UNCA CSCI 235
Final Exam Fall 2018
11 December 2018 – 3:00 pm to 5:30 pm

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.

Name:_____

Problem 1 (10 points) C expressions
In the left column, there are fifteen tricky and not-so tricky C expressions. Write their values in the right column. Express your answers as 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`.

`0123`	
`0xEB`	
`14 && 14`	
`42 & 35`	
`42 >> 3`	
`42 | 35`	
`42 << 3`	
`42 ^ 35`	
`~42 + 1`	
`3 * 4 / 5`	
`(3 * 4) / 5`	
`1 < (2 < 3)`	
`17 & ~17`	
`17 && -17`	
`(17 == 17) * 17`	

Problem 2 (4 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.

15	**32**
-15	**-32**

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

11001000	**00010011**

Problem 4 (3 points) Decimal to Q4.4 conversion
Convert the following two 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.

3.3	-1.414

Problem 5 (6 points) Adding numbers with flags
Add the following pairs of six-bit numbers. Based on the result of this addition, set the four x86-64 status bits: CF (carry), OF (overflow), SF (sign) and ZF (zero).

111011 **+ 000101** **CF__, OF__, SF__, ZF__**	**011100** **+ 000100** **CF__, OF__, SF__, ZF__**
100000 **+ 100000** **CF__, OF__, SF__, ZF__**	**010110** **+ 000110** **CF__, OF__, SF__, ZF__**

Problem 6 (2 points) Range
What is the range of numbers that can be stored in 16-bit twos-complement numbers? (The `short` of Java is a 16-bit twos-complement number.)

Problem 7 (2 points) Range
What is the range of numbers that can be stored in 16-bit unsigned numbers? (The `char` of Java is a 16-bit unsigned number.)

Problem 8 (6 points) Formatted printing

Suppose that the `int` variable C has the value 170 (in decimal). The left column in the table below has a `printf` statement. The right column has the desired output for that `printf` within a six character field. Your task is to fill in the underlined part (the stuff after the %). ***You must use a single "conversation specifier" (the thing starting with a %) in your format string. No "ordinary characters" are allowed.*** This means the following are not allowed because they contain ordinary characters.

```
printf("000160", C) ;   // contains only ordinary characters
printf("   %3d", C) ;   // starts with three ordinary characters
```

`printf("%_____",C) ;`	_ _ _ **1 6 0**
`printf("%_____",C) ;`	**0 0 0 1 6 0**
`printf("%_____",C) ;`	_ _ **+ 1 6 0**
`printf("%_____",C) ;`	_ _ _ **2 4 0**
`printf("%_____",C) ;`	_ _ _ _ **a 0**
`printf("%_____",C) ;`	_ _ _ _ **A 0**

Problem 9: goto programming (8 points)
In the style of a recent homework, implement the C function shown below using only two control structures:

goto *label* ;
if (*expression*) goto *label* ;

This specifically means that you can't use the `for`, `while`, `switch`, `break`, `continue`, or even the statement block delimiters { and }. You can use the `if`, but only when the conditional expression is immediately followed by a `goto` statement. Also, do not use the `?:` operator of C (and Java) to simulate an `if-then-else`.

```
int population(unsigned int p) {
    int c = 0 ;
    while (p > 0) {
        if (p & 1) {
           ++c ;
        }
        p = p >> 1 ;
    }
    return c ;
}
```

```
int population(unsigned int p) {
    int c = 0 ;
```

```
  return c ;
}
```

Problem 10 (6 points) & and >>
The following expressions and declarations were used in the preceding question to determine the "population" (number of 1's) in an integer. Answer a couple of questions about this census program.

What is the role of the expression "`p & 1`" and the statement "`p = p >> 1`" in calculating the number of 1's?

Why must the parameter p be `unsigned`?

Problem 11 (6 points) CSCI arithmetic
Perform the following operations and express the results as they should be for CSCI 235 and other geeky environments. *You **must** use powers of 2!*

4 Mi * 32 ki
16 Mi / 64
$\log_2$(16 ki)

Problem 12 (13 points) C Programming

Write a program that reads (**using scanf**) letters (from A to Z). Such as

```
A   B  C  C  A
```

Your program should sum the number of time each letter appears in a neat table such as:

```
A:   2
B:   1
C:   2
……
Z:   0
```

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

```
}
```

Problem 13 (5 points) Boolean expression to truth table

Fill in the truth table on the right below so that it corresponds to the following Java (and C) expression:

```
X = (!A || B && C) && !C
```

If you prefer the computer engineering style, you can think of the equation as

```
X = (A’ + B C) C’
```

A	B	C	X
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

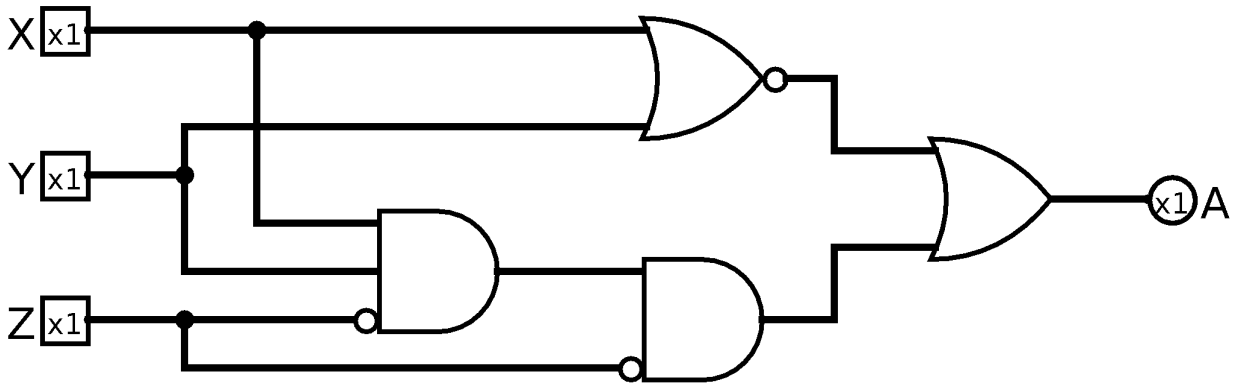
Problem 14 (5 points) Truth table to Boolean expression

The truth table below specifies a Boolean function with three inputs, **A**, **B**, and **C** and one output **X**.

