CSC 230
Spring 2023 (CRN 20763/20764)
Midterm #1: Thursday, 16 February 2023

Time allowed: 60 minutes

STUDENT NAME: ______________________________

STUDENT NUMBER: ______________________________

Marking Guide

Please remember the golden rule about writing an exam:

Don't Panic!

Students must check the number of pages in this examination paper before beginning to write their answers and report any discrepancy immediately.

- **All answers are to be written on this exam paper.**
- The exam is closed book. Other than the AVR instruction set.
- When answering questions, please do not detach any exam pages!
- ***A basic calculator is permitted***. Cellphones must be set to Airplane mode.
- Partial marks are available for the questions in sections B.
- The total marks for this exam is 20.
- There are 6 printed pages in this document, including this cover page.
- We strongly recommend you read the entire exam through from beginning to end before starting on your answers.
- **Please have your UVic ID card available for inspection by an exam invigilator.**

Section A (10 marks): For each question in this section, place an X beside <u>all</u> answers that apply. Each question is worth three (1) marks. *Partial marks are <u>not</u> given for incomplete answers*.

Remember: Hexadecimal numbers begin with `0x`; binary numbers begin with `0b`; octal numbers begin with `0`; and all other numbers are decimal. *All numbers are unsigned unless the question specifies otherwise.*

Question 1: The unsigned integer `0x912` can be represented as:

____ `0b010100100111`

____ `0b000111010101`

_X__ `0b100100010010` → 0.5

_X__ `2322` → 0.5

____ None of the above.

Question 2: The unsigned integer `0b111001110` is equivalent to:

_X__ `0716` → 0.5

____ `460`

_X__ `0x1CE` → 0.5

____ `0x5D`

____ None of the above.

Question 3: The unsigned integer `0716` is equivalent to:

____ `0b000101111010`

____ `762`

____ `0x17A`

_X__ `0b111001110` → 1.0

____ None of the above.

Question 4: The decimal number `-110` represented as a 10-bit two's complement number is equivalent to:

____ `0b1000011011`

____ `0b1110011010`

____ `0b1001100101`

_X_ `0b1110010010` → 1.0

____ None of the above.

Question 5: The seven-bit two's complement number `0b1010111` is equivalent to:

____ `0b011010110` as an nine-bit two's complement number.

_X_ `-41` → 1.0

____ `-26`

____ `-29`

____ None of the above.

Question 6: The most positive value that can be represented using a seven-bit two's complement number is:

____ `0b1000000`

_X_ `0b0111111` → 0.5

____ `64`

_X_ `63` → 0.5

____ None of the above.

Question 7: The C *flag* within the AVR status register:

_X_ can be directly set with the status register via the **sec** instruction. → 0.5

_X_ is used by some branch instructions. → 0.5

____ is used by the `rjmp` instruction.

____ is set as a result of using the `clc` instruction.

____ None of the above.

Question 8: If we consider I/O port E, then:

____ we set the data-direction for each bit (input or output) by an appropriate value stored in the PIND and PORTD registers.

_X__ we set the data-direction for each bit (input or output) by an appropriate value written the DDRE register. → 1.0

____ we read values from the port by reading from the PDDE register.

____ we read values from the port by reading from the POUT register.

____ None of the above.

Question 9: The *fetch-decode-execute cycle*:

____ Describes the steps taken when the assembler generates a sequence of `fet`, `dec`, and `exe` instructions that appear in a loop.

_X__ Permits the AVR mega2560 to fetch and decode an instruction in one cycle, and to execute it in the next cycle(s). → 1.0

____ Permits the AVR mega2560 to read the instruction from data memory, and then write the results to program memory.

____ Is another name for the meaning of the `fde` instruction .

____ None of the above.

Question 10: The AVR architecture's *pseudo-registers* X, Y, and Z:

_X__ actually refer to specific pairs of general-purpose registers. → 0.5

____ actually refer to memory-addressed I/O ports.

____ can be allocated as needed to any pair of registers (e.g. X to point to `r13:r12`, for some assembly-language program).

_X__ may be used to hold unsigned 16-bit integers, signed 16-bit integers, or 16-bit memory addresses. → 0.5

____ None of the above.

Section B (10 marks 3,3,4 for a,b,c): One question

Question 11: Consider the following program written in AVR assembler:

```
.cseg
.org 0

start:     ldi r16, 0b00010111
           clr r17
loop:      add r16, r16
           dec r18
           inc r17
           cpi r17, 3
           brne loop
done:      rjmp done
```

a) How many executions occur for the **inc r17** instruction? *Explain your answer.*

It is incremented three times – moving from 0 up to and including 3 (0 → 1, 1 → 2, 2→ 3. Once `cpi r17, 0x03` is encountered with `r17` equal to 3, the `brne` is not longer taken.

→ 3.0 Marks

b) What is the value in **r16** when the program reaches the instruction **rjmp done**? *Explain your answer, showing both hexadecimal and 8-bit twos-complement.*

The initial value of r16 is 23; each time through the labelZ loop, r16 is added to itself – so first time through r16 goes from 23 to 46; second time through is goes from 46 to 92; and last time through it goes from 92 to 184.

Final value is 184. which is 0xB8. As 0xB8 is 0b10111000, using the sign rule produces 0b01001000 – which means the value is equivalent to -72 in eight-bit two's complement.

→ 3.0 Marks

c) How would you modify the end of this program such that the value in **`r16`** would be stored at the first address in SRAM? Answer this by providing the AVR assembler lines needed before or after (or both!) the **`rjmp done`** line. *Explain your answer, and clearly describe any assumptions you are making.*

The lowest location in RAM is 0x200, however, unlike the ending of the RAM which can be referred to by RAMEND, the first location of memory can only be referred to label following .DSEG as the following:

```
.DSEG
RAMSTART: .byte 1
. . .

. . .
     ldi r31, HIGH(RAMSTART)
     ldi r30, LOW(RAMSTART)
     st Z, r16
stop:   rjmp stop
```

→ 3.0 Marks → There are many possible correct answers.