IDS - Homework 2

Athazahra Nabila Ruby - 2306173113 - KKI

1.

	Decimal	8, 4, -2, -1	excess-3	2, 4, 2, 1	excess-6
a.	23	0110 0101	0101 0110	0010 0011	1000 1001
b.	83	1000 0101	1011 0110	1110 0011	1110 1001
c.	360	0101 1010 0000	0110 1001 0011	0011 1100 0000	1001 1100 0110
d.	2045	0110 0000 0100 1011	0101 0011 0111 1000	0010 0000 0100 1011	1000 0110 1100 1011
e	5120	1011 0111 0110 0000	1000 0100 0101 0011	1011 0001 0010 0000	1011 0111 1000 0110

1.1

a. $(23)_{10} \xrightarrow{8,4,-2,-1} 0110\ 0101$

$(23)_{10} \xrightarrow{\text{excess-3}} 56 = 0101\ 0110$

$(23)_{10} \xrightarrow{2,4,2,1} 0010\ 0011$

$(23)_{10} \xrightarrow{\text{excess-6}} 89 = 1000\ 1001$

b. $(1000\ 0101)_{8,4,-2,-1} \xrightarrow{\text{decimal}} (83)_{10}$

$(83)_{10} \xrightarrow{\text{excess3}} 11\ 6 = 1011\ 0110$

$(83)_{10} \xrightarrow{2,4,2,1} 1110\ 0011$

$(83)_{10} \xrightarrow{\text{excess-6}} 14\ 9 = 1110\ 1001$

c. $(0110\ 1001\ 0011)_{\text{excess-3}} \xrightarrow{\text{decimal}} 6\ 9\ 3 \xrightarrow{-3} (360)_{10}$

$(360)_{10} \xrightarrow{8,4,-2,-1} 0101\ 1010\ 0000$

$(360)_{10} \xrightarrow{2,4,2,1} 0011\ 1100\ 0000$

$(360)_{10} \xrightarrow{\text{excess-6}} 9\ 12\ 6 = 1001\ 1100\ 0110$

d. $(0010\ 0000\ 0100\ 1011)_{2,4,2,1} \xrightarrow{\text{decimal}} (2\ 0\ 4\ 5)_{10}$

$(2045)_{10} \xrightarrow{8,4,-2,-1} 0110\ 0000\ 0100\ 1011$

$(2045)_{10} \xrightarrow{\text{excess-3}} 5378 = 0101\ 0011\ 0111\ 1000$

$(2045)_{10} \xrightarrow{\text{excess-6}} 8\ 6\ 12\ 11 = 1000\ 0110\ 1100\ 1011$

e. $(1011\ 0111\ 1000\ 0110)_{\text{excess-6}} \xrightarrow{\text{decimal}} 11\ 7\ 8\ 6 \xrightarrow{-6} (5\ 1\ 2\ 0)_{10}$

$(5120)_{10} \xrightarrow{8,4,-2,-1} 1011\ 0111\ 0110\ 0000$

$(5120)_{10} \xrightarrow{\text{excess-3}} 8453 = 1000\ 0100\ 0101\ 0011$

$(5120)_{10} \xrightarrow{2,4,2,1} 1011\ 0001\ 0010\ 0000$

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2. a. −23.3113

•) 23 $\xrightarrow{\text{base 2}}$ 16 + 4 + 2 + = 10111

•) 0.3113 $\xrightarrow{\text{base 2}}$ 0.3113 × 2 = 0.6226 ..... (1)

0.6226 × 2 = 1.2452

0.2452 × 2 = 0.4904

0.4904 × 2 = 0.9808

0.9808 × 2 = 1.9616

0.9616 × 2 = 1.9232

0.9232 × 2 = 1.8464

0.8464 × 2 = 1.6928

0.6928 × 2 = 1.3856

0.3856 × 2 = 0.7712

0.7712 × 2 = 1.5424

0.5424 × 2 = 1.0848

0.0848 × 2 = 0.1696

0.1696 × 2 = 0.3392

0.3392 × 2 = 0.6784

0.6784 × 2 = 1.3568

0.3568 × 2 = 0.7136

0.7136 × 2 = 1.4272

0.4272 × 2 = 0.8544

0.8544 × 2 = 1.7088 .... (20) = 0.01001111101100010101

round to 19 fraction bits

= 0.0100111110110001011

−23.3113 $\xrightarrow{\text{base 2}}$ −10111.0100111110010001011

= −1.01110100111111 0010001011 × 2^{4} → 4 + 127 = 131

sign	exponent	fraction
= 1	10000011	01110100111110110001011

= C1BA7D8B

b. 2023.2024

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•) $2023 \xrightarrow{\text{base 2}} 1024 + 512 + 256 + 128 + 64 + 32 + 4 + 2 + 1$

