1. Read these instructions carefully. Failure to follow these instructions exactly will result in loss of points or even a zero on the exam.
2. One 8.5 x 11 note sheet is allowed.
3. No calculators are allowed.
4. **PRINT** your first and last name at the top of this page.

**You will lose 5 points if I cannot read your name.**

1. On **SIDE 2** of the Scantron sheet, put each letter of your last name, your first initial, and your middle initial with no spaces and bubble in the letters. Do not include numbers. Simply leave them out. Do not fill in any other sections on SIDE 2.

**You will lose 5 points if you do not enter your name AND bubble in the letters on SIDE 2.**

1. **PRINT** your name on **SIDE 1** of the Scantron sheet on the line provided at the top of the page. Put your section number and the letter A after your name if this is exam A. Put your section number and the letter B after your name if this is exam B.

**You will lose 5 points if you fail to PRINT your name or fail to put the letter of the exam after your name**

1. All answers **MUST** be transferred to the Scantron sheet.
2. Scantron sheets must be completed with a #2 pencil. You must erase any incorrect marks completely. If you do not erase completely, that question will be marked wrong.
3. Perform all work on this exam.
4. Work is required for credit. I will assume you are guessing if you show no work and may count the answer wrong.
5. If you fail to turn in this portion of your exam **you will receive a zero for a grade** regardless of your score on the Scantron.
6. **Do not wait until the end to bubble in answers. If you run out of time you WILL NOT be given extra time.**

**ALL QUESTIONS ARE 3.5 POINTS EXCEPT FOR THE PROGRAMMING PROBLEM WHICH IS 9 POINTS.**

1. Convert 110100100 unsigned binary to decimal.

a) 420 b) 428 c) 452 d) 404 e) None/All

1. Convert 100001 6-bit 2's compliment to decimal.

a) -31 b) -32 c) -1 d) -2 e) None/All

1. Convert -204 decimal to 9-bit 2's complement.

a) 100110100 b) 111001100 c) 11001100 d) 100110011 e) None/All

1. Convert 0.3125 to 16-bit floating point.

a) 0x3680 b) 0x4500 c) 0x4680 d) 0x3500 e) None/All

1. Convert floating point 0x41520000 to decimal.

a) 41/128 b) 105/128 c) 41/128 d) 13&1/8 e) None/All

1. Using 4-bit signed numbers what is the sum of 1100 + 1110?

(V in an answer means overflow occurred)

a) 1010 b) 1010V c) 1011 d) 1011V e) None/All

1. Using 4-bit signed numbers what is the sum of 0010 + 0111?

(V in an answer means overflow occurred)

a) 1001 b) 1001V c) 1010 d) 1010V e) None/All

1. What is the largest unsigned value possible using 18 bits?

a) 128K-1 b) 128K c) 256K d) 64K-1 e) None/All

1. What is the largest signed value possible using 16 bits?

a) 64M-1 b) 64M c) 32K d) 32K-1 e) None/All

1. Assume 4-bit unsigned numbers. What is ~(6 & 1)?

a) 8 b) 13 c) 15 d) 5 e) None/All

1. Assume 4-bit unsigned numbers. What is ~(13 | 9)?

a) 6 b) 12 c) 8 d) 3 e) None/All

1. Using 8-bit unsigned numbers. What is 104 << 3? (104 is 01101000 in binary)

a) 128 b) 13 c) 107 d) 64 e) None/All

1. Using 5-bit one's complement numbers, what is -1?

a) 00001 b) 11111 c) 10001 d) 11110 e) None/All

1. Using 5-bit signed magnitude numbers, what is -10?

a) 01010 b) 10110 c) 11010 d) 10101 e) None/All

1. What is the correct form of extending signed 4-bit number 0001 into an 8-bit storage space?

a) 11110001 b) 00000001 c) 00010000 d) 00011111 e) None/All

1. What is the correct form of extending signed 4-bit number 1110 into an 8-bit storage space?

a) 11111110 b) 00001110 c) 11100000 d) 11101111 e) None/All

**Use the program to the right for the next four questions.**

1. What is the address associated with label A?

.orig 0x3000

LDI R0, A

LEA R1, D

LD R2, B

BRZP L1

OUT

L1

HALT

A .fill 3007

B .fill 3008

C .blkw 3

D .stringz "Mama"

