

Name:

Solve following problems. Do not use calculator, mobile device, or computer. You use only pen and pencil. You can use textbook and ppt slides. Do not use Internet. Your answer should be well organized. Otherwise I do not count to your grade meaning that it is 0 points. You must show all works to solve a problem. Do not skip any step or abbreviate any. If you skip or abbreviate any, then it is the 0 point.

1. Convert the following values from decimal to IEEE Standard 754 values: **Show all works.**

a) 204.5

b) 12.785

c) 307.2

d) -0.05432

1. a) 204.5

$$204 \% 2 = 0$$

$$102 \% 2 = 0$$

$$51 \% 2 = 1$$

$$25 \% 2 = 1$$

$$12 \% 2 = 0$$

$$6 \% 2 = 0$$

$$3 \% 2 = 1$$

$$1$$

$$0.5 * 2$$

----- Binary point -----

$$1.0 * 2$$

204.5 is

11001100.100000000000000000000000 . . .

Moving the binary point to the right seven places yields:

$$1.100110010000000000000000000000 . . . * 2^7$$

Using 8-bit biased binary, if we assume 0 to be at 127 (0111 1111), the exponent 7 may be represented as  $127 (0111\ 1111) + 7 (111) = 134 (1000\ 0110)$ .

0      1000 0110   1001 1001 0000 0000 0000 000  
Sign bit Exponent   Significand

b) 12.785

$$12 \% 2 = 0$$

$$6 \% 2 = 0$$

$$3 \% 2 = 1$$

1

$$0.785 * 2$$

-----Binary point-----

$$1.57 \rightarrow 0.57 * 2$$

$$1.14 \rightarrow 0.14 * 2$$

$$0.28 * 2$$

$$0.56 * 2$$

$$1.12 \rightarrow 0.12 * 2$$

$$0.24 * 2$$

$$0.48 * 2$$

$$0.96 * 2$$

$$1.92 \rightarrow 0.92 * 2$$

$$1.84 \rightarrow 0.84 * 2$$

$$1.68 \rightarrow 0.68 * 2$$

$$1.36 \rightarrow 0.36 * 2$$

$$0.72 * 2$$

$$1.44 \rightarrow 0.44 * 2$$

$$0.88 * 2$$

$$1.76 \rightarrow 0.76 * 2$$

$$1.52 \rightarrow 0.52 * 2$$

$$1.04 \rightarrow 0.04 * 2$$

$$0.08 * 2$$

$$0.16 * 2$$

$$0.32 * 2$$

$$0.64 * 2$$

$$1.28 \rightarrow 0.28 * 2$$

$$0.56 * 2$$

$$1.12 \rightarrow 0.12 * 2$$

$$0.24 * 2$$

$$0.48 * 2$$

$$0.96 * 2$$

$$1.92 \rightarrow 0.92 * 2$$

1.84 --> 0.84\*2  
 1.68 --> 0.68\*2  
 1.36 --> 0.36\*2

12.785 = 1100.1100 1000 1111 0101 1100 0010 1000 1111 ...  
 = 1.1001 1001 0001 1110 1011 1000 0101 0001 111 ... \* 2 ^ 4

0111 1111 (127 d) + 11 (3 d) = 1000 0010

0      1000 0010 1001 1001 0001 1110 1011 100  
 Sign bit Exponent Significand

c) 307.2

307 % 2 = 1  
 153 % 2 = 1  
 76 % 2 = 0  
 38 % 2 = 0  
 19 % 2 = 1  
 9 % 2 = 1  
 4 % 2 = 0  
 2 % 2 = 0  
 1

0.2 \* 2  
 -----  
 0.4 \* 2  
 0.8 \* 2  
 1.6 --> 0.6 \* 2  
 1.2 --> 0.2 \* 2  
 0.4 --> 0.4 \* 2  
 0.8 \* 2  
 1.6 --> 0.6 \* 2  
 1.2 --> 0.2 \* 2  
 0.4 --> 0.4 \* 2  
 0.8 \* 2  
 1.6 --> 0.6 \* 2  
 1.2 --> 0.2 \* 2  
 0.4 --> 0.4 \* 2  
 0.8 \* 2  
 1.6 --> 0.6 \* 2  
 1.2 --> 0.2 \* 2  
 0.4 --> 0.4 \* 2  
 0.8 \* 2  
 1.6 --> 0.6 \* 2  
 1.2 --> 0.2 \* 2

$$0.4 \rightarrow 0.4 * 2$$

...

$$307.2 = 100110011.001100110011001100110011 \dots$$

$$= 1.0011\ 0011\ 0011\ 0011\ 0011\ 0011\ 0011\ 0011 \dots * 2^8$$

$$127 + 8 = 135 = 0111\ 1111 + 1000 = 1000\ 0111$$

0      1000 0111 0011 0011 0011 0011 0011 001  
Sign bit Exponent Significand

d) -0.05432

$$-0.05432 = 0.0000\ 1101\ 1110\ 0111\ 1110\ 1010\ 0101\ 1111\ 1000\ 0 \dots$$

$$= 1.1011\ 1100\ 1111\ 1101\ 0100\ 101 \dots * 2^{-5}$$

$$127 - 5 = 122 = 0111\ 1010$$

1      0111 1010 1011 1100 1111 1101 0100 101  
Sign bit Exponent Significand

0.05432 \* 2  
-----Binary point-----  
0.10864 \* 2  
0.21728 \* 2  
0.43456 \* 2  
0.86912 \* 2

