ECE 331 Spring 2013 **Homework 11**

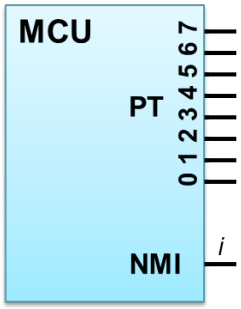
Due April 8 at the beginning of class.

1. The memory/address table to the right shows the stack during an interrupt service routine where the automatically saved register values from the main program have already been pushed to stack. Assuming no additional values have been pushed to the stack:
   a) What value was in the accB when the interrupt occurred?
   b) What value was in iY when the interrupt occurred?
   c) What is the return address for the interrupt routine?

SP →	61
	D9
	42
	83
	2E
	CB
	0B
	50
	5A
	74
bottom of stack	

2. Assume you have a microcontroller with a single *active-high* non-maskable interrupt pin **NMI** and an 8-bit bidirectional I/O port **PT[7:0]** as shown to the right. Sketch a schematic that shows and briefly describe in text how you could connect the microcontroller to a device that generates three unique interrupt sources (active high digital output signals) so that:
   i) each of the three interrupt sources can be *masked by software* on the microcontroller, i.e., the controller can block each individual interrupt source
   ii) a microcontroller interrupt is generated when *any* interrupt (that is not masked by software) occurs

   Assume it is not necessary to determine which of the three sources generated the interrupt. Call the interrupt signals **i1, i2, and i3**. Use any pins on port PT necessary, but clearly identify all used MCU pins as input (i) or output (o). Use any external 2- or 3-input logic gates needed to complete your design.



3. Given the following components:
   i) One MCU with an *active-low* maskable interrupt input pin (**IRQ'**) and an 8-bit bidirectional I/O port **PP[7:0]**. (similar schematic diagram as MCU in problem 2)
   ii) Multiple alarm sensors, each with a single digital output (**SO1, SO2, etc.**) that exhibit the following function:

condition	**SO**
no alarm	high (1)
alarm	open circuit (hi Z)

   iii) Any logic gates or resistors, as needed.

   Sketch a schematic for an alarm embedded system that is capable of:
   a) connecting to 2 individual alarm sensors
   b) generating a maskable interrupt when ANY sensor has an "alarm" condition
   c) upon interrupt, identifying which of the 2 sensors has an "alarm" condition

   Clearly identify all used MCU pins as input (i) or output (o) and briefly describe in text how your circuit works. Note: although there are similarities between this problem and problem 2, the result will be quite different because the interrupts and NMI in problem 2 are different from the alarms and IRQ' here.

4. Consider a microcontroller timer unit with a 16-bit counter operating with an 8MHz clock:
   a) How many unique values can the timer unit hold?
   b) What is the maximum count value (in decimal) of the counter?
   c) How much time (in milliseconds) will the counter take to overflow?
   d) How many times will the timer counter overflow in 0.5 seconds assuming it starts with an initial value of $0000,
   e) Following from (d), what value (in hex) will be in the 16-bit counter after 0.5 seconds?

5. Consider the microcontroller timer unit in problem 4 with a 16-bit counter operating with a 8MHz clock. Assuming the timer counter started with an initial value of $A3E4, what value will be on the timer counter after 0.5 seconds?

6. Consider a microcontroller timer unit with a 24-bit counter operating with a 16MHz clock where the timer counter can be initialized (loaded) at any 24-bit value. What should the initial counter value (in hex) be set to in order for the counter to overflow when 1 second has elapsed.

7. Using lecture notes and other internet resources, briefly describe the following timer functions for the 68HC12 microcontroller:
   a. Pulse accumulator
   b. Output compare
   c. Input capture