October 24th, 2012

COE/BME-538 Midterm Exam

Name: _____ **Student #:** _____ **Time: 90 min.**

Notes:
1. Closed book.
2. Write the answers in the space provided.
3. No question during the exam. State your assumptions.

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1. Multiple Choice Questions (encircle the correct answer): **[1 mark each]**

a) What instruction is used to exit a subroutine?

i) rtb ii) rtf iii) rti **iv) rts** v) str

b) How many memory locations can the HCS12 access without the expanded memory?

i) 65535 **ii) 65536** iii) 64000 iv) 32000 v) 32K

c) How many address lines are required to access 32K memory locations?

i) 15 ii) 16 iii) 32 iv) 64 v) 128K

d) Which of the following instructions will swap the contents of registers Y and SP:

i) exg y,sp ii) xg ysp iii) tys iv) lds #2 v) staa $3

2. Fill in the underlined spaces and identify the register contents after the execution of the programs below:

a) Load Reg.A with $35 and subtract the value $CF located at $1200 from the contents of Reg.A. Then, store the result in the memory location at $1250. Fill in the underlined spaces.

[3 marks]

```
org     $1500
ldaa    #$35        ; load Reg.A with $35
suba    $1200       ; subtract the value $CF located at $1200 from Reg.A
staa    $1250       ; store the result at $1250
swi                 ; stop
```

```
  11001 1100
- 0011 0101
  1100 1111
  0110 0110
```

Show the contents of **Reg.A** and **CCR** after the execution of the program: **[3 marks]**

Reg.A	Bit #: 7 6 5 4 3 2 1 0 Contents: **0 1 1 0 0 1 1 0**	**CCR**	Bit code: S X H I N Z V C Bit #: 7 6 5 4 3 2 1 0 Contents: **x x x x 0 0 0 1**

b) Complete the assembly instructions below by filling in the underlined spaces: **[3 marks]**

```
start   ldx    #$32     ; load register X with $32                  (2 E-clk)
lp      nop             ; no operation                              (1 E-clk)
        dbne   x,lp     ; decrement Reg.X and branch if not equal   (3 E-clk)
end     nop;            ; no operation                              (1 E-clk)
```

What is the program execution time from start to end if 1 E-clk = 10 ns. Show the calculations. **[1 mark]**

2E + (1E+3E)×50 + 1E = 20 ns + 2000 ns + 10 ns = 2030 ns ≈ 2 μs

3. Short answer questions. **[1 mark each]**

a) What is the resolution of an ***n***-bit ADC that is designed to convert voltage from the range of **0** to **5** V?

$5 / 2^n$ V

b) What is the difference between *scan* and *non-scan* modes of an ADC?

It is only one sequence of conversions in non-scan mode.

c) What are the two possible sizes of the result of an A-to-D conversion (in bits), which can be selected by the user of the HCS12 microcontroller system?

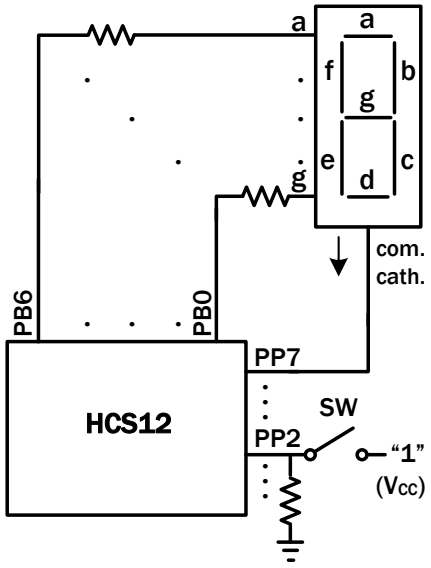
8-bit and 10-bit sizes.

4. What are the contents of the topmost 3 bytes of the stack after the execution of the following code (fill in the table below)? **[4 marks]**

```
                Assembly Code          Instruction Length
                                       (in bytes)
        org     $4000
        lds     #$3000      ; 3 bytes
        ldaa    #$32        ; 2 bytes
        jsr     mel         ; 2 bytes
mel     psha                ; 1 byte
forev   bra     forev       ; 2 bytes
```

Stack Address	Stack Content	
$**2FFD**	$**32**	
$**2FFE**	$**40**	
$**2FFF**	$**07**	
$**3000**	$xx	← SP

5. The system below is designed to monitor the current state of the switch SW connected to the pin 2 of the Port P. If the switch is opened, the HCS12 must display the character ‘O’ on the 7-segment display. If the switch is closed, the character ‘C’ must be displayed.



The following program must perform the above task. Fill in the underlined spaces according to the comments: **[8 marks]**

```
        org     $2000
        movb    #0      DDRP
        movb    #$FF    , DDRB          ; Configure port B as output
        bset    DDRP,   $80             ; Configure pin 7 of Port P as output
        bclr    PTP ,   $80             ; Enable the 7-seg. display by clearing PP7 to “0”
sw      brset   PTP,    $04   , closed  ; Branch to ‘closed’, if the SW is closed
opened  movb    #$7E    , PTB  (or #$FE) ; Otherwise, output the code of char. “O” via Port B
        bra     sw                      ; Branch to ‘sw’
closed  movb    #$4E    , PTB  (or #$CE) ; Output the code of character “C” via Port B
        bra     sw                      ; Branch to ‘sw’
        swi
```

6. Complete the following table by filling in the *Instruction* and *Operand* columns, so that the resulting code corresponds to the *Comments* column. **[6 marks]**

Label	**Instruc-tion**	**Operand**	**Comments**
	org	**$4000**	Start the following code at $4000
start	**ldd**	**#$813F**	Make Acc D have value $813F
	asrb		Arithmetic shift right contents of Acc B
	exg	**y,d**	Swap contents of Y and D
	lsld		Logic shift left of contents of Acc D
	bra	**start**	Go to “start”