NOTE: It is my policy to give a failing grade in the course to any student who either gives or receives aid on any exam or quiz.

INSTRUCTIONS: Circle the letter of the best choice for multiple-choice questions. Answer other questions as indicated. Use pencil, if you have one, for diagrams.

1. On average, how many yes/no questions should it take to determine which card a person has picked from a normal 52-card deck?
   A. 1
   B. 4
   C. 13
   D. 52
   E. $log_2(52)$

2. What do all odd numbers have in common?
   A. They are all positive.
   B. They can all be divided evenly by 2.
   C. In binary, their rightmost bit is always 1.
   D. Their value can always be determined by asking 20 yes/no questions.
   E. Their value can always be determined by asking 2^{20} yes/no questions.

3. Why is the hexadecimal number system used so often?
   A. It does integer arithmetic faster than binary.
   B. It's more precise than decimal.
   C. It helps obscure cryptanalysis calculations.
   D. It can represent a binary value exactly using ¼ as many characters as binary itself.
   E. It's the only way to do arithmetic involving fractions.

4. Using two's complement notation, why are there more negative numbers than positive?
   A. Negative numbers are smaller, so more of them fit into the same space.
   B. There has to be an even numbers of values that can be represented, and one of them has to be zero, so that means there cannot be the same number of positive and negative values.
   C. Negative numbers are more important than positive numbers, so there are more of them.
   D. This is a bogus question: everyone knows there are more positive numbers than negative numbers when using two's complement.
   E. This is a bogus question: there are exactly the same number of numbers greater than zero as there are numbers that are less than zero when using two's complement.

5. How much is 2^{10}?
   A. 256
   B. 512
   C. 1024
   D. 2048
   E. 10^3

6. How many nanoseconds are there in a millisecond?
   A. 0.001
   B. 1 (they are synonyms)
   C. 1,000
   D. 1,000,000
   E. 1,000,000,000

7. What is the period of a 1 MHz signal?
   A. 1 sec
   B. 0.001 sec
   C. 0.000001 sec
   D. 0.000000001 sec
   E. 0.000000000001 sec

8. How long is one picosecond?
   A. 0.001 sec
   B. 0.000001 sec
   C. 0.000000001 sec
   D. 0.000000000001 sec
   E. 0.000000000000001 sec

9. How long is one picosecond, in nanoseconds?
   A. 1,000,000 nsec
   B. 1,000 nsec
   C. 0.001 nsec
   D. 0.000001 nsec
   E. 0.000000001 nsec

10. What is the period of a 5 GHz signal?
    A. 5 GHz
    B. 200 milliseconds
    C. 200 microseconds
    D. 200 nanoseconds
    E. 200 picoseconds

11. How many bytes are there in a 250 GB disk?
    A. 250×10^{30}
    B. 250×2^{30}
    C. 250×10^{9}
    D. 250×2^{9}
    E. 256

12. How many bits would it take to select one byte from a 1 MB memory?
    A. 1
    B. 10
    C. 20
    D. 30
    E. 40

13. What is the decimal value of this 32-bit two's complement number: 11111111111111111111111111011001?
    A. -3
    B. +3
    C. -345,724,212,314,145,652,435
    D. +345,724,212,314,145,652,435
    E. The same as the decimal value of this 7-bit two's complement number: 1011001.

14. What is the 4-bit two's complement representation of negative 7?
    A. 1111
    B. 0111
    C. 17
    D. 1001
    E. 07

15. If you are working with 4-bit two's complement numbers, what do you get if you negate 0101_2?
    A. 1001
    B. 1010
    C. 1011
    D. 1100
    E. 1101

16. Assuming 16-bit two's complement notation, what is the decimal value of hex FFFE?
    A. +2
    B. -2
    C. +3
    D. -3
    E. All of the above.

17. Fill in the empty cells in the following table for the 4-bit version of the MIPS ALU. All values given are in hexadecimal. The function bits are A_{inv}, B_{neg}, F_1, and F_0 from left to right. The condition code bits are Carry, Overflow, Negative, and Zero from left to right. You may answer in either binary or hexadecimal, but be consistent.

A	B	Function	Result	Condition Code
3	5	1		
3	5	2		
3	5	6		
3	5	7		
3	D	2		
8	F	2		

18. Minimize this function using a Karnaugh Map. Answer here, and show all work.

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0

19. Draw a schematic diagram for your minimized function in Question 18 using AND, OR, and NOT gates.

20. What is the *gate input count* for your minimized function? _____

21. How many *propagation delays* does your minimized function in Question 18 use? _____

22. Draw a symbol for a 4 × 1 multiplexer; label all inputs and outputs meaningfully. Look at the next question before you answer this one.

23. Draw the AND, OR, and NOT gates to implement the multiplexer in the previous question.

24. Using symbols for full adders, draw a schematic diagram for a two-bit adder/subtracter for two's complement numbers.

25. Define the following terms:

A. *Propagation delay* _____

B. *Minterm* _____

C. *Hertz* _____

D. *Exclusive OR* _____

E. *Overflow* _____