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What is your last digit of your SID (0 is regarded as 10)? This value is defined as NUM_1 in the whole question paper. (Since my last digit is 7, NUM_1 is 7)

Question 1. (15%)

Consider the following RISC-V instructions. Please note that we treat NUM_1%2 and NUM_1%2+1 as decimal values.

```
1     li a1, NUM_1%2
2     li a2, NUM_1%2+1
3     li a3, 6
4     LOOP:
5     slti t0, a3, 1
6     bne t0, zero, DONE
7     add a4, a1, a2
8     addi a1, a2, 0
9     addi a2, a4, 0
10    addi a3, a3, -1
11    jal x0, LOOP
12    DONE:
13    # end of the program
```

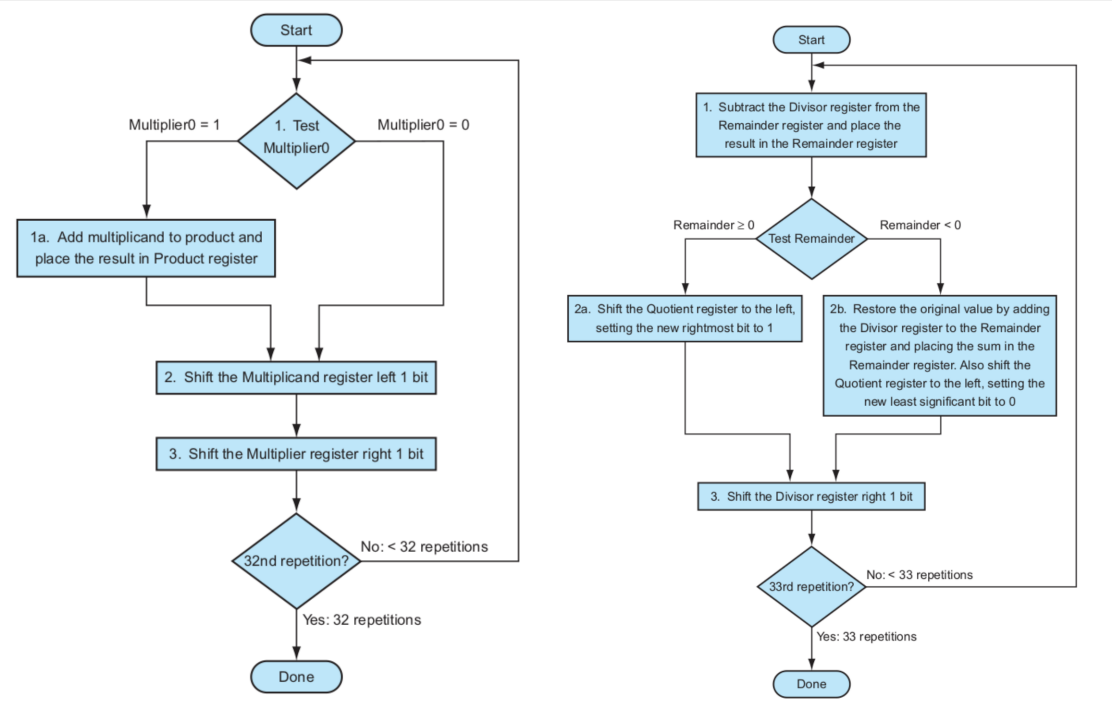
1. How many times is the branch instruction executed? (7%)
2. What are the final values of a1 and a2. (8%)

Answer:

1. 6 times (with one more check which is line 5 and 6 as shown)
2. a1 = 21, a2 = 34

Question 2. (20%)

Read through the multiplication / devision algorithm:



Left: multiplication algorithm, Right: division algorithm

Write down the step by step procedure to calculate 5×2 or 0101×0010. Use Multiplier0 to indicate the least significant bit of the multiplier. List the initial values and the values in 1st to 4th iterations of Multiplier, Multiplier0, Multiplicand and Product. In each iteration, list the values after 1, 2 and 3 steps in Figure 1 left separately. (Represent Multiplier as 4bits, Multiplier0 as 1bit, Multiplicand as 8bits, Product as 8bits.)

Answer:

Iteration	Step	Multiplier	Multiplier0	Mcand	Product
0	Initial value	010<u>1</u>	1	0000 0010	0000 0000
1	1⇒Prod=Prod+Mcand	0101	1	0000 0010	0000 0010
	Shift left Multiplicand	0101	1	0000 0100	0000 0010
	Shift right Multiplier	001<u>0</u>	0	0000 0100	0000 0010
2	Shift left Multiplicand	0010	0	0000 1000	0000 0010
	Shift right Multiplier	000<u>1</u>	1	0000 1000	0000 0010
3	1⇒Prod=Prod+Mcand	0001	1	0000 1000	0000 1010
	Shift left Multiplicand	0001	1	0001 0000	0000 1010
	Shift right Multiplier	000<u>0</u>	0	0001 0000	0000 1010
4	Shift left Multiplicand	000<u>0</u>	0	0010 0000	0000 1010
	Shift right Multiplier	000<u>0</u>	0	0010 0000	0000 1010

Question 3. (20%)

IEEE 754 Floating-Point Standard

1. What decimal number does this single precision float $\texttt{C13C0000}_{16}$ represent? (Show your work.) (10 %)
2. What is -1.510 in IEEE single precision binary floating point format? (Show your work.) (10%)

Answer:

1. (a) by breaking the hexadecimal number into binary, we get

$$\texttt{C13C0000}_{16} = \texttt{11000001001111000000000000000000}_2$$

   (b) the first bit indicate the sign, in this case it is a negative number

   (c) the next 8 bits are used to express the exponent offset by -127, so the exponent in this case is $\texttt{10000010}_2 - \texttt{127}_{10} = \texttt{130}_{10} - \texttt{127}_{10} = \texttt{3}_{10}$

   (d) the following 23 bits are the mantissa