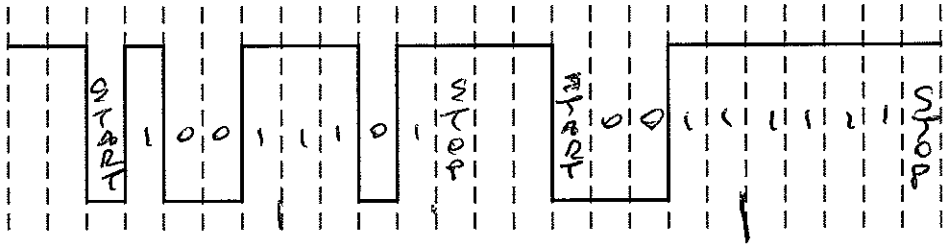
Name SOLUTIONS

ELC 411-01 – Embedded Systems
Fall 2015
Larry Pearlstein

Final Exam

10 points

1) Serial (UART/RS-232) protocol – decode the following protocol waveform (high = 1, low = 0)



1011 1000 = 0xB9 1111 1100 = 0xFC

10 points

2) Analog to Digital Converter (ADC)

a. Given a bandlimited signal that occupies the bandwidth 20 Hz to 20 KHz, what is the minimum sampling frequency required to avoid aliasing, according to Nyquist?

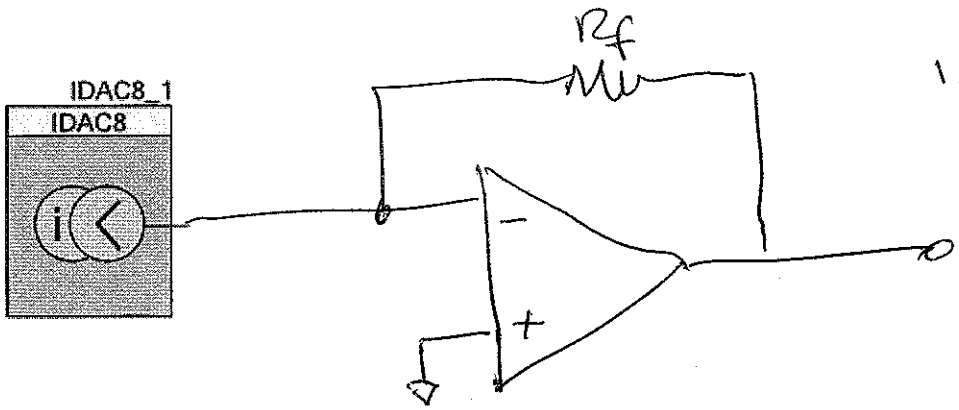
$f_s \geq 2 f_{max}$

b. Circle the type of PSoC ADC that you would use for medium precision applications, that require fairly high speed sampling rates (e.g. 100 KHz sampling rate)?

i. Flash
ii. Pipelined
iii. Successive Approximation
iv. Delta-Sigma

10 points

3) Digital to Analog Converter (DAC): Given the current DAC below, with a 0 to 1 mA current output, design a circuit that will convert the current to a proportional output voltage, with component choice to produce a full-scale output voltage of -4 volt.



$1mA \cdot R_f = 4$

$R_f = 4K\Omega$

Name _____

10 points

4) Direct Memory Access (DMA)

a. If the source is memory, and the destination is memory, describe the proper configuration of the DMA address mode for source and destination (static, or stepping).

DMA TARGET	ADDRESS MODE (STATIC OR STEPPING)
Source	stepping
Destination	stepping

b. Describe the circumstances whereby the DMA engine and CPU would compete with each other for access to resources. Would this happen frequently – why or why not?

LD / ST Both to MEM, No.

15 points

5) Fixed point arithmetic (use opposite sheet)

a. Convert real to fixed: -5.25 to C1.3.4

b. Convert real to fixed: 3.125 to U5.3

c. Convert fixed to real: 0xB, interpreted as C1.1.2 to real.

d. Convert fixed to real: 0xB, interpreted as U2.2 to real.

e. Rounding fixed point number to integer, round 0x5, interpreted as U2.2 to integer

