Midterm 1: CST8227 Interfacing

Fall 2011

Time: 60 minutes; Test scored out of: 30 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 are uncertain what a question is asking, make reasonable assumptions, write those assumptions down on this test paper, and continue answering the question.

6. Use the last page (blank) to show extra work, if necessary.

What is your:

NAME? _____ Student Id? _____

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1. [9 marks+1 Bonus] Digikey sells a white LED, of the kind used for flashlights and other similar lighting. I want to use a Teensy to control one of these LEDs at full brightness. It **must** operate **safely** so neither the Teensy nor the LED burn out. I need to plan out the actual circuit and calculate all operating values, so that I can order any other required components at the same time. The opposite page shows a relevant section of the data sheet; make reasonable choices as necessary. (You may ask for help with this question, but it will cost you marks.)

Include correct units for all values and show all your work!

A. Operating Values

Total current from 5V supply = _____

Voltage across the LED = _____

Extra component(s) required = _____
(component type(s) or "none")

Value of extra component(s) = _____
(if required)

B. Draw a circuit diagram which **clearly** shows how to wire up the circuit.

C. Bonus What special wiring and/or programming consideration must be used to operate this circuit safely? Be **clear** in your answer.

Description: "[This white] Power LED Light Source is a high performance energy efficient device which can handle high thermal and high driving current. The Cool White Power LED is available in various color temperature ranging from 4000K to 10000K and Warm White Power LED ranging from 2600K to 4000K."

Absolute Maximum Ratings at $T_A = 25°C$

Parameter	ASMT-Mx6x / ASMT-MxHx	Units
DC Forward Current [1]	150	mA
Peak Pulsing Current [2]	300	mA
Power Dissipation	555	mW
LED Junction Temperature	145	°C
Operating Ambient Temperature Range	-40 to +120	°C
Storage Temperature Range	-40 to +120	°C

Notes:
1. DC forward current – derate linearly based on Figure 7.
2. Pulse condition duty factor = 10%, Frequency = 1kHz

Optical Characteristics ($T_A = 25°C$)

		Correlated Color Temperature, CCT (Kelvin)		Viewing Angle 2θ½ [1] (Degrees)	Luminous Efficiency (lm/W)
Part Number	Color	Min	Max	Typ	Typ
ASMT-MW62-NGJ00	Cool White	4000	10000	110	83
ASMT-MW62-NHK00		4000	10000	110	99
ASMT-MY62-NGJ00	Warm White	2600	4000	110	77

Notes:
1. θ½ is the off-axis angle where the luminous intensity is ½ the peak intensity.

Electrical Characteristic ($T_A = 25°C$)

	Forward Voltage V_F (Volts) @ $I_F = 150mA$		Reverse Voltage V_R (Volts)	Thermal Resistance $R_{\theta j\text{-}ms}$ (°C/W)[1]
Dice Type	Typ.	Max.	Max.	Typ.
InGaN	3.3	3.7	5	27

Note:
1. $R_{\theta j\text{-}ms}$ is Thermal Resistance from LED junction to metal slug.

Digikey Part no: 516-2266-5-ND
Manufacturer part no: ASMT-MWH2-NFH00
Data sheet source: http://www.avagotech.com/docs/AV02-1319EN

2. [1 mark] What is the resistance, in ohms, of a resistor whose colour bands are:
gold, black, black, brown ?

3. [2 marks] How much power is converted to heat when a 10Ω resistor has 100mA flowing through it? Show all your work.

4. [1 mark] What colour bands would appear on a 680KΩ resistor?

5. [6 marks + 2 **Bonus**] Write a simple program for the Teensy which will take a reading of the voltage on pin 1, once per second, and "type" that into the host computer system running some sort of text editor or work processor. Note that measurements must be "typed" as the value in the range of 0 to 5 (volts). For any defaults, be sure to **include a comment** about it or them.

Bonus: Ensure the file is saved to disk after each value; include enough lines of code, reasonably close to being correct, to **convincingly** show that you know what to do.

6. [2 marks] Think about an ordinary kitchen fridge and its basic operation to keep food at a (*reasonably*) constant temperature. how would you characterize: (**A**) the temperature sensing method; and (**B**) the control of the cooling mechanism. Refer to “analog” and “digital” and any specific implementations of these two.

7. [1 mark] Give a **clear** definition of the term "analog" when referring to electronic signals.

8. [1 mark] Which is a faster data transfer method on the Teensy, the keyboard emulation or serial mode?

9. [1 mark] Your lab kit includes only the resistor values 220Ω, 330Ω, 1KΩ, and 10KΩ. A project requires a resistance as close as possible to 80Ω . How can you obtain that value?

10. [1 mark] You used a photocell light sensor in the theramin project for Lab 7. Did the resistance go up or down when light was shone on it?

(Continued on next page)

11. [7 marks] You have a project where you need to acquire (ie. receive) a stream of serial data. Unfortunately, the Arduino is too slow to capture each data bit, so you decide to use a shift register. The data **bits** are available as an electrical signal (normal 0-5V) but the data **clock** is available only as a flash of light. The resistance of your photocell light sensor varies between 1KΩ – 1MΩ with the light pulse (choose whichever value you like for light / no light).

The control and data signals for the 74HC575 shift register are:

SER = SERial input data
SRCLK = Shift Register CLocK, rising edge triggered
RCLK = output Register CLocK, rising edge triggered
$\overline{OE}$ = Output Enable (active low)
Q_A – Q_H = parallel data output

You must create a basic circuit diagram showing how things will be connected, including the following items:

A. [1 mark] **Clearly** show how you will arrange the photocell and another resistor to create a signal that varies from (close to) 0V to (close to) 5V when a light pulse occurs. **Clearly** indicate your assumption about how the photocell resistance changes with increased light.

B. [1 mark] **Clearly** show the connection from the photocell circuit to a suitable shift register pin. Label the pin by its signal name. Connect this same signal to some pin on the Arduino (just pick some number so you can reference it in your code below). 'HC575 = SRCLK

C. [2 marks] **Clearly** show all necessary shift register connections: data signals, control signals, and connections to the Arduino. Identify shift register pins by name, and choose numbers for Arduino pins (so they can be referenced in your code below).

D. [3 marks] Write a snippet of Teensy code to poll the photocell input. (1)When it goes High for the 8th time, activate the shift register so the serial data is available on the output pins and then (2) read this data. [You may use approximate / pseudo code for (2), but it must be very **clear** !]

(Continue your work from the previous question on this page)