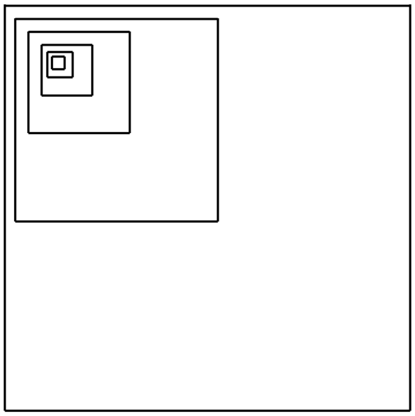
PES, Section 1.1

Introduction to Embedded Systems

1. Is the following picture an accurate depiction of Moore's Law? Explain your answer



The picture is inaccurate.

According to Moore's Law, the transistor density doubles every 18 months. In other words, the area of each transistor shrinks by one-half.

In the picture above, the X- and Y-dimensions of the transistor (length and width) are both shortened by one-half. If the area of the original transistor was XY, then the area after one generation of Moore's Law (18 months) is (½X)(½Y) = ¼XY, which is faster shrinkage than Moore's Law.

PES, Section 1.2
Basic Components

1. Which of the following basic components were not discussed in PES Section 1.2.

____ LED

_**X**__ Motion Detector

____ Button

____ Switch

_**X**__ Dial

_**X**__ Dip Switch

2. True or False?

The inputs and outputs to the Riverside-Irvine Microcontroller Simulator (RIMS) are analog signals. The programmer must write C code to perform analog-to-digital conversion to read the inputs and digital-to-analog conversion to write to the outputs.

False – The RIM inputs and outputs are digital.

3. True or False?

The RIMS inputs are named PortA0 … PortA7, and the RIM outputs are named PortB0 … PortB7.

False – The RIM inputs are named A0…A7 and the outputs are named B0…B7.

In-class exercises, quizzes, and exams will refer to RIM, not ATmega. Make sure that you don't confuse the two.

PES, Section 1.3
RIMS

1. Write a C program for RIMS that sets B2 = 1 whenever the numbers of 1s on A2, A1, and A0 is odd (i.e., when A2A1A0 are 001, 010, 100, or 111). Hint: Use logical OR (||) in addition to logical AND.

```
#include "RIMS.h"

void main() {
        while (1) {
                B2 =    (!A2 && !A1 && A0) ||
                        (!A2 && A1 && !A0) ||
                        (A2 && !A1 && !A0) ||
                        (A2 && A1 && A0);
        }
}
```

