Tutorial 4 Solutions

Consider the following instruction sequence where registers R_1, R_2 and R_3 are general purpose and $MEMORY[X]$ denotes the content at the memory location X.

Instruction	**Semantics**	**Instruction Size** (bytes)
MOV $R1, (5000)$	$R1 \leftarrow$ MEMORY[5000]	4
MOV $R2, (R3)$	$R2 \leftarrow$ MEMORY[$R3$]	4
ADD$R2, R1$	$R2 \leftarrow R1 + R2$	2
MOV $(R3), R2$	MEMORY[$R3$] $\leftarrow R2$	4
INC $R3$	$R3 \leftarrow R3 + 1$	2
DEC $R1$	$R1 \leftarrow R1 - 1$	2
BNZ 1004	Branch if not zero to the given absolute address	2
HALT	Stop	1

Assume that the content of the memory location 5000 is 10, and the content of the register R_3 is 3000. The content of each of the memory locations from 3000 to 3020 is 50. The instruction sequence starts from the memory location 1000. All the numbers are in decimal format. Assume that the memory is byte addressable.

After the execution of the program, the content of memory location 3010 is ________

[5000] = 10
R3 = 3000
[3000 - 3020] = 50
BYTE ADDRESSABLE

Address	Instruction	Trace
1000	MOV R1(5000)	R1 <- [5000] R1 <- 10
1004	MOV R2 ,[R3]	R3 = 3000 R2 <-[3000] R2 = 50
1008	ADD R2 R1	R2 = R2 + R1 R2 = 60
1010	MOV [R3] R2	[3000] <- R2 [3000] = 60
1014	INC R3	R3 = R3+1 R3 = 3001
1016	DEC R1	R1 = R1 - 1 R1 = 9
1018	BNZ 1004	Z NOT SET TO 1004
1020	HALT	-

[3001] = 50 + 9 = 59 R1 = 8

.

.

[3008] = 50 + 2 = 52 R1 = 1
[3009] =50 + 1 = 51 R1 = 0
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[3010] = 50 Unaffected Z FLAG SET COMES OUT OF LOOP

Q1 Solution

Representation of 50 and -50 in Sign Magnitude 1st Complement and 2nd Complement

50 Requires 6 bits for addressing and 1 bit for sign

- 2nd Complement 1st Complement and Sign Magnitude: 0110010

For -50, Representation will change

- Sign Magnitude 1110010
- 1st Complement: 1001101
- 2nd Complement 1001110

Q2 Solution

The 16-bit 2’s complement representation of an integer is 1111 1111 1111 0101; its decimal representation is

2nd Complement number is 1111 1111 1111 0101

To find the value of the same, we can see this in 2 ways.

- Take 2nd Complement of the no, find the value, and put a negative sign as it is a negative integer
  1st Compliment: 0000 0000 0000 1010
  2nd Compliment 0000 0000 0000 1011
  1011 -> 11 in decimal and put a negative sign
  Value is (-11)

- Since 2nd Compliment is a weighted representation, we can directly calculate the value.
  Ignoring Trailing Zeros, we have 10101

  10101 -> -2^4 + 2^2 + 2^0
  -> -11

Q3 Solution

Let A = 1111 1010 and B = 0000 1010 be two 8-bit 2's complement numbers. Their product in 2's complement is

$$A = 1111 \quad 1010 = -6$$
$$B = 0000 \quad 1010 = 10$$
$$A \times B = -60 = 1100 \quad 0100$$

Q4 Solution

Consider the following 32-bit pattern

1 1011 0110 011 0000 0000 0000 0000 0000

The value is

$$
\begin{aligned}
& (-1)^{1} \times 2^{10110110-01111111} \times 1.011 \\
= \;& -1.375 \times 2^{55} \\
= \;& -49539595901075456.0 \\
= \;& -4.9539595901075456 \times 10^{16}
\end{aligned}
$$

Q5 Solution

Given the following binary number in 32-bit (single precision) IEEE-754 format:
00111110011011010000000000000000
The decimal value closest to this floating- point number is

Exponent - 01111100 = 124

True exponent = 124 - 127 = -3

So in normalized form it will be

$= 1.1101101 * 2^{-3}$

$= 0.237$

Q6 Solution

The decimal value 9.75 in IEEE single precision floating point

Sign (1 bit) =
0 (a positive number)

Exponent (8 bits) =
1000 0010

Mantissa (23 bits) =
001 1100 0000 0000 0000 0000

Q7 Solution

The decimal value 0.5 in IEEE single precision floating point

Sign (1 bit) =
0 (a positive number)

Exponent (8 bits) =
0111 1110

Mantissa (23 bits) =
000 0000 0000 0000 0000 0000

Q8 Solution

Consider three registers R1, R2, and R3 that store numbers in IEEE-754 single precision floating point format. Assume that R1 and R2 contain the values (in hexadecimal notation) 0x42200000 and 0xC1200000, respectively.

If $R3 = \frac{R1}{R2}$, what is the value stored in R3?

Here, last 20 zeroes
are not written in
numerator and denominaor

$$\mathbf{R_3} = \frac{R_1}{R_2} = \frac{42200000}{C1200000} = \frac{0\ 100\ 0010\ 0\ 010}{1\ 100\ 0001\ 0\ 010} = \frac{+132\ \ 010}{-130\ \ 010} = \mathbf{\text{-}(2 + 127)000 = 110000001000 = C08}$$

For IEEE single precision format,
S(Sign Bit) = 1 bit
E(Exponent) = 8 bits
M(Mantissa) = 23 bits

(1) Sign bit will be -ve because division of +ve and -ve will result in a -ve number
(2) Exponent will be (132 - 130 = 2) and biased exponent will be 2 + 127 = 129
(3) Normalized Mantissa will be $\frac{1.010}{1.010} = 1.000$

Q9 Solution