UNCA CSCI 235
Final Exam Fall 2017
3:00-5:30 pm, Tuesday, 12 December, 2017

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.

If you want partial credit for imperfect answers, explain the reason for your answer!

Name:_____

Problem 1 (15 points) C expressions
In the left column, there are twelve C expressions. Write their values in the right column. Express your answers in base 10. You may assume that all of these numbers are stored in 16-bit two's complement representation.

`~21`	
`!21`	
`21 & 15`	
`21 | 15`	
`21 ^ 15`	
`21 / 10`	
`21 > 10`	
`21 << 2`	
`21 >> 2`	
`0x10 + 10`	
`2017 > 2016 + 1`	
`15*235 && 0`	

Problem 2 (6 points) Decimal to two's complement conversion

Convert the following four signed decimal numbers into **six**-bit *two's complement* representation. Some of these numbers may be outside the range of representation for **six**-bit two's complement numbers. Write "out-of-range" for those cases.

10	**32**
-10	**-32**

Problem 3 (6 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) into signed decimal representation. If you can't express the number exactly, give the nearest Q4.4 representation.

-2.25
5.0
0.555

Problem 4 (6 points) Q4.4 to decimal conversion

Convert the following three Q4.4 *two's complement* numbers (four fixed and four fractional bits) into signed decimal representation.

01110000
11010100
00000101

Problem 5 (6 points) Number puzzle

According to gdb, the C debugger, `(1/2017)*2017` is not 1. Why?

According to gdb, the C debugger, `(1/2017.0)*2017.0` is not `1.0` . Why?

Problem 6 (8 points) Printing a table

Write a loop, in C, to neatly print a table of squares from 0 to 99. Here are a few lines from the middle of the printout illustrating a possible output format.

```
30 * 30 =   900
31 * 31 =   961
32 * 32 =  1024
```

Write your code in the lines below.

Problem 7 (15 points) Summing initial numbers

Suppose you have a file named "numbers.txt" containing lines which start with an integer and are followed by a single word. Here's an example of a four-line file that satisfies this requirement.

```
       1 lonely
   12    dozen
     2017 year
               13 unlucky
```

Write a few lines of C that:

- Open the file "`numbers.txt`" for reading.
- If "`numbers.txt`" cannot be read, print an error message and then exit.
- Read the lines of the file. You may assume that **all** lines are in the correct format: No error checking is expected!
- Print a neatly formatted listing of the number and the word for each input line. You may assume that no number is greater than 9999.
- After the last line is read, print the sum of all the numbers.

Here is an example of the program's output for the input shown above:

```
          1  lonely
         12  dozen
       2017  year
         13  unlucky
THE TOTAL OF THE NUMBERS IS 2043
```

Write your answer on the following page. It really doesn't require near that much room.

```
#include <stdio.h>
#include <stdlib.h>

int main(int argc, char **argv) {

  return (EXIT_SUCCESS) ;
}
```

Problem 8 (6 points) Which is faster?

Assume that X is declared as a 300 by 300 array of integers as follows:

```
int X[300][300] ;
```

Which of the following loops are likely to be executed the fastest on a modern computer. *Justify your answer!*

```
for (int i = 0; i<256; ++i)
     S = S + X[235][i] ;
```

```
for (int i = 0; i<256; ++i)
     S = S + X[i][235] ;
```

Problem 9 (6 points) Structure and fields

Suppose you are given the following definition.

```
struct collegeInfo {
   char name[51] ;
   char city[21] ;
   int enrollment ;
}
```

Write a few lines of C code that

- Declare a variable `wwc` of type `struct collegeInfo`.
- Initialize `wwc` appropriately for a college named Warren Wilson College that is located in Swannanoa and has 753 students.

Problem 10 (6 points) On the average

You must show your work to receive full credit for this problem! Work the problem to completion!

Suppose a computer can retrieve a value from its cache in 20 µsec and from DRAM in 5 msec.

What is the average memory access time if the cache hit rate is 0.9?

What is the average memory access time if the cache hit rate is 0.5?

Problem 11 (8 points) Cache structures

Suppose a puny computer with 16-bit address has a 4-way set-associate 2k (2048) byte cache and each block of the cache is 32 bytes:

- How many blocks does this puny cache have?
- How many sets does this puny cache have?
- The 16-bit address is divided into three fields: tag, index, and offset. How many bits are each allocated in each of these fields? (I suggest illustrating your point.)

Problem Z (12 points) Definitions

To finish off, give short definitions of the following concepts, functions, hacks, types, variables, etc., we have seen in this course.

Fell free to skip two: I will grade the best six of eight definitions.

`argv[2]`
`digitalRead()`
`FILE *`
GNU toolchain
`pinMode()`
Randal E. Bryant
Raspberry Pi
`strncmp()`