$= 11111100111$

•) $0.2024 \xrightarrow{\text{base 2}}$

$0.2024 \times 2 = 0.4048$ ... (1)

$0.4048 \times 2 = 0.8096$

$0.8096 \times 2 = 1.6192$

$0.6192 \times 2 = 1.2384$

$0.2384 \times 2 = 0.4768$

$0.4768 \times 2 = 0.9536$

$0.9536 \times 2 = 1.9072$

$0.9072 \times 2 = 1.8144$

$0.8144 \times 2 = 1.6288$

$0.6288 \times 2 = 1.2576$

$0.2576 \times 2 = 0.5152$

$0.5152 \times 2 = 1.0304$

$0.0304 \times 2 = 0.0608$

$0.0608 \times 2 = 0.1216$ ...(14) $= 0.00110011110100$ round to 13 fraction bits

$= 0.0011001111010$

$2023.2024 \xrightarrow{\text{base 2}} 11111100111.0011001111010$

$= 1.11111001110011001111010 \times 2^{10}$ $10 + 127 = 137$

sign	exponent	fraction
0	10001001	11111001110011001111010

$= \boxed{0x44FCE67A}$

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3. a. $\overset{x}{0x\,AA7BCA1A} - \overset{y}{0x\,CC206404}$

•) $x =$ 1010 1010 0111 1011 1100 1010 0001 1010

sign	exponent	fraction
(-) 1	010 10100	111 1011 1100 1010 0001 1010

$\underbrace{01010100}$ → $84 - 127 = -43$

$x = -1.11110111100101000011010 \times 2^{-43}$

to make the exponent the same as y, we need to multiply it by 2^{68}

because $x = 0.00000000\ldots \times 2^{25}$, we can say that $x = 0$

•) $y =$ 1100 1100 0010 0000 0110 1010 0000 0100

sign	exponent	fraction
(-) 1	10011000	010 0000 0110 1010 0000 0100

$\underbrace{10011000}$ → $152 - 127 = 25$

$y = -1.01000000110101000000100 \times 2^{25}$

$x - y = 0 - (-1.01000000110101000000100 \times 2^{25})$

$= 1.01000000110101000000100 \times 2^{25}$

exponent $= 127 + 25 = 152$

sign	exponent	mantissa
0	10011000	010 0000 0110 1010 0000 0100

$=$ 0x 4C206A04

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b. $\overset{x}{0\text{x}CE225061} + (\overset{y}{0\text{x}68FFF0AA} + \overset{z}{0\text{x}58A1000})$

•) x = 1100 1110 0010 0010 0101 0000 0110 0001

sign	exponent	fraction
(-) 1	10011100	010 0010 0101 0000 0110 0001

$\rightarrow 156 - 127 = 29$

$x = -1.010\,0010\,0101\,0000\,0001 \times 2^{29}$

to make the exponent the same as y, we need to multiply it by 2^{53}

because $x = -0.000000000\ldots \times 2^{82}$, we can say $x = 0$

•) y = 0110 1000 1111 1111 1111 0000 1010 1010

sign	exponent	fraction
(+) 0	11010001	111 1111 1111 0000 1010 1010

$\rightarrow 209 - 127 = 82$

$y = 1.11111111111110000101010101 \times 2^{82}$

•) z = 0101 1000 1010 0001 0000 0000 0000

sign	exponent	fraction
(+) 0	10110001	010 0001 0000 0000 0000

$\rightarrow 177 - 127 = 50$

$z = 1.010000100000000000 \times 2^{50}$

to make the exponent the same as y, we need to multiply it by 2^{32}

because $z = 0.00000000\ldots \times 2^{82}$, we can say that $z = 0$

$x + y + z = 0 + 1.11111111111110000101010101 \times 2^{82} + 0$

$= 1.11111111111110000101010101 \times 2^{82}$

$= 0\text{x}68FFF0AA$

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4. a. rounding mode is the method used to determine the answer given by a floating-point computation when the exact result is between two floating-point numbers but is not a floating-point number itself.

why is it important? : - different rounding modes can lead to different results, therefore it can determine how errors grow through computations
- it impacts the precision and accuracy of numerical algorithms
- crucial for portability of code because it ensures the consistency of results accross different hardware and software problems

b. 1) round down
- rounds to largest representable value less than or equal to the original number
- used in financial calculations (to avoid overestimating profit)

2) round up
- rounds to smallest representable value greater than or equal to the original number
- used in scientific / engineering calculations (to ensure that the values are never underestimated)

3) round toward zero
- rounds to zero
- used in binary to integer conversion

4) round to nearest =
- rounds to nearest representable value, if the result is midway in between 2 representable values, the even representable (lowest-order bit is 0) is chosen.
- the default rounding mode for floating point calculations

Index of comments

1.1 You should explain the process that you used to get the answer. (-10)