

600.102: Foundations of Computer Science

Midterm 1

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Time: 40 Minutes

Start here: Please fill in the following important information using a **permanent pen** before you do **anything** else! Your exam will **not** be graded if you use a pencil or erasable ink on this page.

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Ethics Pledge: With your signature you **certify** the information above and you also **affirm** the following:
“I agree to complete this exam without unauthorized assistance from any person, materials, or device.”

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Date: _____

Instructions: Please read these instructions carefully before you start. **Switch off** your phones, pagers, and other noisy gadgets! You are **not** allowed to have anything but a pen (pencil, eraser) and this exam on your desk. You are **not** allowed to talk to anyone during the exam. If you have a question, please raise your hand **quietly**. You must **remain seated quietly** until all exams have been collected. Remember that you can **not** claim grading errors if you do not use a **permanent** pen for your answers.

Do not open before you are told to do so!

You got _____ out of 40 points.

1 Binary Warmup

(12 points)

For each of the following statements, determine whether it is either **true** or **false**. (1 point each)

1. The addition of two n -bit numbers produces at most an $n + 1$ -bit result.
2. All combinatorial circuits can be implemented purely out of AND gates (using no other gates).
3. The number 10001011 in binary is -117 in decimal (signed interpretation).
4. One problem with ones-complement representation is that it can only represent even numbers.
5. A pseudo-instruction directs the processing of source code by the assembler.
6. Using memory-mapped I/O we can keep the address bus free for RAM and ROM exclusively.
7. An overflow condition cannot occur if we add a positive and a negative number.
8. Abstraction means ignoring certain details in order to focus more clearly on important issues.
9. The number 10001011 in binary is 139 in decimal (unsigned interpretation).
10. The circuit for a half adder has three inputs to add two digits and a carry.
11. The `nop` or no-operation instruction is 100% useless.
12. One problem with electronic voting systems is that they concentrate the elections in fewer hands.

2 Tough Choices

(8 points)

For each of the following questions, circle **one** answer out of the choices given. (2 points each)

1. Consider the **exclusive or** (XOR) gate. Its output A is high if and only if its two inputs X and Y are different. Which of the following is the **disjunctive normal form** (DNF) for the XOR?
 - (a) $A = X \cdot Y' + X' \cdot Y$
 - (b) $A = (X + Y)'$
 - (c) $A = (X' + Y') \cdot (X + Y)$
 - (d) $A = (X \cdot Y)'$
 - (e) None of the above.
2. Which of the following **most accurately** describes what an **interrupt** is?
 - (a) An interrupt is a state in which the processor does not know what to do.
 - (b) Interrupts were used in the 1950s to allow operators to stop overheating machines.
 - (c) Interrupts allow processors to react to asynchronous events such as network traffic.
 - (d) All of the above.
 - (e) None of the above.
3. The **range of values** representable by a **signed 16-bit register** is which of the following?
 - (a) -2^{16} to 2^{16}
 - (b) -2^{15} to 2^{15}
 - (c) $-2^{15} - 1$ to 2^{15}
 - (d) -2^{15} to $2^{15} + 1$
 - (e) None of the above.
4. Which of the following **cannot** be easily encoded for processing by a computer?
 - (a) Speed of a car.
 - (b) Length of a wall.
 - (c) Image from a television camera.
 - (d) Signals from a combinatorial circuit.
 - (e) None of the above.

4 Circuit Design

(12 points)

Design a 2-to-4 decoder circuit that sets **one of four outputs** to high depending on the binary pattern supplied on the **two inputs** (the other outputs should be low); use only NOT, AND, and OR gates. You can use whatever design techniques you feel comfortable with, but you should give me more than just the finished circuit. A block diagram and some truth tables would be nice for example.

This page is intentionally **mostly** blank in case you run out of space elsewhere. If you ended up here early, please go over **everything** again and remain seated **quietly**! Make sure that the title page is filled out correctly and in **permanent** pen. Maybe you want to "rewrite" your **answers** in permanent pen as well?