E .fill 'C'

.end

a) 0x3005 b) 0x3006 c) 0x3007 d) Can't tell

1. What is the address associated with label D?

a) 0x3009 b) 0x300B c) 0x3001 d) 0x3008

e) None / All of the above

1. What is the address associated with label E?

a) 0x3016 b) 0x3010 c) 0x300A d) Can't tell

1. What hex value is stored in memory location x3003?

a) 0x2204 b) 0x0601 c) 0x0602 d) 0x0c01

e) None / All of the above

1. Which addressing mode has the effective address stored in memory at PC + PCOffset

a) Relative b) Immediate c) Base register d) Indirect e) None

1. Which addressing mode has the effective address stored in a Register.

a) Relative b) Immediate c) Base register d) Indirect e) None

The following is a listing of registers and memory for the LC3. The microprocessor has just finished executing one instruction and is now ready execute the next instruction.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Registers before fetch and execute. | | | | | | | | | | |
| PC | IR | R0 | R1 | R2 | R3 | R4 | R5 | R6 | R7 | CC |
| x2AE7 | x983F | x0018 | x0004 | x0009 | x0003 | x000A | x0018 | x0003 | x0005 | N |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Memory before fetch and execute. | | | | | | | | | | |
| Address -> | x2AE5 | x2AE6 | x2AE7 | x2AE8 | x2AE9 | x2AEA | x2AEB | x2AEC | x2AED | x2AEE |
| Value -> | x2AE6 | x0011 | xBC03 | x55C0 | x0004 | x2AE7 | x2AE5 | x2AE8 | x001B | x2AED |

Answer the following four questions assuming you have executed the next instruction as indicated by the above register and memory values.

1. What is the effective address of the instruction?

a) x2AEB b) x2AE5 c) x2AE7 d) x2AEE e) None

1. Which register was used by the instruction?

a) R0 b) R2 c) R4 d) R6 e) None

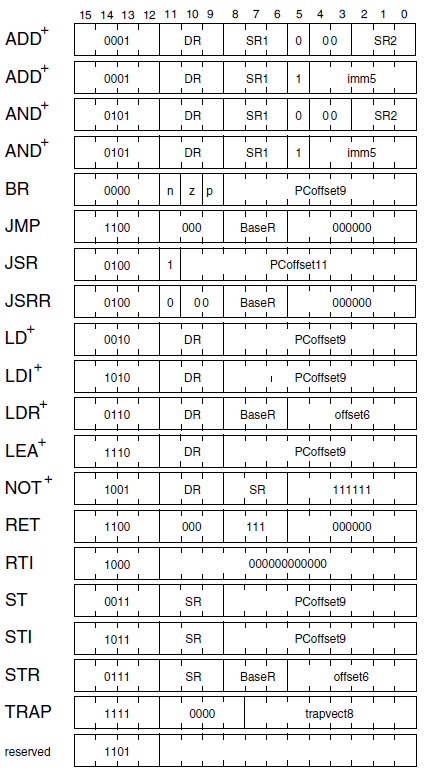
1. Which memory locations were changed by the instruction, if any?

a) x2AEB b) x2AE5 c) x2AE7 d) x2AEE e) None

1. Which of the following registers changed, if any?

a) R0 b) R2 c) R3 d) R6 e) None

1. Write a main in assembly for an LC3 program that gets a key press from the user using GETC and prints the word hello if that keypress is an uppercase H (ASCII for H is 72 decimal).

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