UNCA CSCI 235
Exam 2 Fall 2018 Solution
27 November 2018

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 (10 points) C expressions
In the left column, there are ten 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`.

`0x64`	100
`050`	40
`19 && 0`	0
`19 & 27`	19
`19 ^ 27`	8
`37 * 2 / 10`	7
`19 >= 4`	1
`19 >> 4`	1
`19 | 4`	23
`(7 != 5) * 235`	235

Problem 2 (4 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.

10011001 -6.4375	00011000 1.5

Problem 3 (4 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.

-3.5 **11001000**	2.71828 **00101011**

Problem 4 (10 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** **000000** **CF_1, OF_0, SF_0, ZF_1**	**010110** **+ 000110** **011100** **CF_0, OF_0, SF_0, ZF_0**
101111 **+ 100000** **001111** **CF_1, OF_1, SF_0, ZF_0**	**011000** **+ 001000** **100000** **CF_0, OF_1, SF_1, ZF_0**

Problem 5 (4 points) Range
What is the range of numbers that can be stored in 8-bit twos-complement numbers? (The byte of Java is an 8-bit twos-complement number.)

-2^7 to 2^7-1 or -128 to 127

Problem 6 (4 point) 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.)

0 to $2^{16}-1$ or 0 to 65535

Problem 7 (6 points) CSCI arithmetic
Perform the following operations and express the results as they should be for CSCI 235 and other geeky environments. *Use powers of 2!*

16 ki * 64 ki $2^4 * 2^{10} * 2^6 * 2^{10} = 2^{30} = 1$ Gi
32 ki / 128 $2^5 * 2^{10} / 2^7 = 2^8 = 256$
$\log_2$(32 Gi) $\log_2(2^5 * 2^{30}) = \log_2(2^{35}) = 35$

Problem 8 (6 points) Compile and run
Suppose you have written the following program and stored it in a file named `prob8.c` .

```
#include <stdio.h>
int main(int argc, char *argv[]) {
  printf("%s is %d\n", argv[2], argc) ;
  return 0 ;
}
```

What would be an appropriate **Makefile** for the program? Assume you want to store the executable in the file **prob8**. I am giving you the first line of the **Makefile**. You need to put in the others. Write your **Makefile** so that typing the command **make** (with no arguments) will compile your program.

```
CFLAGS = -std=c99 -Wpedantic -Og -g

all:  prob8
```

Now comes the tricky part of the riddle. Below is the start of a single command typed from the command prompt. What command line arguments do you pass to **prob8** to make it print this single output line?

```
IV is 4
```

Just complete the command.

```
./prob8   a   IV   b
```

Problem 9 (20 points) C Programming

Write a program that reads (**using scanf**) a bunch of highway "numbers" (a string followed by a number) from a terminated standard input stream that are entered as shown below.

```
                  US 25  NC
         694          I 26   NC 251
```

Your output should be a neatly formatted list of highways (one per line as shown below) followed by a count of the number of NC highways. So, for the above example, the output should something like

```
       US     25
       NC    694
       I      26
       NC    251
NC count:     2
```

```
#include <stdio.h>
#include <string.h>
int main(int argc, char *argv[]) {
    char routeType[100] ;
    int  routeNumber ;
    int  ncCount = 0 ;
    while (scanf("%s%d", routeType, &routeNum)==2) {
        printf("%5s %5d\n", routeType, routeNum) ;
        if (!strcmp("NC", routeType)) {
            ++ncCount ;
        }
    }
    printf("NC count: %7d\n", ncCount) ;
}
```

Problem 10 (10 points) Boolean expression to truth table and circuit

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

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

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

```
X = (A B)' C'
```

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

Second, draw a logic circuit (AND, OR, …) to implement the boolean expression and corresponding truth table.

