25 points total. Don't miss the binary arithmetic on the back of the last page!

1. The trustees of Karnaugh University (Alice, Bob, Carol, and David) have convened once more! They're considering a proposal to require all students to take Digital Electronics. If Alice, Bob, and Carol all vote YES, the proposal will pass. If Bob, Carol, and David all vote NO, the proposal will fail. In all other cases, the University will make its decision without even caring how the trustees voted.

A. (One point.) 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	0
0	0	0	1	X
0	0	1	0	X
0	0	1	1	X
0	1	0	0	X
0	1	0	1	X
0	1	1	0	X
0	1	1	1	X
1	0	0	0	0
1	0	0	1	X
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	1
1	1	1	1	1

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

C. (One point.) Write out any logic equation that implements the truth table. You may use any number of logic gates (any number at all).

D. (Three points.) Write a Verilog module (including the **module** and **endmodule** statements) that implements the circuit equivalent to your logic equation.

2. The surviving victors (Beetee, Peeta, Annie, Enobaria, Katniss, Haymitch, and Johanna) are voting on whether to hold the Hunger Games one last time. Peeta votes NO. Haymitch votes the same way as Katniss, and Johanna votes the opposite way as Annie. The majority of the seven votes determines the outcome.

A. (One point.) Complete this truth table, where 1 as an input represents a YES vote, and 1 as an output indicates that a majority of the **seven** victors voted YES.

Beetee	Annie	Enobaria	Katniss	Majority
0	0	0	0	_____
0	0	0	1	_____
0	0	1	0	_____
0	0	1	1	_____
0	1	0	0	_____
0	1	0	1	_____
0	1	1	0	_____
0	1	1	1	_____
1	0	0	0	_____
1	0	0	1	_____
1	0	1	1	_____
1	1	0	0	_____
1	1	0	1	_____
1	1	1	0	_____
1	1	1	1	_____

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

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

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

E. (One point.) We know that the sum of the seven votes is Sum = (Beetee + Peeta + Annie + Enobaria + Katniss + Haymitch + Johanna). Now write an expression for Sum in terms of only three of the input variables. (I'm looking for arithmetic and regular algebra, not Boolean algebra.)

F. (Seven points.) Using your result from part E, write a Verilog module that computes a sum and uses an **if** statement (but no explicit Boolean operators) to determine whether the majority of victors voted YES or NO.

3. (One point.) Convert **11101101** (assuming two's complement representation) into base 10.

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

      00111110

    +10111110

                Carry: Overflow:

      01000101

    +11010001

                Carry: Overflow: