Floating Point Rounding Modes:

Round the following binary numbers to the nearest **integer** using each of the four modes, when needed:

	0.00_2	0.01_2	0.10_2	0.11_2	1.00_2	1.01_2	1.10_2	1.11_2
Half-way?	No	No	Yes	No	No	No	Yes	No
$+\infty$	0	0	1	1	1	1	10_2	10_2
$-\infty$	0	0	0	1	1	1	1	10_2
Zero	0	0	0	1	1	1	1	10_2
Even	0	0	0	1	1	1	10_2	10_2

Floating Point

Convert the following decimal numbers into binary (not float):

1.5
$= 2^0+2^{-1}$
$= 1.1_2$

0.25
$= 2^{-2}$
$= 0.01_2$

0.8
$= 2^{-1}+2^{-2}+2^{-5}+2^{-6}+\ldots$
$= 0.\overline{1100}_2$ (repeating)

-16.5
$= -(2^4+2^{-1})$
$= -10000.1_2$

Give the best hex representation of the following numbers (using single precision floats):

1.0
$= 1_2$
S = 0
E = 127
M = 0
0x3f800000

-7.5
$= -111.1_2$
S = 1
E = 129
M = 0b1110…0
0xc0f00000

(1.0/3.0)
$= 0.\overline{01}_2$
S = 0
E = 125
M = 0b$\overline{01}$
0x3eaaaaaa

(186.334/0.0)
$= +\infty$
S = 0
E = 255
M = 0
0x7f800000

What is the value of the following single precision floats?

0x0
0

0xff94beef
-NaN

0x1
$2^{-126} \times 2^{-23} = 2^{-149}$

These were all special numbers. Remember that exponent for denorm is 2^{-126}.

Performance Metrics

Exercises

You are the lead developer of a new video game at AE, Inc. The graphics are quite sexy, but the frame rates (performance) are horrible. Doubly unfortunately, you have to show it off at a shareholder meeting tomorrow. What do you do?

1) You need to render your latest and greatest über-l33t animation. If your rendering software contains the following mix of instructions, which processor is the best choice?

Operation	Frequency
ALU	30%
Load	30%
Store	20%
Branch	20%

A's CPI	B's CPI	C's CPI
1	1	1
3	5	3
2	3	4
3	2	2

```
Average CPI:

A: 1*.3 + 3*.3 + 2*.2 + 3*.2 = 2.2
B: 2.8
C: 2.4

A wins.
```

2) What if the processors had different clock speeds? Assume A is a 1 Ghz processor, B is a 1.5 Ghz processor, and C is a 750 Mhz processor.

```
1/frequency = seconds/cycle
cycles/inst * seconds/cycle = seconds/inst, a better estimate of
performance.

seconds / cycle: A = 1 ns, B = .66 ns, C = 1.33 ns
seconds / inst: A = 2.2 ns, B = 1.86 ns, C = 3.2 ns.

B wins.
```

3) But wait, these processors are made by different manufacturers, and use different instruction sets. So the renderer (for the different architectures) takes a different number of instructions on each. Which is best if your main loop on A averages 1000 instructions; on B it averages 800 instructions; and on C it averages 1200 instructions?

```
We now have instructions/program.
seconds/inst [from part b] * inst/program = seconds/program, the
runtime.

instructions / program: A = 1000, B = 800, C = 1200
seconds/program: A = 2.2 us, B = 1.493 us, C = 3.84 us.
B produces the fastest program, and wins.
```