BRAC UNIVERSITY
Department of Computer Science and Engineering
Semester: Summer2024
Section-9, 10, 12

Long Multiplication

if (last bit of multiplier = 1)

1. Product = multiplicand + product
2. 1 bit left shift of multiplicand
3. 1 bit right shift of the multiplier

if (last bit of multiplier = 0)

1. 1 bit left shift of multiplicand
2. 1 bit right shift of the multiplier

Number Of Iteration = Number of bits in multiplier

8 * 9 = 72 in 4 bit architecture

	Multiplicand 0000 1000	**Multiplier 1001**	**Product 0000 0000**
1	0000 1000	1001	0000 1000
	0001 0000	1001	0000 1000
	0001 0000	0100	0000 1000
2	0010 0000	0100	0000 1000
	0010 0000	0010	0000 1000
3	0100 0000	0010	0000 1000
	0100 0000	0001	0000 1000
4	0100 0000	0001	0100 1000
	1000 0000	0001	0100 1000
	1000 0000	0000	0100 1000

Optimized Multiplication

if (last bit of multiplier = 1)

1. MSB of Product = multiplicand + product MSB half bits
2. 1 bit right shift product

Product

if (last bit of multiplier = 0)
1 bit right shift product

Number Of Iteration = Number of bits in multiplier

8 * 9 = 72 in 4 bit architecture

	Multiplicand 1000	**Product 0000 1001**
1	1000	1000 1001
		0100 0100
2	1000	0010 0010
3	1000	0001 0001
4	1000	1001 0001
		0100 1000

Converting into Floating Point Representation

Question:

Convert 70·8863 to 32 bit IEEE 754 Floating Point Representation.

Step 1: Decimal to binary conversion.

70 = 1000110

70·8863 = 1000110·111000101

0·8863
× 2
1·7726
× 2
1·5452
× 2
1·0904
× 2
0·1808
× 2
0·3616
× 2
0·7232
× 2
1·4464
× 2
0·8928
× 2
1·7856

0·8863 = 0·111000101

Step-02 : Normalize the binary number

1000110 · 111000101

$\hookrightarrow$ 1 · 000110 111000101 $\times 2^6$

NOTE: If you were told in the question that you have to calculate exact 20 bits for the fractional part, We had to calculate for 5 bits by the multiplication.

Here we get exact 15 bits for the fraction out of 23 bits.

Step 03: Calculate bias and find out biased exponent.

for 8 bit ~~for~~ exponent field

we get bias value $= 2^{n-1} - 1$

$= 2^{8-1} - 1 = 127$

$\therefore$ Biased exponent $= 6 + 127 = 133$

133 = 1000 0101

Step - 04: Find out fraction and sign bit.

sign bit = 0

fraction = 0001 10111 000101 00000000

Step- 05 : Represent

sign bit	Exponent	fraction
1 bit	8 bit	23 bit

0	1 00000101	0001 10111 000101 00000000
sign bit	exponent	fraction

Floating Point to Decimal Conversion

Question:

0x F2400120

This number is in single precision floating point representation. What is the decimal value?

Step-01: Hexadecimal → Binary

F2400120

↳ 1111 0010 0100 0000 0000 0001 0010 0000

Step-02: Organize binary number into format.

1	1110 0100	1 000000 0000 0001 0010 0000
sign bit	biased exponent	fraction

Step-03: find out exponent and fraction

Biased exponent = 11100100 = 228

bias = $2^{n-1} - 1 = 127$

$\therefore$ exponent = 228 − 127 = 101

fraction = 10000 000000000 10010 0000

$= (1 \times 2^{-1}) + (1 \times 2^{-15}) + (1 \times 2^{-18})$

= 0.5000343323

Step - 04: Use formula:

$$\text{Decimal value} = (-1)^{s} \times (1 + \text{fraction}) \times 2^{\text{exponent}}$$

$$= (-1)^{1} \times (1 + 0.5000343323) \times 2^{101}$$

$$= -1.5000343223 \times 2^{101}$$

$$= -3.8030388843 \times 10^{30}$$

Convert the number 20.7895 into a floating point format where total bit length would be 20 and 6 bits will be allocated for the biased exponent field