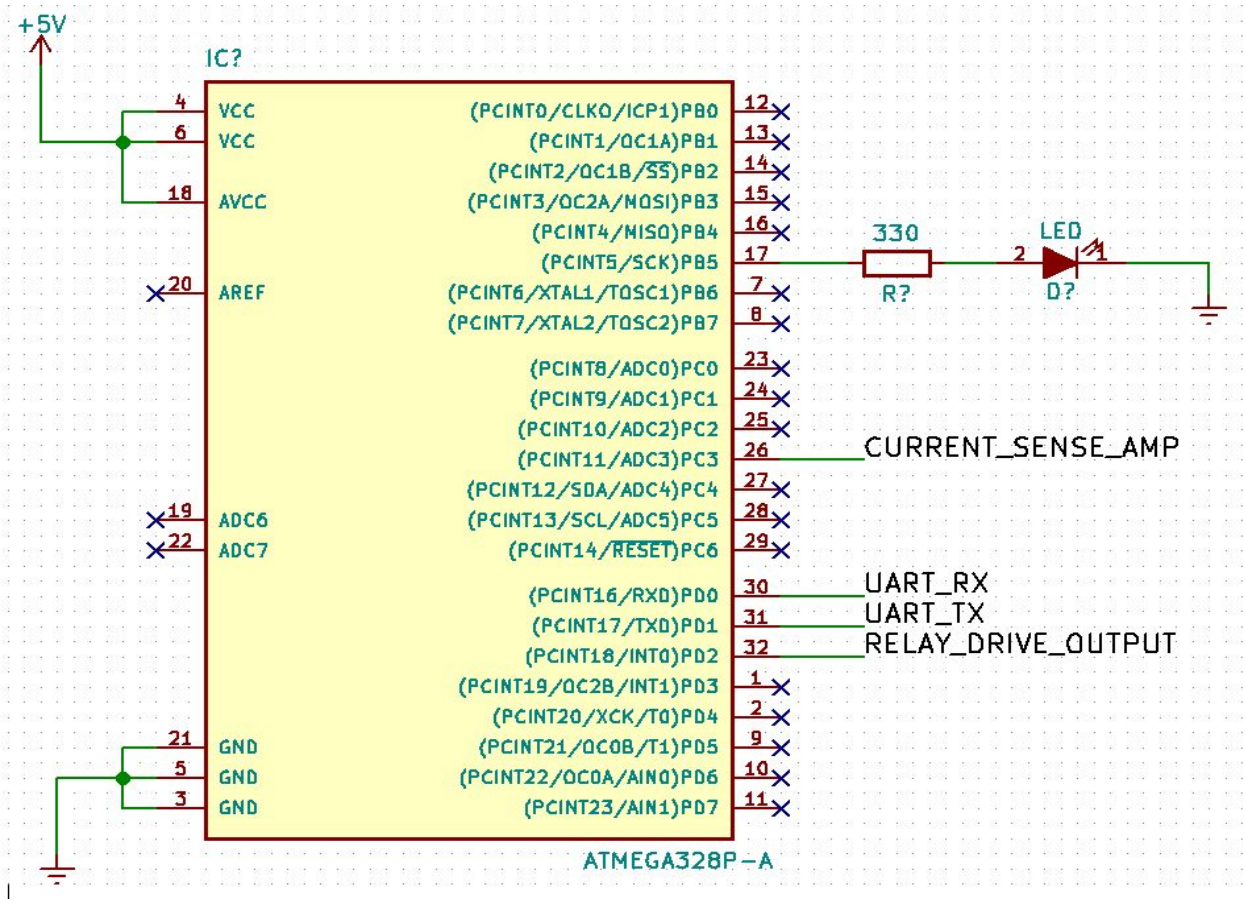
EE4144 Intro to Embedded Systems | Name:_____
Quiz 2 | ID: _____

Background:

1) Consider an Atmega328p microcontroller (the same as in the Arduino) connected in the setup that is detailed in the schematic below.



The hardware setup is as follows:

a) An LED is on PB5 (PORTB, Pin 5) and is wired in series with a 330-Ohm resistor for current-limiting.
b) Analog input 3 (ADC3, on PC3) is wired to a sensor that measures current (Current_Amps) through a power load. The voltage input to the our processor is V_ADC, and is defined as :

V_ADC = 0.5 * Current_Amps

c) Pin PD2 is used to drive a relay that turns on or off the current (Current_Amps) in the power load which is measured by our ADC. When the relay is on (i.e. PD2 is logic HIGH), a circuit turns on and causes a large amount of current to flow.

Essentially, we have a relay that turns On/Off current through a load. We are measuring that same current back through our analog input.

The Requirements:

a) When a byte 0x31 is received on the UART, set PD2 and PB5 HIGH (Turn ON the Relay and LED)
b) When a byte 0x30 is received on the UART, set PD2 and PB5 LOW (Turn OFF the Relay and LED)
c) If the current in the load exceeds 2 Amps, send a byte 0x45 over the UART (This does not need to be done using interrupts). Also, turn OFF the digital output PD2 (Turn OFF Relay and the LED)
d) The software written in parts (a), (b) and (c) MUST make sure that unless commanded to turn on the relay over UART, PD2 must be driven LOW by default (i.e. Relay is OFF by default)

The Solution:

1. Write the setup() function that: [10 pts]
    a. Sets up the UART to 9600 bps, 8n1
    b. Sets up the ADC for reading the analog voltage
    c. Sets up the digital I/O settings for the relay and the LED.
2. Write the loop() function that: [10 pts]
    a. Checks the analog voltage of the current sensor. (No interrupt required for this part).
    b. Write the relay and LED I/O as necessary.
    c. Write the UART as necessary, making sure the UART data register is “ready” to written to. (Hint: As in recitation)
3. Write the Interrupt routine that [10 pts]:
    a. Controls the relay and LED based a byte received at the UART.

Extra Credit [5 pts]:

Describe a critical hardware design flaw in the circuit as shown in this quiz, and how you would tell the company’s hardware designer to fix it.

HINT: Consider what signal the relay will see coming from the microcontroller. With the present circuit, is it possible to make sure the relay is OFF by default, even if the microcontroller loses control of the PD2 output port due to some software malfunction?