

Midterm 1: CST8227 Interfacing

Winter 2011

Time: 50 minutes; Test scored out of: 32 marks; Total Marks available: 35 marks
(Allocation of marks is shown beside each question)

Instructions:

1. BEFORE answering any questions, please check that your copy of the test has all pages (as indicated in the footer at the bottom of each page). Please read all questions carefully, then answer the question below first!
2. Be sure to **mark your name** on all pages of this midterm.
3. All work necessary for finding your answer should be shown on this test paper. If you do **not** show your work, **you will not get any marks!!**
4. No calculators are allowed. Numbers have been chosen to work out conveniently. Maybe you'd be better working in fractions instead of decimal values?
5. If you get stuck on a multi-part question, you can ask for help and get representative values to continue working on the later sections. You will **not** get credit for any answers you are given!
6. If you are uncertain what a question is asking, make reasonable assumptions, write those assumptions down on this test paper, and continue answering the question.

What is your:

NAME? _____

Student Id? _____

(Continued on next page)

1. A tricolour LED contains red, green, and blue LEDs. The red LED has an operating voltage of 2V; the blue and green LEDs have an operating voltage of 3V.

A. [4 marks] Assuming that we start by operating each LED with a convenient current of 2 mA, what is the ideal resistance to use for each LED with an Arduino? **Show your calculations.**

$$\begin{array}{ll} \text{Red @ 2V: } (5V - 2V) / 2 \text{ mA} = 1.5K \text{ ohm} & [2 \text{ marks}] \\ \text{Blue @ 3V: } (5V - 3V) / 2 \text{ mA} = 1K \text{ ohm} & [2 \text{ marks}] \end{array}$$

B. [2 marks] Your kit contains plenty of 220, 330, 1K, and 10K ohm resistors. How would you obtain the necessary resistance (or “close enough”, ie. +/- 5%) for each of the above values, using only resistors from your kit? **Show any work required.**

Blue LED: single 1K ohm resistor
Red LED: three resistors in series: 1K + 330 + 220 = 1550 ohms
OR 1K + a pair of 1K in parallel = 1500 ohms; other combos are possible

C. [3 marks] What are the colour markings on each of the resistors used above? Include a tolerance band.

1K = brown, black, red, gold
330 = orange, orange, brown, gold; 220 = red, red, brown, gold

D. [2 marks] After experimenting with your circuit, you find that the blue LED is only half as bright as the red LED. Explain clearly what you can do to make the blue LED brighter, so it matches the red LED. **Give exact values** of any new or different components and show any calculation(s) required.

LED is reasonably linear for brightness: double the current! Blue LED now gets 4mA.
New resistor = $(5V - 3V) / 4mA = 500 \text{ ohms}$

E. [1 mark] You determined what changes were necessary in the previous step. Can you satisfy those requirements from the components in your kit? Explanations must be **clear**.

Use two 1K ohm resistors in parallel to get 500 ohms of resistance.

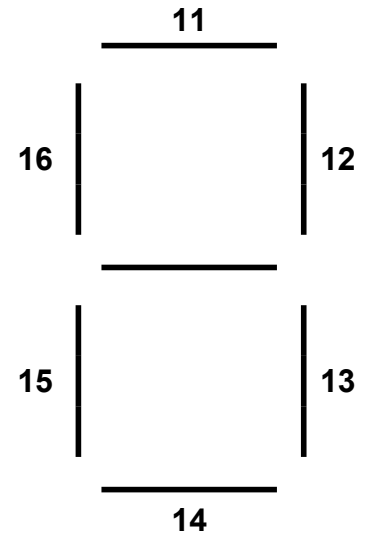
F. [3 marks] Give the chart below for the final result for the blue LED (ie. step D). Show all calculations.

1 mark = copy correct values; 1 mark = formula; 1 mark = correct value **and** units

| | Voltage | Current | Power |
|----------|-------------------|---------------------|-------------------------------------|
| blue LED | 3V (no change) | 4 mA (copy from Q!) | $3V * 4 \text{ mA} = 12 \text{ mW}$ |

2A. [7 marks+ 1 Bonus] Assume you have an Arduino connected to a 7-segment display and a switch. The 7-segment display is supplied with power to the common anode; individual segments are connected to the Arduino pins identified in the diagram (right). The switch is connected between Arduino pin 10 and ground (0V).

Write a complete, correct Arduino program which lights up each segment in succession with each press of the switch for example: **14, 15, 16, 11, 12, 13, 14, 15, 16, 11, 12, ...**



```
// Defines: nice, but not mandatory
#define SwitchPin 10
#define FirstSeg 11
#define StartSeg 14
#define LastSeg 16

void setup() { // 1 mark = setup() & loop()
  int I;
  pinMode( SwitchPin, INPUT );
  // 1 mark = initialize pin modes
  // 1 mark = set initial pin states
  for ( I = FirstSeg; I <= LastSeg; I++ ) {
    pinMode( I, OUTPUT );
    digitalWrite( I, HIGH );
  }
}

void loop() {
  int currSegment = StartSeg;

  if ( digitalRead(SwitchPin) == 0 ) { // 1 mark = switch press
    digitalWrite( currSegment, HIGH ); // 1 mark = turn off last
    if ( ++currSegment > LastSeg ) // 1 mark = roll-over
      currSegment = FirstSeg;
    digitalWrite( currSegment, LOW ); // 1 mark = turn on new
    while ( digitalRead(SwitchPin) == 1 ) // 1 mark = release sw
      ;
  }
}
```

2B. [1 mark] The above description is missing one item that is essential for the switch to operate reliably. What is that item? Be **clear**, giving values as necessary.

A **pull-up resistor** (between 5V and the switch) is needed to prevent a floating input.

3. [1 mark] If you program a Teensy to emulate a mouse movement of (10, 10), **clearly** describe the direction in which the mouse moves on the screen.

The mouse moves to the right and down.

4. [4 + 1 Bonus] A student would like a Teensy to emulate a mouse click on the Windows "Start" button, then use the Up arrow three times, and start the (highlighted) program. Explain **clearly** what steps can be done, giving specific names of functions you would use. Exact code is not required; the important part is the **method(s)**.

Absolute mouse positioning is not possible (in general) = 1 mark
(One work around is to blindly & repeatedly move the mouse South-West: Mouse.move()
It will eventually end up at "Start" no matter where it was originally.) = 1 mark
Mouse.click() generates a standard left-click. = 1 mark
Repeat Keyboard.print(KEY_UP) three times. = 1 mark
Do Keyboard.print(KEY_ENTER) = 1 mark

5. [1 mark] The Teensy is measuring one of it's inputs over 2000 times per second. You need to log all the data to a laptop computer. How could you do that? Give specific function names.

There is only one method: serial.print() which can transfer approx 1MB/sec.
Keyboard.print() is **not** acceptable because it's limited to ~500 keystrokes/sec.

6. [1 mark] Give a **clear** definition of the term "digital" when referring to electronic signals.

A voltage or current that is produced at one of several finite levels,
with a step-wise (abrupt) transition between levels.

7. [3 marks] State and explain some of the key parameters when comparing and evaluating compact systems such as embedded or mobile systems. Give typical values if possible.

See notes & graph from Wk03Day2 notes; any three of below are acceptable
Speed: Processor speed; typical values range from dozens of MHz to several GHz
Storage and Memory capacity: RAM, Flash; range from dozens of KB to GB
Power consumption: Usually battery powered; ranging from fractions to several watts
Cost: Limitations set by application; ranging from dozens to hundreds of dollars

Extra work or calculations