EECS 498 homework 3a: *Due 12/5 by 3pm*

The following is to be done individually and your answers are to be typed where viable (diagrams and the like can be drawn freehand). The assignment must be stapled.

This homework will be assigned in two parts. ~~The first (this one) will deal with lecture material. The second will deal with student talks and is expected to be assigned on Nov 25th.~~ The entire homework is now here and was posted on 11/21.

---

1. Say you have an FPGA where the Vcc to ground value is required to be in the range of 3.7 to 3.5V. Say that FPGA can draw up to 1A and that the power converter generates a solid 3.65V.
    a. What is the maximum impedance your PDN (power distribution network) can have?
    b. Use the spreadsheet found on the course website with this assignment to generate a set of capacitors from those listed that will meet these requirements. You may assume you only need to worry about frequencies in the 1MHz to 900MHz range and you may include the PCB power/ground plane. Your solution should use as few capacitors as possible while meeting these requirements.

2. Anti-resonance
    a. In your own words, explain what "anti-resonance" is.
    b. The spreadsheet above does not address the impact of anti-resonance.
        i. How could that cause problems?
        ii. Why do you think they ignore it?
        iii. How does one deal with anti-resonance?

3. Say you have a processor named "Bob" which requires 2.5-4V and has the following run modes

Run mode	MIPS	Current
Fast	10.0	50µA
Slow	1.0	10µA
Stopped	0	2.0µA

    a. If you have a task that runs once a second for 10K instructions and otherwise does nothing. It is running at room temperature. Assuming waking up and sleeping have no cost.
        i. How would you use the run modes to achieve the lowest energy utilization?
        ii. Say you are using three of these batteries http://panasonic.com/industrial/includes/pdf/Panasonic_Lithium_BR1220_BR1225.pdf to power your device. How long would you expect the power to last?
        iii. Say you are using one of these batteries http://panasonic.com/industrial/includes/pdf/Panasonic_Lithium_BR1220_BR1225.pdf (BR1220) to power your device. How long would you expect the power to last? (hint, think carefully about limits…)

4. Peukert Effect
    a. Explain what the Peukert effect is.
    b. How it is the Peukert effect reflected in the above data sheets?

5. Say you wish to use the following voltage regulator: http://www.sparkfun.com/datasheets/Components/LM7805.pdf (µA7805C) to drive a device at 5V and 200mA using an 8V source. (You may need to use other datasheets/websites to answer this question).
    a. Is this regulator capable of driving source a device with that source? If not, explain why not, if so, explain what you had to check to insure that it was capable.
    b. How much power will be wasted by the converter as heat? Will we need a heat sink? Justify your answer to both parts.

6. Switching supplies
    a. What are the pros and cons of switching power supplies compared to linear regulators?
    b. Explain the terms boost, buck and boost-buck as they apply to switching regulators
    c. Find a switching power supply that can be used in place of the LM705 listed above.
        i. How much power would it waste given the same problem?
        ii. How would its cost compare to the LM705?

7. DSP
    a. Explain what makes a DSP application different than a traditional application.
    b. Explain what makes a Digital Signal Processor different than a traditional application.
    c. While mightily out of date, http://edu.cs.tut.fi/pd2006/lecture7/node3.html provides a performance comparison of some DSPs vs. mainstream processors. In a paragraph or two, explain those results.
    d. [optional] Can you find a solid (and ideally independent) performance comparison between (say) the Atom processor and more recent DSPs? How have things changed? Candy bar to the best answer(s).

<HW3b starts here>

8. Student talks. In many cases you are going to need to go beyond the slides themselves to answer these questions.
    a. Wireless:
        i. Define the terms dBm and dBi in the context of wireless communication.
        ii. In some ways dBi is a measure compared to an "idea" device. Why is it that some antennas have a dBi better than that ideal?
        iii. Say you have transmitter with an antenna gain of 2 dBi and transmission power of 15dBm and a receiver with an antenna gain of 4 dBi, transmission sensitivity of -60dBm. They are transmitting using (about) a 2.4 GHz frequency band. What is the theoretical range for this device?
        iv. Say you are using an XBee-PRO® 802.15.4 (http://www.digi.com/pdf/chart_xbee_rf_features.pdf) as both a receiver and transmitter and both use a whip antenna (http://www.digi.com/technology/rf-tips/2007/08). What is the theoretical range for this device?

b. Bluetooth
    i. What is Bluetooth primarily used for?
    ii. Why does Bluetooth support both SCO (Synchronous Connection-Oriented) and ACL (Asynchronous Connectionless) in the baseband layer?
    iii. Consider slide 23 of the Bluetooth talk. Assuming you have 0 dBi antennas, what is the (approximate) transmission sensitivity (in dBm) of the Bluetooth receiver for the three power levels listed? What do you imagine accounts for inconsistencies between those three cases?
c. USB
    i. Describe the difference between isochronous and bulk transfers. Compare this difference to the SCO and ACL transfers of Bluetooth.
    ii. Explain the difference between logical pipes and end points in USB.
d. Touch screens
    i. Consider slide 14 of the touch screen presentation. Explain why the pinModes are different between the two functions. Also explain why it might be a good idea to set pins to be input before changing the other pins to output (rather than how it was done in the code on that page).
    ii. Say you've got a design that will use a touch screen that will be kept outside of a remote location outside of Appleton WI. It will see a lot of use, you'll be the one in charge of heading out there (from Ann Arbor) to fix it if it breaks, and you have a pretty large budget. What type of touch screen would you think would be the best for the job? Why?
e. OBD
    i. Explain how OBD and CAN are related.
    ii. Explain why there are multiple buses on the OBD connector and which one(s) are in use on new cars today.
    iii. Consider the VPW signaling and the PWM signaling schemes discussed in this presentation.
        - Why does the VPW scheme have two different states for 0 and 1?
        - Why doesn't the PWM scheme need bit stuffing?
f. Cameras
    i. Why does vertical smearing happen on CCD cameras?
    ii. Consider slide 47 of the presentation. How does this interface seem to differ from I2C?