UNIVERSITY OF VICTORIA

EXAMINATIONS DECEMBER 2000

CSC 230 F01: COMPUTER ARCHITECTURE AND ASSEMBLY LANGUAGE

NAME..... STUDENT NO. .....

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TO BE ANSWERED ON THE PAPER **DURATION: THREE HOURS**

STUDENTS MUST COUNT THE NUMBER OF PAGES IN THIS EXAMINATION PAPER BEFORE BEGINNING TO WRITE, AND REPORT ANY DISCREPANCY IMMEDIATELY TO THE INVIGILATOR.

THIS QUESTION PAPER HAS **SIX** PAGES PLUS THIS COVER PAGE.

- The exam is worth a total of **100** points.
- Point values for each question are shown in square brackets.
- Read the entire paper carefully before starting work. Attempt every question. Do the easiest questions first. Leave 15 minutes at the end to check your work.
- Answer in the spaces provided (you do not necessarily have to use all the space provided and may use other areas on the **fronts** of the pages if necessary). Use the backs of the pages for rough work.
- This is a closed book examination. **No course notes, books or calculators, are permitted.**
- You are permitted to use the 6811 information sheets provided.

QUESTION	MAX. MARK	STUDENT'SMARK
1	10	
2	8	
3	6	
4	15	
5	12	
6	6	
7	5	
8	12	
9	15	
10	11	
TOTAL	**100**	

1. **[10 marks]**

   a) 1101.101_2 = _13.625_ $_{10}$ = _D.A_ $_{16}$

   b) 22.15_{10} = _$10110.00\overline{1001}$_ $_2$ = _$16.2\overline{6}$_ $_{16}$

   c) The 8-bit two's complement representation of -31_{10} is _11100001_ $_2$

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2. **[8 marks]** For the IEEE single precision floating point representation of the decimal value -12.125, complete the following:

   - the value of the sign bit (binary) _1________
   - the value stored for the exponent (decimal) _130______
   - the stored mantissa (do not show the hidden bit) (binary) _100001___
     (trailing zeros could be ignored)
   - the complete 32 bit representation (hexadecimal) _C1420000_

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3. **[6 marks]** Perform the following binary division (***perform all steps in binary***):

   $0.100_2 \div 1.1111_2$

   $= 1000_2 \div 11111_2$

```
                 0.0110000100001...
        11111 ⟌1000.00
               1111 11
               0000 010 0000
                        11111
                        0000100000
                             11111
                             00001
```

(In the quotient, the digits 10000 after "0.01" are marked with an overline.)

   verify: $0.5 \div 1.9375_{10} = 8 \div 31_{10} = 0.25806_{10} = 0.0\overline{10000}_2$

4. **[15 marks]** The following program copies string STR2 to string STR1. Parameters are passed to subroutine SCPY via program memory. Fill in the **15** blanks (indicated by _____) in the program shown below so that it behaves as described in the comments.

```
SBASE  EQU   $1FF
       ORG   $100
STR2   FCC   'UVic'
       FCB   _00_
STR1   RMB   _5__

       ORG   $C000
       LDS   _#SBASE_
       JSR   SCPY          ; EXECUTE CPYSTR
       FDB   STR1          ; DESTINATION STRING
       FDB   STR2          ; SOURCE STRING
       STOP

SCPY   _PSHX_              ; SAVE USED REGISTERS
       _PSHY_
       _PSHA_
       TSX
       LDX   _5_,X
       LDY   _0_,X         ; SET Y TO POINT TO DESTINATION
       LDX   _2_,X         ; SET X TO POINT TO SOURCE
SCPY1  LDAA  0,X           ; COPY STRING ONE CHAR AT A TIME
       STAA  0,Y           ; INCLUDING THE TERMINATOR
       BEQ   SCPY2         ; EXIT LOOP AT TERMINATOR
       INX
       INY
       BRA   SCPY1
SCPY2  TSX
       LDY   _5_,X
       INY
       INY
       INY
       INY
       STY   __5_,X
       _PULA_              ; RESTORE REGISTERS
       _PULY_
       _PULX_
       _RTS_
       END
```

5. **[12 marks]** In the following you are required to write simple instruction sequences that perform the indicated function. The answer to the first question is provided as an example:

   a) program the input capture system to capture the time of a rising edge on IC1

   ```
   LDAB    #$10
   STAB    $1021
   ```

   b) program PORT A to allow bits 0 – 2 to be used as general purpose input port pins.

   ```
   LDAB    #$00
   STAB    $1021
   ```

   c) program the output compare system so that pin 6 of PORT A is toggled each time the contents of TCNT are equal to the contents of the corresponding TOC2.

   ```
   LDAB    #$40
   STAB    $1020
   ```

   d) program PORT D to turn LEDs connected to pins 1 and 3 ON.

