►Solution◄

Shift Instructions

(V03, V04, V06) Given that register `s3` contains the value `0xF0000013`, answer the following questions: What is the binary representation of the instruction `lw s3, 0(t1)`?

Question 1: (5 points)
Solution: `0000 0000 0000 0011 0010 1001 1000 0011`
(1 mark) `Opcode = 0000011`
(1 mark) `RD = 10011`
(1 mark) `func3 = 010`
(1 mark) `RS1 = 00110`
(1 mark) `immediate = 0000 0000 0000`

Question 2: (5 points)
Assuming an unsigned representation, what is the decimal value of `t1` after executing the instruction `slli t1, s3, 2`?

Solution: 3,221,225,548
`s3 = 1111 0000 0000 0000 0000 0000 0001 0011`
then shift left by 2
(2 marks) `t1 = 1100 0000 0000 0000 0000 0000 0100 1100`
(3 marks) `t1` = $(2^{32} - 2^{30}) + 2^6 + (2^4 - 2^2)$ = 3,221,225,548

Question 3: (5 points)
Assuming a signed representation, what is the decimal value of `t1` after executing the instruction `slli t1, s3, 2`?

Solution: -1,073,741,748
`s3 = 1111 0000 0000 0000 0000 0000 0001 0011`
then shift left by 2
(1 mark) `t1 = 1100 0000 0000 0000 0000 0000 0100 1100`
That's a negative number. So, we first need to find it's 2's complement.
(1 mark) 1's complement = `0011 1111 1111 1111 1111 1111 1011 0011`
`+ 1`

(1 mark) 2's complement = `0011 1111 1111 1111 1111 1111 1011 0100`
$= (2^{30} - 2^{7}) + (2^{6} - 2^{4}) + 2^{2} = 1{,}073{,}741{,}748$
(2 mark) `t1` = -1,073,741,748

Question 4: (5 points)

Assuming a signed representation, what is the decimal value of `t1` after executing the instruction `srli t1, s3, 2`?

Solution: 1,006,632,964
`s3 = 1111 0000 0000 0000 0000 0000 0001 0011`
then shift right logical by 2
(2 marks) `t1 = 0011 1100 0000 0000 0000 0000 0000 0100`
(3 marks) `t1` = $(2^{30} - 2^{26}) + 2^{2} = 1{,}006{,}632{,}964$

Question 5: (5 points)

Assuming a signed representation, what is the decimal value of `t1` after executing the instruction `srai t1, s3, 2`?

Solution: -67,108,860
`s3 = 1111 0000 0000 0000 0000 0000 0001 0011`
then shift right arithmetic by 2
(2 marks) `t1 = 1111 1100 0000 0000 0000 0000 0000 0100`
(3 marks) Following the same approach in Question 14, `t1` = -67,108,860