1.73824 --> 0.73824 \* 2  
1.47648 --> 0.47648 \* 2  
0.95296 \* 2  
1.90592 --> 0.90592 \* 2

1.81184 --> 0.81184 \* 2  
1.62368 --> 0.62368 \* 2  
1.24736 --> 0.24736 \* 2  
0.49472 \* 2

0.98944 \* 2  
1.97888 --> .97888 \* 2  
1.95776 --> 0.95776 \* 2  
1.91552 --> 0.91552 \* 2

1.83104 --> 0.83104 \* 2  
1.66208 --> 0.66208 \* 2

1.32416 --> 0.32416 \* 2  
0.64832 \* 2

1.29664 --> 0.29664 \* 2  
0.59328 \* 2  
1.18656 --> 0.18656 \* 2  
0.37312 \* 2

0.74624 \* 2  
1.49248 --> 0.49248 \* 2  
0.98496 \* 2  
1.96992 --> 0.96992 \* 2

1.93984 --> 0.93984 \* 2  
1.87968 --> 0.87968 \* 2  
1.75936 --> 0.75936 \* 2  
1.51872 --> 0.51872 \* 2

1.03744 --> 0.03744 \* 2  
0.07488 \* 2  
0.14976 \* 2  
0.29952 \* 2

0.59904 \* 2

2. Compute the results of the following 8-bit binary mathematical operations. Assume all numbers are in binary and in two's complement format. Be sure to verify your results by converting to decimal.

a) 00101000 + 00110111

b) 11100101 - 10011010

c) 11111111 + 00000000

d) 01101110 - 11111100

2. a) 00101000  
+00110111

-----

01011111

b) 11100101

-10011010 --> 01100101 --> 01100110

-----

```
-->  11100101
    +01100110
    -----
    01001011
```

```
c) 11111111
   +00000000
   -----
   11111111
```

```
d) 01100110
   -11111100 --> 00000011 --> 00000100
   -----
```

```
-->  01100110
    +00000100
    -----
    01101010
```

3. **Showing all work**, convert the following numbers:

- 1101001 from binary to decimal
- 0111 1100 0100 1001 0110 1010 1011 1101 from binary to hexadecimal
- 18324 from decimal to binary
- Convert the result from c) to hexadecimal
- Convert 1001 1110 1010 0010 binary to hexadecimal.
- Convert 123 decimal to binary
- Convert 111001 binary to decimal

3. a) Convert 1101001 to decimal

$$75 = 1 + 8 + 32 + 64$$

b) convert 0111 1100 0100 1001 0110 1010 1011 1101 to hex

7 C 4 9 6 A B D

c) Convert 18324 to binary

$$18324 \% 2 = 0$$

$$9162 \% 2 = 0$$

$$4581 \% 2 = 1$$

$$2290 \% 2 = 0$$

$$1145 \% 2 = 1$$

$$572 \% 2 = 0$$

$$286 \% 2 = 0$$

$$143 \% 2 = 1$$

$$71 \% 2 = 1$$

$$\begin{array}{r}
 35 \% 2 = 1 \\
 17 \% 2 = 1 \\
 8 \% 2 = 0 \\
 4 \% 2 = 0 \\
 2 \% 2 = 0 \\
 1
 \end{array}$$

result is 100011110010100

$$\begin{array}{cccc}
 \text{d) } 100 & 0111 & 1001 & 0100 \\
 4 & 7 & 9 & 4
 \end{array}$$

$$\text{e) } 9\text{EA}2$$

$$\begin{array}{r}
 \text{f) } 123 \% 2 \rightarrow 1 \\
 61 \% 2 \rightarrow 1 \\
 30 \% 2 \rightarrow 0 \\
 15 \% 2 \rightarrow 1 \\
 7 \% 2 \rightarrow 1 \\
 3 \% 2 \rightarrow 1 \\
 1
 \end{array}$$

$$1111011$$

$$\text{g) } 111001 \text{ is } 1 + 8 + 16 + 32 = 57$$

4. Convert the following decimal value to binary: **Show all works.**

304.875d

Put the binary number above in scientific notation. That is, convert it to a value in the format:  $x.\text{xxxxxxxx} * 2^y$ . Determine the value of  $y$  in both decimal and binary.

$$4. 304\text{d} = 1\ 0011\ 0000\text{b}$$

$$\begin{array}{l}
 0.875 * 2 \\
 1.75 \Rightarrow 0.75 * 2 \\
 1.5 \Rightarrow 0.5 * 2 \\
 1.0
 \end{array}$$

$$\Rightarrow 0.875\text{d} = 0.111\text{b}$$

$$304.875\text{d} = 1\ 0011\ 0000.111\text{b} = 1.0011\ 0000\ 111 * 2^8\text{d or } 1000\text{b}$$

5. Convert the following numbers to two's complement using 8 bits. Remember that one bit will represent the sign. Then add the two numbers. **Show all works.**

24d  
-31d

5)  $24 = 0001\ 1000$   
 $31 = 0001\ 1111 \Rightarrow -31 = 1110\ 0001$

$0001\ 1000$   
 $+1110\ 0001$

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$1111\ 1001 = -7d$