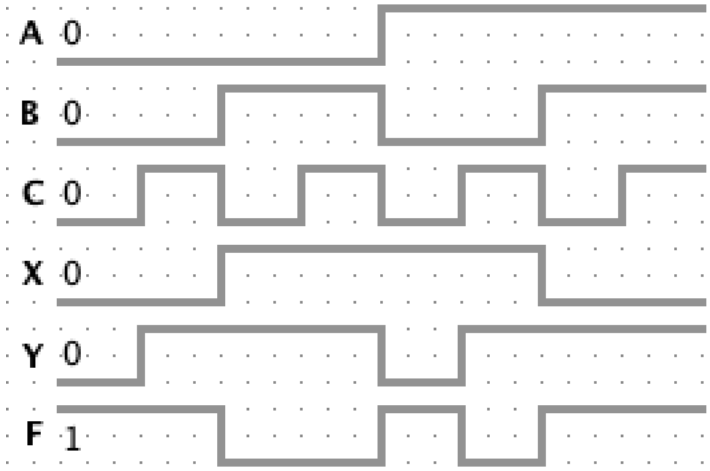
$F = C\bar{D} + BC + \bar{A}BD$

[2 pt] X choices
[1 pt each] correct term/grouping
[-0.5 pt each] smaller grouping used
[-0.5 pt each] extra grouping included

Question 3: Waveforms & Verilog [11 pts]

(A) Consider the Verilog simulated testbench waveforms shown. If we know that X and Y are outputs of 2-input logic gates, complete the module `Mystery` below. [8 pts]

For both X and Y:
[2 pt] Correct input signals
[1 pt] Correct gate used
Overall:
[1 pt] Correct Verilog syntax

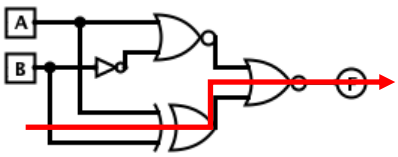



```
module Mystery (F, A, B, C);
      output logic F;
      input  logic A, B, C;
      logic   X, Y;

      xor  G1 (X, A, B); or assign X = A ^ B;

      or   G2 (Y, B, C); or assign Y = B | C;

      nand G3 (F, X, Y);
endmodule
```

(B) Given the Verilog module `Circuit` below, assume the logic delays shown. If the values of inputs A and B first become known at $t = 0$ and output F is unknown at $t = 0$, at what time will you know the value of F? [3 pts]

XOR	NOR	NOT
20 ns	8 ns	4 ns

```
module Circuit (F, A, B);
      output logic F;
      input  logic A, B;

      assign F = ~(~(A | ~B) | (A ^ B));
endmodule
```



$t = 28$ ns