   ```
   LDAB    #$3F    (can be any number that has pins 1,3 = 1)
   STAB    $1009   (allow counting 0 -7 or 1 - 8)
   LDAB    #$0A    ($05 is also okay)
   STAB    $1008
   ```

6. **[6 marks]** Compare between caches and virtual memory with respect to: purpose, data unit, and method of implementation:

	Caches	**Virtual memory**
purpose	speed	expand memory
data unit	line	page
method of implementation	hardware	hardware /software

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7. **[5 marks]** Number the following steps from 1 to 5 in the order they are performed in processing an interrupt on the 6811 using the interrupt jump table technique:

⇓ correct answer

1	1	1	1	recognize the interrupt event and set the event flag
3	2	3	2	load the PC with the value from the appropriate interrupt vector
5	5	5	5	execute the first instruction of the interrupt handling routine
2	3	4	4	push the processor registers onto the stack
4	4	2	3	execute the appropriate jump instruction in the jump table
5	4	3	2 marks (the list shows the common responses, others: 1 mark)	

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8. **[12 marks]** In a table, differentiate between RISC and CISC with respect to number of registers, memory access, addressing modes, and instruction count, length, and complexity.

Aspect	**CISC**	**RISC**
Number of registers	Less # of registers	Contains lots of registers
memory access	Almost all instruction groups could access memory	Only load and store instructions access memory
addressing modes	A lot Rich	Few Simple
instruction count	Less than RISC	More than CISC
instruction length	Might be variable	Fixed
instruction complexity	More complex than RISC	Complexity is reduced

9. **[15 marks]** A push button is connected as an input to IC2. The program below polls IC2 and turns pin 2 of PORT B ON only after the button has been pressed and released the number of times specified by the constant **`LIMIT`**. For example, in the program below as **`LIMIT = 5`**, pin 2 of PORT B will not be turned ON until the button has been pressed and releases 5 times.

   Modify the program to use the input capture interrupt capabilities of the 6811. You are required to make the ***minimum*** possible modifications in the given program.

```
REGBASE   EQU     $1000
PORTB     EQU     $4
TMSK1     EQU     $22
TCTL2     EQU     $21
TFLG1     EQU     $23
IC2F      EQU     $8
IC2       EQU     $2
PIN2      EQU     $4
SBASE     EQU     $1FF
LIMIT     EQU     5
COUNT     RMB     1
DONE      RMB     1

MAIN      ORG     $C000
          LDS     #SBASE
          LDY     #REGBASE
          LDAA    #IC2
          STAA    TFLG1,Y
          BSET    TCTL2,Y IC2F
          LDAA    #LIMIT
          STAA    COUNT
          LDAA    #0
          STAA    DONE
AGAIN     JSR     CHECK
          TST     DONE
          BEQ     AGAIN
          LDAA    #PIN2
          STAA    PORTB,Y
          STOP

CHECK     PSHA
LOOP      BRCLR   TFLG1,Y IC2 LOOP
          LDAA    #IC2
          STAA    TFLG1,Y
          DEC     COUNT
          TST     COUNT
          BNE     EXIT
          INC     DONE
EXIT      PULA
          RTS
          END
```

(Answer to question: 9)

```
REGBASE   EQU    $1000 ; Students do not need to repeat
PORTB     EQU    $4    ; the definition part
TMSK1     EQU    $22
TCTL2     EQU    $21
TFLG1     EQU    $23
IC2F      EQU    $8
IC2       EQU    $2
PIN2      EQU    $4
SBASE     EQU    $1FF
LIMIT     EQU    5
COUNT     RMB    1
DONE      RMB    1

          ORG    $00E5
          JMP    IC2INT

MAIN      ORG    $C000
          LDS    #SBASE
          LDY    #REGBASE
          SEI
          LDAA   #IC2
          STAA   TFLG1,Y
          BSET   TCTL2,Y IC2F
          BSET   TMSK1,Y IC2
          LDAA   #LIMIT
          STAA   COUNT
          LDAA   #0
          STAA   DONE
          CLI
AGAIN     TST    DONE
          BEQ    AGAIN
          LDAA   #PIN2
          STAA   PORTB,Y
          STOP

IC2INT    LDAA   #IC2
          STAA   TFLG1,Y
          DEC    COUNT
          TST    COUNT
          BNE    EXIT
          INC    DONE
EXIT      RTI
          END
```

10. [11 marks]

a) **[3 marks]** What is the key feature of a load/store machine?

Only load and store instructions access memory.

b) **[1 mark]** What is the purpose of the PC register on the 6811?

It points to next byte of program code to be executed.

c) **[3 marks]** State 3 distinct situations in which the value in the PC is modified.

Any three of the following points

- It is updated as bytes of code are fetched.
- A branch instruction is executed.
- A jump instruction is executed.
- A JSR instruction is executed.
- An RTS instruction is executed.
- In processing an interrupt
- An RTI instruction is executed.

d) **[2 marks]** Explain the functional differences between the 6811 JMP and JSR instructions.

The JSR instruction pushes the PC onto the stack. The JMP does not.

e) **[2 marks]** Explain the functional differences between the 6811 RTS and RTI instructions.

The RTI instruction pulls all registers off the stack. The RTS does not.

END OF EXAMINATION