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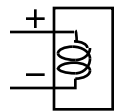
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This is an open book, open notes exam. You must put your answers on these pages only, you can use the back. You have 50 minutes, so please allocate your time accordingly.

*Please read the entire quiz before starting.*

**(25) Question 1.** Design the hardware interface that allows the computer to control a DC motor. The computer will use pulse-width modulation on PT0. No software is required, just the hardware. The motor coil needs about 12 V at 5A to run at maximum speed. The system should NOT be isolated, so no 6N139 or IL-5 can be used. There will be back EMF voltages, so protect the electronics. Show the hardware circuit, labeling all chip numbers and component values.

PT0----



(10) **Question 2.** Consider a 6812 parallel port output pin, like PJ0. *See the data sheet.*

Part a) What is the maximum output low current it can sink?

Part b) At the maximum current, what will be the output low voltage?

(15) **Question 3.** In this problem consider the following two C functions.

```
void Set0(void){
    PORTJ = PORTJ | 0x01;    // PORTJ bit 0 is high
}
void Set1(void){
    PORTJ = PORTJ | 0x02;    // PORTJ bit 1 is high
}
```

The following show the assembly code produced by the ICC12 compiler.

Set0 bset PORTJ, #01 rts	Set1 bset PORTJ, #02 rts
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Part a) Are these two functions friendly? *Be very specific and justify your answer.*

Part b) Do these two functions have critical sections? *Be very specific and justify your answer.*

Part c) As debugging instruments are these functions minimally intrusive? *Be very specific and justify your answer.*

**(50) Question 4.** The following is Program 6.6 from page 301-302 of the book. Modify this program from Chapter 6 so that the range is 36 $\mu$ s to 128ms. In addition, add software so that measurement overflow is detected. In particular, set Period equal to \$FFFF, and Done equal to +1 if the period is greater than 256 ms. Change both the code and comments.

```
// PT1/IC1 input = external signal
// rising edge to rising edge
// resolution = 500ns
// Range = 36  $\mu$ s to 32 ms,
// no overflow checking
// IC1 interrupt each period,
unsigned int Period; // units of 500 ns
unsigned int First; // TCNT first edge
unsigned char Done; // Set each rising
void Ritual(void){
    asm(" sei"); // make atomic
    TIOS &= 0xFD; // PT1 input capture
    DDRT &= 0xFD; // PT1 is input
    TSCR = 0x80; // enable TCNT
    TMSK2= 0x32; // 500ns clock
    TCTL4 = (TCTL4&0xF3)|0x04; // rising
    First = TCNT; // first will be wrong
    Done=0; // set on subsequent
    TFLG1 = 0x02; // Clear C1F
    TMSK1 |= 0x02; // Arm IC1
    asm(" cli");}
#pragma interrupt_handler TIC1handler()
void TIC1handler(void){
    Period=TC1-First;
    First=TC1; // Setup for next
    TFLG1=0x02; // ack by clearing C1F
    Done=0xFF;}
#pragma abs_address:0xffec
void (*TC1_vector[])() = { TIC1handler};
#pragma end_abs_address
```