A	B	C	X
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

Write a Boolean expression corresponding to the function specified in the table. You do not need to write an “efficient” expression; however, ridiculously complex expressions will not be given full credit. The phrase “ridiculously complex expressions” means “expressions with require more than five minutes of instructor time to decode”.

Problem 15 (8 points) Circuit to Boolean expression and truth table
A gate-level circuit is shown below with three inputs on the left and a single output on the right.



First, write the Boolean expression corresponding to this circuit. (Don't worry about the "x1". It indicates that the connection is for a single bit.)

Next, complete the following truth table so that it corresponds to this digital logic circuit.

X	Y	Z	A
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Problem 16: Definitions (7 points)
Give short definitions of the following concepts, functions, hacks, programs, types, variables, etc., you have seen in the labs and homework of this course, *Feel free to skip one: I will grade the best seven of eight definitions.*

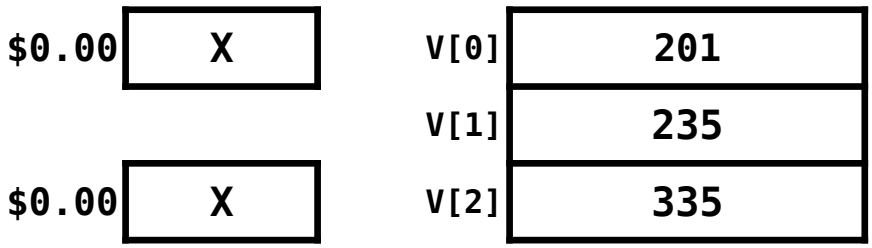
`-std=c99`
`-Wpedantic`
`analogWrite()`
Circuit Playground Express
`logisim`
`nano`
`opendir()`
`qsort()`

Problem 17 (8 points)
In this question, you are to fill in boxes representing the following C integer or pointer variables to show their values after each of seven sections of C code are executed. **You should consider all the sections as being independently executed after the following declaration and initialization statements**:

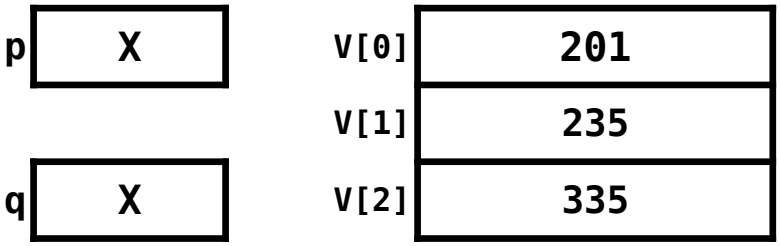
```
int    V[3] = {201, 235, 335} ;
int    *p = NULL ;
int    *q = NULL ;
```

As you know, **`null`** in Java is similar to **`NULL`** in C. Draw the value **`NULL`** with a little ***X***. Don't ever just leave the pointer variable boxes empty.

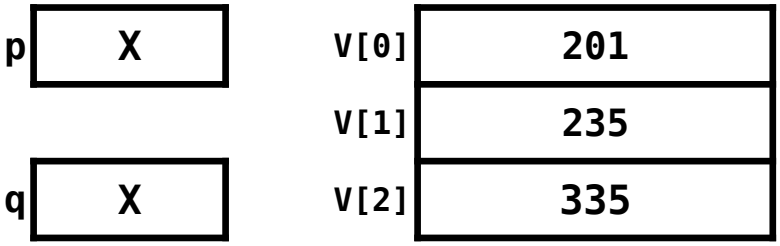
```
p = &V[0] ;
q = &V[2] ;
*p = *q ;
++*p ;
```



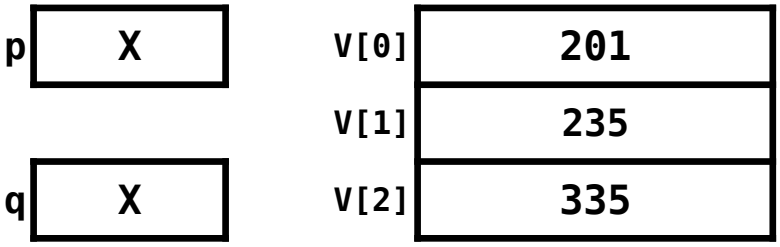

```
q = V ;
p = q + 1 ;
*p = 181 ;
*q = *p + 100 ;
```




```
p = &V[1] ;
q = &V[2] ;
*q = q - p ;
*p = *q - *p ;
```




```
p = &V[0] ;
q = &V[2] ;
*q = (*p)++ ;
```



CSCI 255
Handy Table of Numbers

Powers of Two

2^0	1
2^1	2
2^2	4
2^3	8
2^4	16
2^5	32
2^6	64
2^7	128
2^8	256
2^9	512

2^{10}	1024
2^{11}	2048
2^{12}	4096
2^{13}	8192
2^{14}	16384
2^{15}	32768
2^{16}	65536
2^{17}	131072
2^{18}	262144
2^{19}	524288

2^{10}	1 Ki
2^{20}	1 Mi
2^{30}	1 Gi

Hex table

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111