CIS 2107
Computer Systems and Low-Level Programming
Spring 2011
Midterm

March 3, 2011

Name: ______________________________

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**Instructions**
The exam is closed book, closed notes. You may *not* use a calculator, cell phone, etc.

For each of the questions of this quiz, you can assume the following sizes for C data types:

<table>
<thead>
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<th>type</th>
<th>bytes</th>
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<tr>
<td>char</td>
<td>1</td>
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<tr>
<td>short</td>
<td>2</td>
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<tr>
<td>int</td>
<td>4</td>
</tr>
<tr>
<td>long</td>
<td>8</td>
</tr>
<tr>
<td>float</td>
<td>4</td>
</tr>
<tr>
<td>double</td>
<td>8</td>
</tr>
<tr>
<td>void*</td>
<td>4</td>
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</table>
For the following questions, you can assume that my home directory is the jfiore directory.

1. Unix shell stuff.

(a) (1 point) If I’m in my home directory i.e., /home/jfiore, what’s the single command that I can type in order to remove the assignment 2 files directory?

(b) (1 point) If I’m in my home directory, what’s the one command that I can type in order to create a files directory within the assignment 1 directory?

(c) (1 point) What can we type to see the file stuff.txt in hexadecimal along with an ASCII interpretation?

(d) (1 point) When I compile a file that contains some C functions but with no main( ), we compile it with the -c switch. Why? What specifically does the -c switch do?

(e) (1 point) If I’m in my home directory, what’s the one command that I can type to move prog.c to the files directory inside assignment 2?

(f) (1 point) If I run the command gcc -E prog.c to run the preprocessor only on prog.c, what does the resulting file contain (i.e., how is it different from prog.c)?

(g) (1 point) If I’m in my home directory, what can I type to get a long directory listing (names, permissions, owner, length, etc) of the contents of the directory?

(h) (1 point) What’s the command that allows me to see what’s in prog.c one page at a time?
2. Some conversions.

(a) 112 gbits = ? kbits

(b) 2 minutes = ? nanoseconds

(c) 144 bits = ? mbytes

(d) 32 kbytes = ? bits

(e) 72 mbytes = ? tbits

Convert each of the following from base 10 to base 2 and base 16

3. 110

4. 246

5. Using the approximation trick that we talked about in class, about how much are each of the following?

(a) \(2^{41}\)

(b) \(2^{26}\)

(c) \(2^{33}\)

6. What is \(1110011_2 + 1101110_2\) in base 2?

\[
\begin{array}{cccccccc}
1 & 1 & 1 & 1 & 0 & 0 & 1 & 2 \\
+ & 1 & 1 & 0 & 1 & 1 & 1 & 0_2 \\
\end{array}
\]

points: ________

out of a possible 10

2 of 11 exam continues...
(2 points) 7. What is A53695\textsubscript{16}+CFB98\textsubscript{16} in base 16?

\[
\begin{array}{cccccc}
\text{A} & 5 & 3 & 6 & 9 & 5_{16} \\
\text{+} & C & F & B & 9 & 8_{16} \\
\hline
\end{array}
\]

(1 point) 8. In hex, what is the smallest integer that can be represented by a 32-bit two’s complement int?

8. ______________

(1 point) 9. In hex, what is the largest integer that can be represented by a 32-bit two’s complement int?

9. ______________

(1 point) 10. In hex, what is the largest integer that can be represented by a 32-bit unsigned int?

10. ______________

(1 point) 11. In hex, what is \(-1\) as a 32-bit two’s complement int?

11. ______________

(2 points) 12. What is printed by the following?

```c
char x = 80, y=60;
char signed_sum;
unsigned char unsigned_sum;

signed_sum = x+y;
unsigned_sum = x+y;

printf("%d\n", signed_sum);
printf("%u\n", unsigned_sum); /* recall that %u means to print as unsigned */
```

13. **Some bit operations.** If we have char \(i = 0x53, j = 0xF9;\), what is the result of the following operations? Your answer must be in the form of exactly two hex digits\(^1\).

(1 point) (a) \(i \mid j\)

(a) ______________

(1 point) (b) \(i \& 0xFF\)

(b) ______________

\(^1\)Ignore the possibility of promotion to 32-bit ints. Behave as though we're living in the land of 8-bit arithmetic.
(1 point) (c) \(^\sim i\)

(c) ____________

(1 point) (d) \(i^j\)

(d) ____________

(1 point) (e) \(! (i \& 0)\)

(e) ____________

(1 point) (f) \(i >>> 2\)

(f) ____________

(1 point) (g) \(i \&\& 0xFF\)

(g) ____________

(6 points) 14. For this question, we’re doing 4-bit two’s complement representation of integers. Fill in the empty boxes in the following table. Addition and subtraction should be performed based on the rules for 4-bit, two’s complement arithmetic. Recall that in your book’s notation, TMin is defined to be the smallest negative two’s complement number that we can represent, and TMax is the largest positive one.
15. fun with floats

(a) How would we represent the number 199.5625\textsubscript{10} in fixed-point binary?

(b) Normalize your answer from part (a).

(c) How would 199.5625\textsubscript{10} be stored in a C 32-bit float variable? (Remember that for 32-bit floats, the bias value is 127.)

16. If I have the following:
int main(void)
{
    int a=10;
    int b=20;

    int *p=&a;
    int *q=p;

    p++;
    (*q)++; 

    and memory is laid out like this:

    | 1000 |
    |      |
    |      |
    |      |
    | 1004 |
    |      |
    |      |
    |      |
    | 1008 |
    |      |
    |      |
    |      |
    | 1012 |

    what do you see if you print:

    (1 point) (a) a

    (1 point) (b) &a

    (1 point) (c) b

    (1 point) (d) &b

    (1 point) (e) p

    (1 point) (f) *p

    (1 point) (g) &p

    points: __________
out of a possible 1

17. Use the following code to answer the questions.

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

typedef struct {
    int x;
    int *p;
    int A[4];
} junk;

void func(junk);

int main(void)
{
    int i=171;
    junk j;
    j.x=1;
    j.p=&i;
    *(j.p)=2;
    j.A[0]=3;
}
```

points: __________
out of a possible 1
void func(junk j)
{
    j.A[0]=3333;
    *(j.p)=37;
    j.x=1111;
}

(a) How many bytes are passed to the function func( )?

(2 points) (a) __________

(b) j.x

(2 points) (b) __________

(c) *(j.p)

(2 points) (c) __________

(d) j.A[0]

(2 points) (d) __________
18. Write a function which is passed an int A[ ] and its length. The function reverses the order of A[ ]. Do not use the [ ] operator.

19. Write a function is_non_neg( ), which takes as an argument an int x. The function returns 1 if x >= 0, or 0 if x < 0. Do not use the < or > operators. You cannot assume that ints are 4-byte values.
20. big-endian/little-endian

(5 points)  (a) Write a function called `is_big_endian()` which returns 1 if the machine running the function is big endian or 0 otherwise.

(1 point)  (b) If we’re on a 32-bit little-endian machine and `int x` has the value 0x01234567, and `x` is stored starting at address 1000, what is the value of the byte stored at address 1002?

21. (8 points) Write a function `findstr()` which takes two arguments: a string n (think n for needle) and a string h (think h for haystack). The function returns the index of the first occurrence of n in h or -1 if n is not found. Do not use any function in `string.h`.

points: _______  9 of 11  exam continues...
(7 points) 22. Write a program which reads text from STDIN until EOF is entered. The program writes out all of the letters entered but with all of the consonants removed. Before quitting, the program prints the number of letters read and the number removed.