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**1. Convert the following decimal fractions to binary with a maximum of six places to the right of the binary point:**

a) 27.59375 $= 16+8+2+1+\frac{1}{2}+\frac{1}{16}+\frac{1}{32}$

= 0001 1011.1001 1

b) 105.59375 $= 64 +32+8+1+\frac{1}{2}+\frac{1}{16}+\frac{1}{32}$

= 0110 1001.1001 1

c) 241.53125 $= 128+64+32+16+1++\frac{1}{2}+\frac{1}{32}$

= 1111 0001.1000 1

d) 327.78125 $= 256+64+4+2+1+\frac{1}{2}+\frac{1}{4}+\frac{1}{32}$

= 0001 0100 0111.1100 1

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**2. Convert the following binary fractions to decimal:**

a) 0010 0001.1110 $= \frac{1}{8}+\frac{1}{4}+\frac{1}{2}+1+32$

= 33.875

b) 0011 1111.1001 1 $= 32+16+8+4+2+1+\frac{1}{2}+\frac{1}{16}+\frac{1}{32}$

= 63.59375

c) 0100 1100.1011 = 64+8+4+0.5+0.125+0.0625

= 76.6875

d) 1000 1001.0111 = 0.25+0.125+0.0625+1+8+128

= 137.4375

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**3. Convert the hexadecimal number DEAD BEEF$_{16}$ to binary.**

1 2 3 4 5 6 7 8 9 A B C D E F

0001 0010 0011 0100 0101 0110 0111 1000 1001 1010 1011 1100 1101 1110 1111

D E A D B E E F

1101 1110 1010 1101 1011 1110 1110 1111

DEAD BEEF$_{16}$ = 1101 1110 1010 1101 1011 1110 1110 1111

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**4. Represent the following decimal numbers in binary using 8-bit signed magnitude, one's complement, and two's complement representation:**

a) 77 = 64+8+4+1

= 0100 1101

one's complement = 0100 1101

two's complement = 0100 1101

b) -42 = -32-8-2

= 1010 1010

one's complement = 1101 0101

two's complement = 1101 0110

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**5. What decimal value does the 8-bit binary number 1011 0100 have if:**

**a) it is interpreted as an unsigned number?**

1011 0100 = 128+32+16+4

= 180

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**b) it is on a computer using signed-magnitude representation?**

1011 0100 = 32+16+4 ( not with signed-magnitude)

= 52 ( not with signed-magnitude)

= – 52 (with signed-magnitude)

**c) it is on a computer using one's complement representation?**

1011 0100 = -75

**d) it is on a computer using two's complement representation?**

1011 0100 = -76

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**6. Given a (very) tiny computer that has a word size of 4 bits, what are the smallest negative numbers and the largest positive numbers that this computer can represent in each of the following representations?**

$[-2^{(n-1)}, 2^{(n-1)}-1]$

$[-2^3, 2^3-1]$

[-8, 7]

$[1000, 0111]_2$

**a) One's complement**

$7 = 0111_2$

-8 = -

**b) Two's complement**

$7 = 0111_2$

$-8 = 1000_2$

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7. Add the following unsigned binary numbers as shown.

a) 01000100

10111011 +

11111111

b) 10101100

00100100 +

11010000

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8. Subtract the following signed binary numbers as shown using 2's complement arithmetic.

a) 11000100 11000100

00111011 - → 01000101 +

10001001

b) 01011011 01011011

00011111 - → 01100001 +

00111100

9. Perform the following binary multiplications, assuming unsigned integers:

a) 10011

1011 x

10011

100110 +

10011000

11010001

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b) 11010

1011 x

11010

110100 +

11010000

100011110

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**10. Perform the following binary multiplications using Booth's algorithm, assuming signed two's complement integers:**

note
01 + 11, 00 shift
10 –

A) 1011

x 0101

-00001011 → 11110101 (2')

+00010110 → 00010110 +

-00101100 → 11010100 (2')

+01011000 → 01011000

~~10~~00110111

note

| | | |
|---|---|---|
| 11110101 (2') | 11010100 (2') | 100001011 |
| 00010110 + | 01011000 + | 100101100 + |
| 100001011 | 100101100 | 1000110111 |

Ans. 0011 0111

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b) 0011

1011 x

| | | | |
|---|---|---|---|
| - 00000011 | → | 11111101 | (2') |
| 0 (shift) | → | 00000000 | + |
| 00001100 | → | 00001100 | |
| - 00011000 | → | 11101000 | (2') |
| | | ~~1~~11110001 | |

Ans. 1111 0001