Name: ____

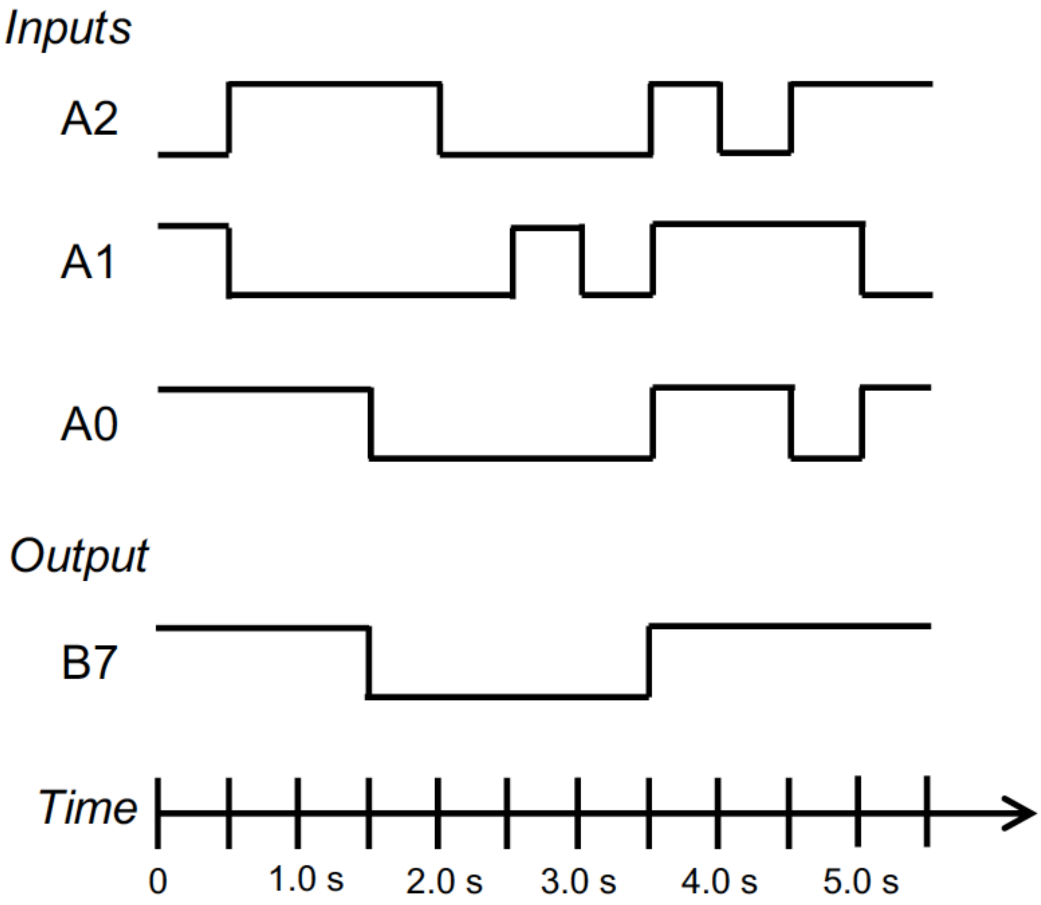
PES, Section 1.4
Timing Diagrams

1. The following C program for RIM sets B7 = 1 whenever the number of 1s on A2, A1, and A0 is greater than the number of zeroes (i.e., when A2A1A0 are 111, 110, 101, or 011).

```
#include "RIMS.h"

void main() {
        while (1) {
                B7 =   (!A2 &&  A1 &&  A0) ||
                       ( A2 && !A1 &&  A0) ||
                       ( A2 &&  A1 && !A0) ||
                       ( A2 &&  A1 &&  A0);
        }
}
```

A partial timing diagram for the three input signals is shown below. Complete the timing diagram by plotting the value for output signal B7.



Name: ____

2. (Note: The program below is the same as for Question 1.)

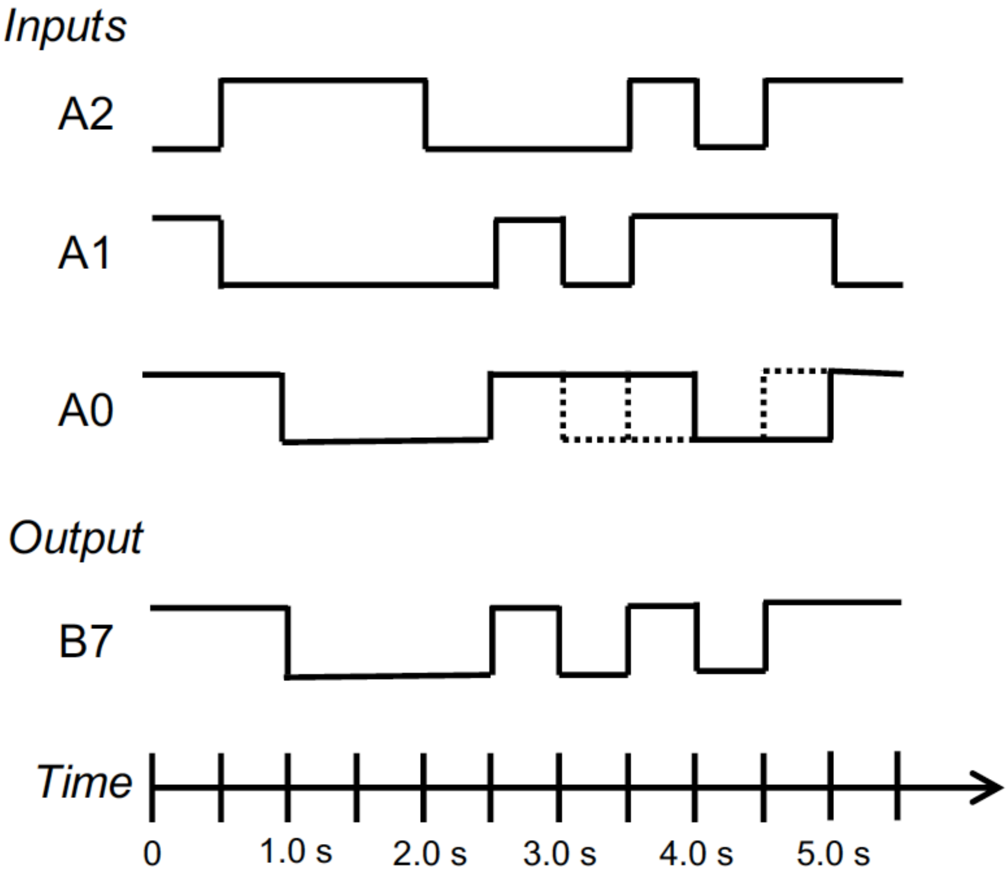
The following C program for RIM sets B7 = 1 whenever the number of 1s on A2, A1, and A0 is greater than the number of zeroes (i.e., when A2A1A0 are 111, 110, 101, or 011).

```
#include "RIMS.h"

void main() {
        while (1) {
                B7 =    (!A2 &&  A1 &&  A0) ||
                        ( A2 && !A1 &&  A0) ||
                        ( A2 &&  A1 && !A0) ||
                        ( A2 &&  A1 &&  A0);
        }
}
```

A partial timing diagram for the three input signals is shown below. Complete the timing diagram by plotting the value for input signal A0.

(Note: Multiple correct solutions are possible)



Name: ____

PES, Section 1.5
Testing

1. Explain the concept of 100% code coverage.

   When testing a program, you want to make sure that every statement executes at least once (i.e., make sure that both sides of each if-then-else statement are tested, all loops iterate at least once, etc.)

2. What is an assertion?

   An assertion compares the B7-B0 outputs to the given expected value, and prints a warning if those values do not match. Assertion statements provide a mechanism for detecting when a program is not behaving as intended.

3. Explain the following…

```
b00000000
wait 100 ms
assert b00000000
b00000001
wait 100 ms
assert b00000001
```

   This is an example of a test vector that also includes timing instructions.

   The first test vector sets inputs A1A0 to 00, waits 100 ms, and checks that B0 is 0. The second test vector then sets A1A0 to 01 and asserts that B0 is 1.