Problem 11 (10 points) Truth table to Boolean expression and circuit

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	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

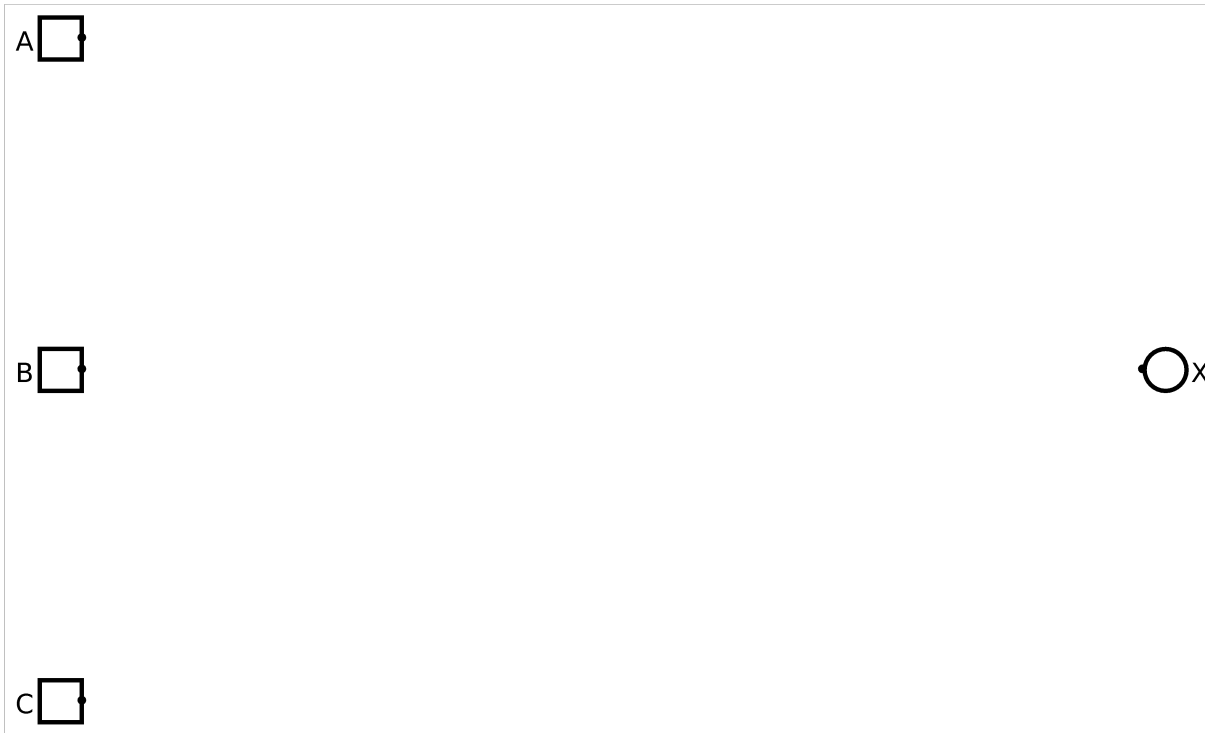
First, write a Boolean expression corresponding to the function specified in the table. You do not need to write an “efficient” expression; however, ridiculously complex expressions will not be given full credit.

A’ B’ C + A’ B C’ + A’ B C + A B’ C

or – with fewer transistors

A’ B + B’ C

Second, draw a logic circuit (AND, OR, …) to implement the boolean expression and corresponding truth table.



Problem 12 (12 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 might guess, **`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[1] ;
q = &V[2] ;
*p = 150 ;
*q = V[1] + 200 ;
```

p	&V[1]
q	&V[2]

V[0]	201
V[1]	150
V[2]	350

```
q = V ;
p = q ;
*p = 300 ;
*q = 400 ;
```

p	&V[0]
q	&V[0]

V[0]	400
V[1]	235
V[2]	335

```
p = &V[1] ;
q = &V[2] ;
*q = *(p++) ;
*p = 13 ;
```

p	&V[2]
q	&V[2]

V[0]	201
V[1]	235
V[2]	13

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

p	&V[0]
q	&V[2]

V[0]	202
V[1]	235
V[2]	201

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