

Instructions:

- For multiple choice questions, circle the letter of the **one best choice** unless the question explicitly states that it might have multiple correct answers.
- There is no penalty for guessing.
- Place drawings and other long answers on the backs of any exam sheets; **be sure to put the question number next to those answers**; use pencil rather than ink.
- Multiple choice questions count approximately 2/3 as much as the others.

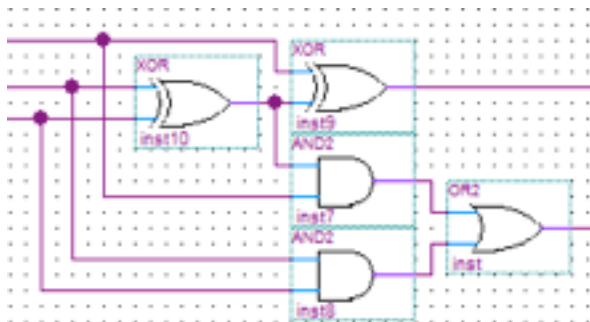
1. Are you allowed to use a calculator or other electronic device during this exam?
 - A. No
 - B. No
 - C. No
 - D. No
 - E. I guess not.
2. Is a cell phone an electronic device?
 - A. Yes
 - B. Yes
 - C. Yes
 - D. Yes
 - E. You'd better believe it!
3. Which pair of values differ by two orders of magnitude?
 - A. 1 and 10
 - B. 9 and 328
 - C. 98 and 100
 - D. 1 milligram and 1 kilogram
 - E. 1 google and 1 yahoo!
4. The Canon i950 printer uses 2 picoliter ink drops and prints 74 million drops per second. At what rate does it use ink?
 - A. $2 \times 10^{-12} \times 74 \times 10^6$ picoliters
 - B. $2 \times 10^{-12} \times 74 \times 10^6$ seconds
 - C. $2 \times 10^{-12} \times 74 \times 10^6$ liters per picosecond
 - D. $2 \times 10^{-12} \times 74 \times 10^6$ seconds per picoliter
 - E. $2 \times 10^{-12} \times 74 \times 10^6$ liters per second
5. What is the frequency of a clock that has a 2,500 picosecond period?
 - A. 4
 - B. 0.0004
 - C. 4 GHz
 - D. 400 MHz
 - E. 0.0004 GHz
6. How many bits would be needed to select one of 32 registers?
 - A. 1
 - B. 32
 - C. 5
 - D. 8
 - E. 6.644
7. How many different values can be represented in 29 bits?
 - A. 512 million
 - B. 256 billion
 - C. 1024×29
 - D. 29^2
 - E. 58

8. What is the 8-bit two's complement representation of $+23_{10}$?
- A. 1110 1001
 - B. 0001 0111
 - C. 1110 1000
 - D. 1001 0111
 - E. 0010 0011
9. What is the 8-bit two's complement representation of -23_{10} ?
- A. 1110 1001
 - B. 0001 0111
 - C. 1110 1000
 - D. 1001 0111
 - E. 0010 0011
10. What is the two's complement of -23_{10} ? *Hint*: this question is not the same as the previous one.
- A. 1110 1001
 - B. 0001 0111
 - C. 1110 1000
 - D. 1001 0111
 - E. 0010 0011
11. Convert the unsigned binary number 1101.0110 to decimal.
- A. 123.456
 - B. 9.75
 - C. 11.25
 - D. 12.125
 - E. 13.375
12. Using 4-bit two's complement arithmetic, **circle the letters of all the calculations that will cause overflow to be true**. Show all binary calculations for possible partial credit for this question and the next one.
- A. $+3 + +5$
 - B. $+3 - +5$
 - C. $-5 + -3$
 - D. $+5 + -3$
 - E. $-5 - -3$
13. Using 4-bit two's complement arithmetic, **circle the letters of all the calculations that will cause carry to be true**:
- A. $+3 + +5$
 - B. $+3 - +5$
 - C. $-5 + -3$
 - D. $+5 + -3$
 - E. $-5 - -3$
14. Convert the hexadecimal number CAFE BABE into binary:
15. How many seconds would it take a processor with a 2.0 GHz clock and an average CPI (clocks per instruction) of 5.0 to execute a billion instructions? Answer below. Show your work for partial credit.

16. How many times faster would the processor be if the clock speed is increased to 2.5 GHz and the CPI is reduced to 4.0? Answer here. Show your work for partial credit.
17. If 20% of the instructions executed by a processor are floating-point add instructions, what is the maximum speedup that can be achieved by making floating-point addition faster?
- 0.125 times faster
 - 1.25 times faster
 - 12.5 times faster
 - 125 times faster
 - No speedup is possible
18. How many input and output wires connect to an 8x1 multiplexer?
- 8 inputs and 1 output
 - 1 input and 8 outputs
 - 11 inputs and 1 output
 - 7 inputs and 2 outputs
 - 0 inputs and 0 outputs
19. Write a truth table for a function with two input variables named A and B, and an output variable named Y. Make minterm numbers 0, 1, and 3 true. *Answer on the back of any exam sheet.*
20. Draw a *symbol* for one slice of the MIPS ALU *on the back of any exam sheet*; label all inputs and outputs meaningfully.
21. Using symbols for the full adder and multiplexer, draw a complete schematic for one slice of the MIPS ALU. *Put your answer on the back of any exam sheet.*
22. Give the values of the ALU function bits for performing each of the following operations:

Operation	A _{inv}	B _{neg}	F ₁	F ₀
AND				
OR				
Add				
Subtract				
Set Less Than				

23. What is the maximum number of propagation delays in this schematic? _____



24. Minimize this equation on the back of any exam sheet. You may use either algebra or a Karnaugh Map, but you must show all work for full credit.

$$y = \bar{a}\bar{b}\bar{c} + \bar{a}b\bar{c} + a\bar{b}c + abc$$