CS224
Fall 2020
Quiz No. 1
Questions (Sep. 23, '20)

2. Number representation (in your answers briefly show your work).

a. Represent the decimal number 85 in binary, octal and hexadecimal notation.

b. Convert the hexadecimal number 0x1A to octal and to base 4 and base 3.

c. Represent the following decimal number: -85 in 2's complement notation using 8, 16, and 32 bits. Show your work and give the results in hexadecimal.

3. Generate the machine instruction in hex for the following symbolic machine instruction. Show your work and provide your final answer inside a box.

addi $t1, $t2, -53

4. Generate the machine instruction in hex for the following symbolic machine instruction. Show your work and provide your final answer inside a box.

jr $t0

5. Convert the following hexadecimal number 012b4020 to symbolic machine instruction format in MIPS. Write your final answer inside the following box. If you see something incorrect please explain.

6. Write a program to find the number of items of an array within a value range. For example for an array {1, 4, 6, 3, 8, 15} the value range 2, 10 (i.e., the numbers greater than or equal to 2 and less than and equal to 10) gives 4 since there are four numbers in this value range. All numbers can be negative or positive. You may assume that the array and the low and high limits are defined in the program in the data segment as follows. Display the result with a message.

```
            .data
array:      .word   1, 4, 6, 3, 8, 18
low:        .word   2
high:       .word   10
arraysize:  .word   6
```

Solutions
See the
following pages.

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Date Given: Sep. 23, '20
Oct. 30, '20

1. Any 5 is good.
See wikipedia textbook etc.

ANSWERS

2.a $85_{10} \rightarrow$ binary, octal, hexadecimal

$\frac{85}{16} = 5$ Remainder $= 5$

$\frac{5}{16} = 0$ ↑stop

Remainder $= 5$ ↑

Verify

$85 = 55_{16} \Rightarrow 5 \times 16 + 5 = 85$

$\underbrace{0}_{1}\underbrace{101\ 0}_{2}\underbrace{101}_{5} = 125_8$ ↓Verify

$= 1 \times 8^2 + 2 \times 8^1 + 5 \times 8^0$

$= 64 + 16 + 5 = 85_{10}$

$\underbrace{01}\underbrace{01}\underbrace{01}\underbrace{01} \Rightarrow 1111_4$

$1 \times 4^3 + 1 \times 4^2 + 1 \times 4^1 + 1 \times 4^0$

$64 + 16 + 4 + 1 = 85_{10}$

$\boxed{85 \Rightarrow 55_{16} \Rightarrow 125_8 \Rightarrow 1111_4}$

2.b $1A_{16} \rightarrow$ Octal $\rightarrow$ Base 4 $\rightarrow$ Base 3

$1A$

$\underbrace{1\ 1}\underbrace{010} = 32_8$

$1A$

$\underbrace{1}\underbrace{10}\underbrace{10} = 122_4$

Base 3 / Conversion $1A \Rightarrow$

$\frac{26}{3} = 8$ Remainder $= 2$

$\frac{8}{3} = 2$ Remainder $= 2$

$\frac{2}{3} = 0$ Remainder $= 2$ ↑

$1A_{16} = 26_{10} = 222_3$

$2 \times 3^2 + 2 \times 3^1 + 2 \times 3^0 =$

$18 + 6 + 2 = 26$

$\boxed{1A_{16} = 32_8 = 112_4 = 222_3}$

2.c -85 in 2's complement using 8, 16, 32 bits

$85_{10} = 55_{16}$

0101 0101

↓

1010 1010

+ 1

1010 1011

AB

FF AB

FFFF FF AB

(3) addi $t1, $t2, -53

$t0 : $8

$t1 : $9

$t2 : $10

No. of bits → $\overset{6}{\text{opcode}}$ / $\overset{5}{\text{rs}}$ / $\overset{5}{\text{rt}}$ / $\overset{16}{\text{imm}}$

Operation in Verilog (from Green Card)

R[rt] = R[rs] + SignExtImm

$\frac{53}{16} = 3$ Remainder: 5

$\frac{3}{16} = 0$ Remainder: 3

$53 = 35_{16}$ $3 \times 16 + 5 \times 16^0 = 48 + 5 = 53$

addi rt, rs, imm

8_{hex} 9 10 -53

$\underbrace{00\,1000}_{2}$ $\underbrace{01\,010}_{1}$ $\underbrace{0}_{4}$ $\underbrace{0\,1001}_{9}$ $\underbrace{1111}_{F}$ $\underbrace{1111}_{F}$ $\underbrace{1100}_{C}$ $\underbrace{1011}_{B}$

0011 0101

↓

1100 1010

+ 1

1100 1011

$\boxed{21\ 49\ FF\ CB_{16}}$

(4) jr $t0 $t0 : $8

Operation in Verilog (from Green Card)

PC = R[rs]

R type $\overset{6}{\text{opcode}}$ / $\overset{5}{\text{rs}}$ / $\overset{5}{\text{rt}}$ / $\overset{5}{\text{rd}}$ / $\overset{5}{\text{shamt}}$ / $\overset{6}{\text{funct}}$

↑ ↑ no register no. is given for them

opcode / rs / rt / rd / shamt / funct

0 8 0 0 0 08

$\underbrace{00\,0000}_{0}$ $\underbrace{01000}_{1}$ $\underbrace{00000}_{0}$ $\underbrace{00000}_{0}$ $\underbrace{00000}_{0}$ $\underbrace{00}_{0}$ $\underbrace{1000}_{8}$

$\boxed{01\ 00\ 00\ 08_{16}}$

⑤ Hext → Symbolic Machine Inst

01 26 40 20

$$\underbrace{0000\ 00}_{\text{opcode=0}}\underbrace{01\ 001}_{\substack{9\\ \text{rs}}}\underbrace{0\ 1011}_{\substack{11\\ \text{rt}}}\ \underbrace{0100\ 0}_{\substack{8\\ \text{rd}}}\underbrace{000\ 00}_{\substack{0\\ \text{shamt}}}\underbrace{10\ 0000}_{\substack{20\\ \text{funct}}}\ \text{Add.}$$

R type

$$\text{add}\ \underset{\substack{8\\ \$t0}}{\text{rd}},\underset{\substack{9\\ \$t1}}{\text{rs}},\underset{\substack{11\\ \$t3}}{\text{rt}}$$

$\boxed{\text{add \$t0, \$t1, \$t3}}$

⑥ Write a program to find the number of items in a value range [Low, high]

```
   .text
   li   $t0,0 #counter
   lw   $t1,low
   lw   $t2,high
   la   $t3,array
   lw   $t4,arraySize
   beq  $t4,$zero,done
next: lw  $t5,0($t3)
   blt  $t5,$t1,next        not next here skip
   bgt  $t5,$t2,next        not next here skip
   addi $t0,$t0,1 #increment counter
skip: addi $t3,$t3,4 #increment pointer
   addi $t4,$t4,-1 # processed one item
   bne  $t4,$zero,next # are we done?
#Result is in $t0
   li   $v0,10
   syscall
```

```
.data
array: .word 1,4,6,3,8,18
low: .word 2
high: .word 10
arraySize. word 6
```

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