CprE 281 HW03

ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Design Examples, Intro to Verilog
Assigned Date: Third Week
Finish by Sep. 12, 2022

P1. (10 points) Write the following expressions as Verilog behavioral assign statements:
E.g., $F = \bar{A}$ as a Verilog assign statement would be "assign F = ~A":

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

P2. (10 points) Match the following descriptions to the Verilog code representation it describes. I.e., Structural or Behavioral Verilog code

A. Verilog code used to abstractly describe a circuit using logic expressions and programming constructs.
B. Verilog code used to describe a circuit in terms of circuit elements, such as logic gates.

P3. (10 points) Given the behavioral-continuous Verilog code below:

```
module Q1(f, a, b, c);
      output f;
      input a, b, c;

      assign f = (~(a&b)|c)&(b|(~a&c);

endmodule
```

A. Rewrite using structural Verilog
B. Rewrite using behavioral-procedural Verilog

P4. (20 points) Given the truth table shown below:

W	X	Y	Z
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

A. Find the simplified boolean expression for this table
B. Write the structural Verilog code for the circuit
C. Write the behavioral-continuous Verilog code for the circuit.
D. Write the behavioral-procedural Verilog code for the circuit

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P5. (20 points) Given the expression $\mathrm{F(A, B, C)} = \sum m(0,1,3,5)$:

A. Write the expression as a simplified SOP expression
B. Write the expression as a simplified POS expression
C. Implement the expression using only NOR gates
D. Implement the expression using only NAND gates
E. Which expression did you use for part C? For part D? Why?

P6. (15 points) Show how to implement the following:

a) 3-input XOR using NAND gates
Hint: How would you implement a 3-input XOR with 2-input XOR gates?
b) 4-input NOR gate using five 2-input NOR gates.
c) 16-to-1 MUX using five 4-to-1 MUX's

P7. (15 points) Given the truth table shown below:

A	B	C	H
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

a) Write the expression for H, then use boolean algebra to obtain the simplified POS expression
b) Write the shorthand SOP expression for H as the sum of the maxterms.
c) Implement a circuit for H which uses exactly 4 NOR gates and no other gates.