Name:_____

Honor Pledge: I am adhering to the Honor Code while taking this test.

Signature:_____ Date:_____

25 points total.

1. (Five points.) The trustees of Karnaugh University (Alice, Bob, Carol, and David) have convened once more! They're considering a proposal to require Digital Electronics to be taught by a robot.

If two or three of the trustees vote YES: the proposal passes, unless Carol is one of the YES votes, in which case the proposal fails.

However, if Carol casts the only YES vote, the proposal passes.

In all other cases, the University will makes its decision without even caring about how the trustees voted.

A. Complete this truth table, where 1 as an input represents a YES vote, and 1 as an output represents the passage of the proposal. X as an output represents "don't care."

A	B	C	D	PASS
0	0	0	0	X
0	0	0	1	X
0	0	1	0	1
0	0	1	1	0
0	1	0	0	X
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	X
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	X

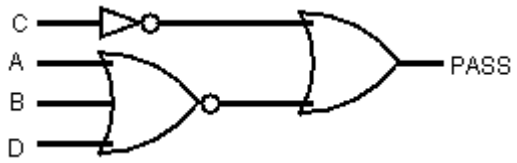
B. Write out a K map equivalent to the truth table.

		CD			
		00	01	11	10
AB	00	**X**	**X**	**0**	**1**
	01	**X**	**1**	**0**	**0**
	11	**1**	**1**	**X**	**0**
	10	**X**	**1**	**0**	**0**

C. Write out any logic equation that implements the truth table. You may use as many gates as you like.

PASS = ~C + ~(A+B+D)

D. Write out the circuit diagram equivalent to the logic equation.



E. Write out a minimized logic equation. (Hint: Only two gates are required, though one has three inputs.) Your responses to C and E may be identical.

PASS = $\overline{C(A+B+D)}$ (one NAND and one three-input OR)

2. Greatjon Umber, Rickard Karstark, Maege Mormont, Galbart Glover, and Jonos Bracken are deciding whether to declare Robb Stark a King in the North. Four YES votes are required to declare Robb a King in the North. Greatjon Umber votes YES unless all four of the others vote NO.

A. (One point.) Complete this truth table, where 1 as an input represents a YES vote, and 1 as an output represents that at least four of the five voters voted YES.

RK	MM	GG	JB	King in the North
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

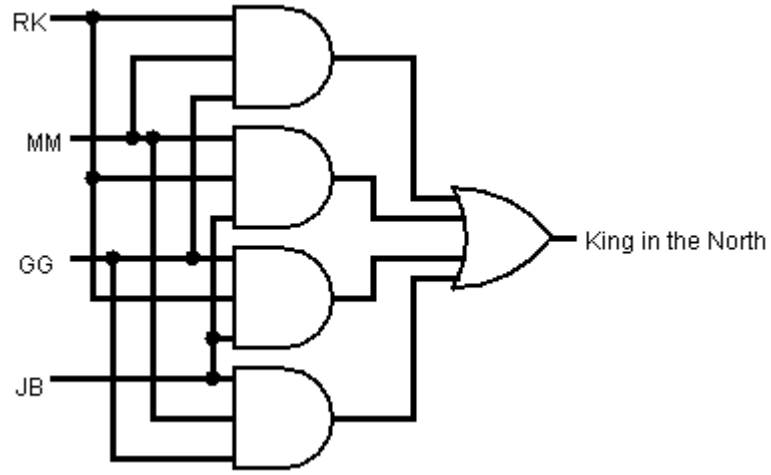
B. (One point.) Write out a K map equivalent to the truth table.

		(GG)(JB)			
		00	01	11	10
(RK)(MM)	00	**0**	**0**	**0**	**0**
	01	**0**	**0**	**1**	**0**
	11	**0**	**1**	**1**	**1**
	10	**0**	**0**	**1**	**0**

C. (One point.) Write out minimized logic equation (using as few gates as possible) equivalent to the K map. (Hint: Five gates are required.)

King-in-the-North = RK&MM&GG | RK&MM&JB | RK&JB&GG | JB&MM&GG

D. (One point.) Draw the circuit diagram equivalent to your response to part C.



E. (Nine points.) Write a Verilog module that computes a sum and uses an **if** statement to determine whether Robb Stark is declared King in the North. There should be four input variables: RK, MM, GG, and JB. Let GU be an internal signal; assign it a value according to the input variables.

```
module partE (input RK, input MM, input GG, input JB, output reg King);

wire GU;

wire [2:0] sum;

assign GU = RK | MM | GG | JB;

assign sum = GU + RK + MM + GG + JB;

always @ (*)

if (sum < 4) King = 0;

else King = 1;

endmodule
```

3. (One point.) Convert **00101101** (assuming two's complement representation) into base 10.

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4. (Six points.) Compute the binary sums, indicating the values of the carry and overflow flags.

```
  11111110
 +00111110
 ---------
  00111100        Carry:  1       Overflow:  0


  01010101
 +11001101
 ---------
  00100010        Carry:  1       Overflow:  0
```