10 points

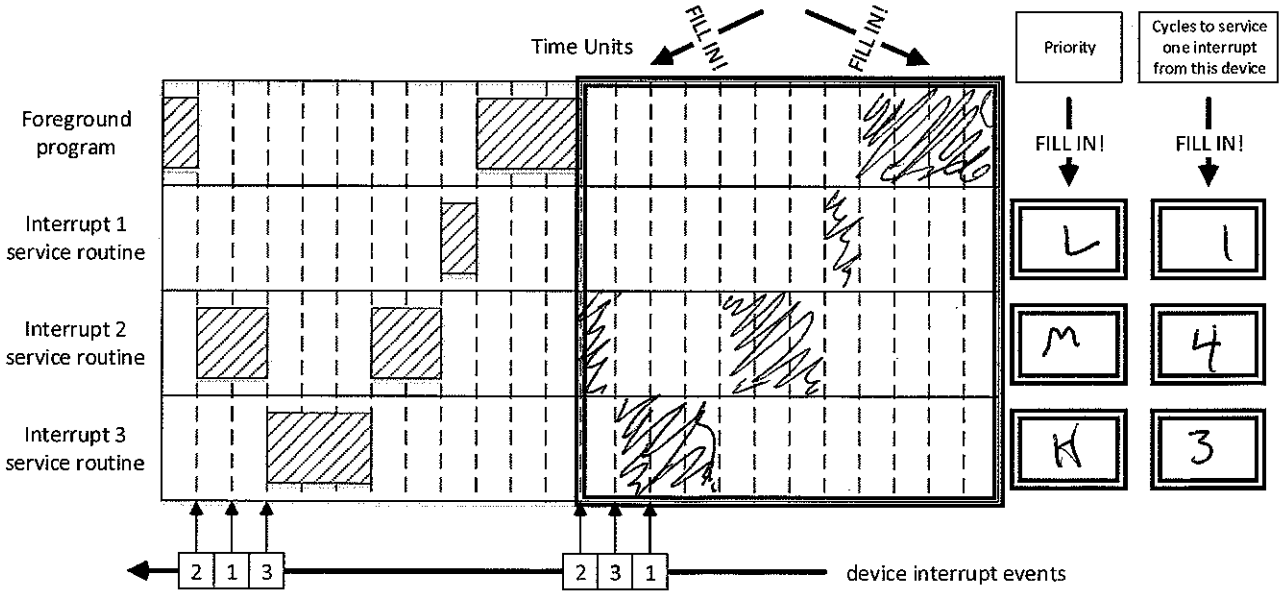
6) Interrupts (use opposite sheet)

a. Describe the process known as "unstacking"? on return from intr, CPU restores state

b. How does one return from interrupt in the ARM Cortex-M3? BX LR, LR contains magic #

10 points

7) Interrupt priorities - based on the left side of the sketch below, determine the interrupt priorities (Highest, Middle, Lowest), how many units are spent servicing each type of interrupt and sketch the activity pattern of the CPU in the entire right half.



THREE ADDITIONAL PROBLEMS ON BACK PAGE!!! →→→→→→→→→→→→→→

Name _____

5.25 → 0101.0100

(a) 2's 1010.1011
+ 1
1010.1100 = 0xAC

(b) 3.125 00011001 = 0x19

(c) B → -5/4 = -1.25

(d) B → 11/4 = 2.75

(e) 0101
+ .10
0 1.11 = 1

THREE ADDITIONAL PROBLEMS ON BACK PAGE!!! →→→→→→→→→→→→→→

Name _____

10 points

8) Generating a Pulse-Width-Modulated signal – assume a clock rate of 12 MHz, and a desired period of 10 ms

a. What is the value required for the Period (initial count) setting?

$10 \times 10^{-3} \cdot 12 \times 10^{6} = 120 \times 10^{3} = 120{,}000 - 1$

b. If we want a 20% duty cycle, what threshold value should we use, assuming that our PWM conidition is "Greater Than or Equal To"?

$= 120{,}000 \cdot \frac{4}{5} = 96{,}000$

10 points

9) Memory

a. Fill in table below the type(s) of memory (SRAM, DRAM, Flash) that satisfy requirements

Require repeated refreshing the values of the contents to avoid loss of data.	DRAM
Non-volatile.	FLASH ROM
Much more efficient when used for sequential access than for random access.	DRAM

b. Why is DRAM so commonly used, in spite of its shortcomings?

Cheap

5 points

10) Very briefly (in 15 words or less), how does the CPU, in an embedded system, interact with on-chip devices, to perform control and ascertain status?

Read / write regs mapped as memory.