

Name: \_\_\_\_\_

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

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

25 points total.

1. Using 8-bit binary (and assuming the existence of a carry flag and an overflow flag)....

A. Convert 4C from hexadecimal to binary.

B. Convert C4 from hexadecimal to binary.

C. Find the sum of 4C + C4 in binary.

D. Interpreting the three numbers (addends and sum) as unsigned binary, convert them all to base 10. Is the arithmetic correct in base 10? If there's any ambiguity involving the carry flag, just explain.

E. Interpreting the three numbers (addends and sum) as 8-bit two's complement, convert them all to base 10. Is the arithmetic correct in base 10?

F. What is the value of the carry flag resulting from the operation in Part C?

G. What is the value of the overflow flag resulting from the operation in Part C?

2. Iron Man, the Hulk, Black Widow, and Captain America are voting on whether to make another Avengers movie (because of course these decisions are made by the fictional characters themselves). Iron Man's vote counts as a regular vote, and it also determines how the Hulk's vote is counted: If Iron Man votes 0, the Hulk's vote doesn't count, and a majority of the three remaining votes determines the outcome. If Iron Man votes 1, the Hulk's vote counts as two votes, and a majority of the five votes determines the outcome. In all cases, 1 as an input is a vote to make another movie, and 1 as an output is the final decision to make it.

A. Write out a K map to design a circuit that indicates the outcome of the vote.

B. Write out an equivalent logic equation that requires at most three **standard** gates with any number of inputs. (Standard gates: NOT, AND, OR, NAND, NOR, XOR, XNOR).

C. (Three points.) Without using an always block, write a Verilog module to implement the circuit.

D. (Ten points.) Write a Verilog module to implement the circuit using only one assign statement, which assigns to "sum" the direct sum of the four votes (before modifying the Hulk's vote). Besides this assign statement, you may use any other Verilog expressions required to implement the complete circuit.

3. The trustees of Karnaugh University (Alice, Bob, Carol, and David) are voting on whether to demolish the university and replace it with luxury condominiums. The outcome of this important vote is determined by extremely nonsensical rules.

If Alice and Bob cast opposite votes, then David's vote determines whether the university will be demolished.

If Alice and David cast opposite votes, then once again David's vote determines whether the university will be demolished.

If all four trustees vote the same way (whether 0 or 1), the university will be demolished.

In all other cases, the trustees don't even care whether the university is demolished.

A. Write out a K map to solve this problem, where 1 as an input is a vote to demolish the university, and 1 as an output is a final decision to demolish the university. X as an output represents "don't care."

B. Write out any logic equation that implements the K map. You may use as many gates as you like.

C. Write out an equivalent logic equation that requires at most two **standard** gates with any number of inputs. (Standard gates: NOT, AND, OR, NAND, NOR, XOR, XNOR). Your responses to B and C may be identical.