This is a closed book and closed notes exam. Communication with anyone other than the instructor is not allowed during the exam. **Furthermore, calculators, cell phones, and any other electronic or communication devices may not be used during this exam.** Anyone needing a break during the exam must leave their exam with the instructor. Cell phones or computers may not be used during breaks.

This exam must be turned in before 6:55 PM.

Name:_____

Problem 1 (30 points) C expressions
In the left column, there are twenty tricky and not-so tricky C expressions. Write their values in the right column. Express your answers in simple base 10 expressions, such as 235 or -235. You may assume that all of these numbers are stored in 16-bit two's complement representation, the usual short.

012	**10**
0x64	**100**
10 >> 2	**2**
10 << 2	**40**
10 / 3 * 5	**14**
10 * 3 / 5	**6**
12 & 7	**4**
12 && 7	**1**
**12	7**	**15**
12 || 7	**1**
12 ^ 7	**11**
12 > 7	**1**
~12	**-13**
!12	**0**
55*66 && 1003/100	**1**

Problem 2 (16 points) Decimal to two's complement conversion
Convert the following four signed decimal numbers into **five**-bit *two's complement* representation. Some of these numbers may be outside the range of representation for **five**-bit two's complement numbers. Write "out-of-range" for those cases.

-16	-19
10000	*out-of-range*
10	63
01010	*out-of-range*

Problem 3 (16 points) Q4.4 to decimal conversion
Convert the following four Q4.4 *two's complement* numbers (four fixed and four fractional bits) into signed decimal representation.

00000001	0.625
10000000	-8
00101010	2.625
10101010	-5.375

Problem 4 (12 points) Decimal to Q4.4 conversion
Convert the following three signed decimal numbers into Q4.4 *two's complement* numbers (four fixed and four fractional bits). If you can't express the number exactly, give the nearest Q4.4 representation.

`-1.25`	**11101100**
`0.4`	**00000011**
`5.5`	**01011000**

Problem 5 (4 points) Floating calculations
One of the following C floating-point multiplications results in 1.0 and one does not:

        2 * 0.5
        5 * 0.2

Which is 1.0? Give an explanation for your choice.

Because 0.5 is ½ or 2^{-1}, it can be represented exactly as a binary fraction. 0.2 is not a fractional power of 2 and can not be represented exactly in floating point.

PS: The IEEE 754 standard allows multiplication to be off by the least significant bit. Consequently, 5 * 0.2 can be 1 or maybe something very close to 1.

Problem 6 (22 points) C Programming
Write a program that reads (use `scanf`) a bunch of integers from a
terminated standard input stream and prints (use `printf`) a nearly formatted
two-line summary of the number of even and odd numbers in the bunch of
integers. Your output must have neatly formatted lines as illustrated below.

```
Number of evens:    1040
Number of odds:      986
```

The input is totally unformatted and only contains integers, somewhat like
these line which contains five odd numbers with the 3 appearing four times:

```
     235    2018    3
    1776                -200    3    3    3
```

Here's two lines to get you started:

```c
#include <stdio.h>
int main(int argc, char *argv[]) {

  // declare, initial            4
  int oddNumber = 0 ;
  int evenNumber = 0 ;
  int nextNumber ;
  // reading number              4
  // checking for end-of-file    4
  while (scanf("%d", &nextNumber) == 1) {
    // testing if odd            5
    if (nextNumber%2 == 0) {
      ++evenNumber ;
    } else {
      ++oddNumber ;
    }
  }
  // printing                    5
  printf("Number of evens: %8d\n", evenNumber) ;
  printf("number of odds:  %8d\n", oddNumber) ;

}
```