

Cpr E 281 MINI  
**PROJECT**  
 ELECTRICAL AND COMPUTER  
 ENGINEERING  
 IOWA STATE UNIVERSITY

Mini Project Answer Sheet

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Lab Section: 1

Date: 3/01/22

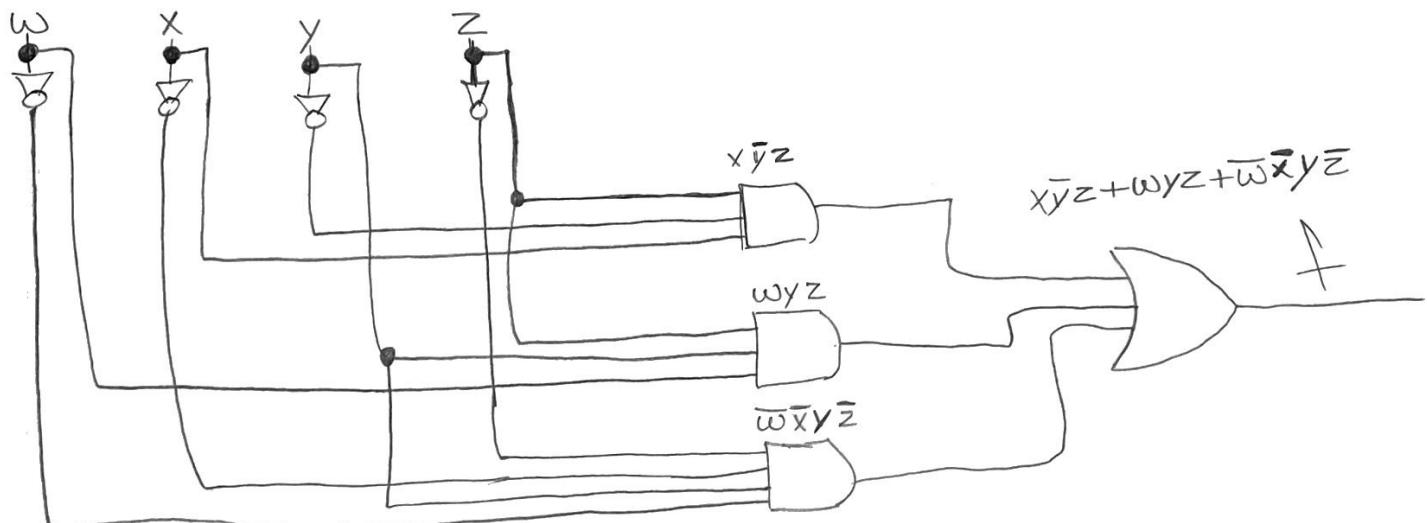
**PRELAB:**

Read the Mini-Project lab document and complete as much of this answer sheet as you can before lab.

TA Initials: J

**LAB:**

4.0 Draw Uncle Bob's circuit below, using only AND, OR, and NOT gates.  $\text{NAND} \rightarrow \text{SOP}$



Bob's Circuit =  $x\bar{y}\bar{z} + wyz + \bar{w}\bar{x}\bar{y}\bar{z}$

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Mini Project Answer Sheet

5.0 Give the shorthand canonical SOP expression for Uncle Bob's circuit and then the Verilog code which implements this behavior:

$$B(W, X, Y, Z) = \underline{X\bar{Y}Z + WYZ + \bar{W}\bar{X}Y\bar{Z}}$$

Verilog:

```
module mProjStep1(F,W,X,Y,Z);
    input W,X,Y,Z;
    output F;
    assign F=(X&~Y&Z)|(W&Y&Z)|(~W&~X&Y&~Z);
endmodule
```

Demonstration of Quartus Results:

M. IC-S

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6.0 Truth table for Uncle Bob's function B and the 4-bit prime detector function P.

	W	X	Y	Z	B	P
Y	0	0	0	0	0	0
! *	0	0	0	1	0	0
*	0	0	1	0	1	1
*	0	0	1	1	0	1
! *	0	1	0	0	0	0
! *	0	1	0	1	1	1
*	0	1	1	0	0	0
*	0	1	1	1	0	1
1	0	0	0	0	0	0
1	0	0	1	0	0	0
1	0	1	0	0	0	0
! *	1	0	1	1	1	1
*	1	1	0	0	0	0
! *	1	1	0	1	1	1
*	1	1	1	0	0	0
!	1	1	1	1	1	1

0011  
0111  
1111

$$P = (\bar{y} \cdot z) + (\bar{w} \cdot \bar{x}) + (\bar{x} \cdot y)$$

Diagram of a 4-bit prime detector function P:

P	wx	yz	00	01	11	10
00	0	0	0	0	0	0
01	0	0	0	1	1	0
11	0	1	1	0	0	1
10	1	0	0	0	0	0

Simplified SOP Expression:

$$P(W, X, Y, Z) = \overline{W}\bar{X}Y + \bar{X}YZ + \overline{W}XZ + XY\bar{Z}$$

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Mini Project Answer Sheet

7.0 Give your implementation of the correct 4-bit prime detector circuit ( $P$ ) below as either Verilog or a schematic (your choice). Then demonstrate the results:

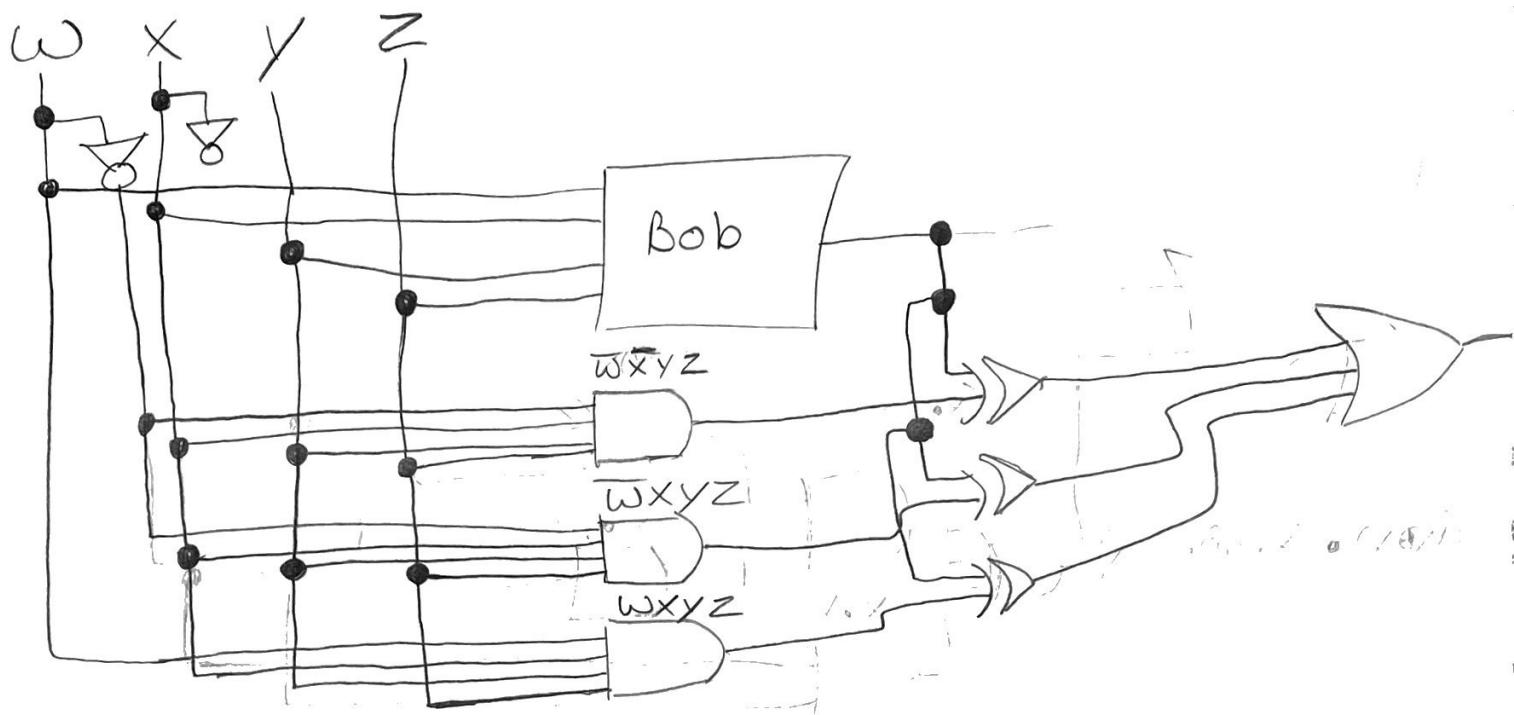
```
module mProjStep2(F,W,X,Y,Z);
    input W,X,Y,Z;
    output F;
    assign F = (~W&~X&~Y) | (~X&~Y&Z) | (~W&~X&Z) | (X&~Y&Z);
endmodule
```

Demonstration of ModelSim Results: M.K.S.

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Mini Project Answer Sheet

8.0 Design and implement a circuit that uses Uncle Bob's circuit but fixes his mistakes.  
Draw it below and demonstrate the results:



Demonstration of ModelSim Results: M9.1C-S