CIS 2107
Computer Systems and Low-Level Programming
Fall 2009
Midterm

October 22, 2009

Name: ________________________________

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**Instructions**
The exam is closed book, closed notes. You may *not* use a calculator, cell phone, etc.
For the following questions, you can assume that my home directory is the `jfiore` directory.

1. Unix shell stuff.

   (1 point) (a) If I’m in my home directory, what’s the command to compile `prog.c` into the executable called `prog`?

   (1 point) (b) What’s the command to run the program `prog` taking its input from `stuff.txt` and writing its output to `out.txt`?

   (1 point) (c) If I’m in any directory, what’s the command to change to my home directory?

   (1 point) (d) What’s the PATH variable?

   (1 point) (e) If I’m in the 2107 directory, what’s the one command that I’d type in order to see the file `stuff.txt` one page at a time?

(2 points) 2. What does it mean when we write that a variable declared outside a function is `static`?

(1 point) 3. (a) 48 gbytes = ? tbits

   (1 point) (b) 32 kbytes = ? bytes

   (1 point) (c) 96 mbytes = ? kbits

   (1 point) (d) 32 tbytes = ? kbytes

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

1 of 10 exam continues...
4. (a) $237_{10}$

(b) $161_{10}$

(c) $111_{10}$

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

(a) $2^{19}$

(b) $2^{23}$

(c) $2^{42}$

points: __________ 2 of 10 exam continues...
6. What is $11100101_2 + 10101_2$ in base 2?

7. What is $64A9_{16} + BDF_{16}$ in base 16?

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

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

10. In hex, what is $-1$ as a 32-bit two’s complement int?

11. What is printed by the following?

```c
char x=64;
x*=2;
printf("x=%d\n", x);
```

points: ______ out of a possible 3 3 of 10 exam continues...
12. **Some bit operations.** If we have \texttt{char i = 0x9C, j = 0xA3;} what is the result of the following operations? Your answer must be in the form of exactly two hex digits\(^1\).

(1 point) (a) \(^\sim\) i

(a) 

(1 point) (b) \(!\)i

(b) 

(1 point) (c) \(!!\)i

(c) 

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

(d) 

(1 point) (e) i\(^\wedge\)j\(^\wedge\)j

(e) 

(1 point) (f) i||j

(f) 

(1 point) (g) i<<2

(g) 

\(^1\)Yes. In real life, some operations could involve promoting the operands to 32-bit ints. Ignore that for now. Just pretend that we're living in the land of 8-bit arithmetic.
(1 point) (h) ijj

(h) ___________

13. **Two’s complement**. The function `TC8()` takes an 8-bit signed int and returns its two’s complement. What would be the value returned by applying `TC8()` to the following? Your answer should be in the form of two hex digits.

(2 points) (a) 0x61

(a) ___________

(2 points) (b) 0xA0

(b) ___________

14. If I have the following:

```c
int main(void)
{
    int a=10, b=20;
    int *p=&a;
    int *q=p;

    ...
}
```

and memory is laid out like this:

```
<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>1000</td>
</tr>
<tr>
<td>b</td>
<td>1004</td>
</tr>
<tr>
<td>p</td>
<td>1008</td>
</tr>
<tr>
<td>q</td>
<td>1012</td>
</tr>
</tbody>
</table>
```

what do you see if you print:

(1 point) (a) a

(a) ___________

(1 point) (b) &a

(b) ___________

(1 point) (c) b

(c) ___________

(1 point) (d) &b

(d) ___________

points: _______ 5 of 10 question 14 continues...
15. What is the value of each of the following after `func()` is called?

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

typedef struct {
  int A[3];
  int x;
  int *p;
} Stuff;

void func(int A[], int x, Stuff s);

int main(void)
{
  Stuff s;
  int x=10;
  s.p=(int*)malloc(sizeof(int));
  s.A[0]=50;
  *(s.p)=60;
  s.x=70;

  func(A, x, s);
  return 0;
}

void func(int A[], int x, Stuff s)
{
  x=111;
  A[0]=222;
  *(s.p)=666;
  s.A[0]=555;
  s.x=777;
}
```

(a) `x`?  
(b) `A[0]`?  
(c) `s.A[0]`?  
(d) `s.x`?

```
(a) __________
(b) __________
(c) __________
(d) __________
```

points: _______ 6 of 10 question 15 continues...
16. Fill in the following code:

```c
#define NROWS 5
#define NCOLS 10

int *A;
int j;
int *p;

/* allocate storage for a NROWSxNCOLS array of int and let A point to it */
```

```c
/* set all items in A to 0. Do not allocate any new storage */
```

17. Write a function which is passed an array of int and its length. The function returns the sum of the array items which are divisible by two.
18. Write a function (you may write additional helper functions if it simplifies things) which is passed a string `s`. The function removes all of the vowels in `s`. You may use functions in `ctype.h`, but not in `string.h`.

19. Integer representation.

(a) Write the function `void printInt(int x)` which prints to the screen each of the bytes of `x` in hex one byte per line. (Reminder: the `printf` format flag to print an int in hex is `%x`.)

(b) If an int 0x01234567 is passed to your function, and we’re running on a little-endian machine, what exactly would be printed to the screen? (If you didn’t do part a, you can still get full credit for this part.)
20. Write a function which is passed a string $s$, and returns a string which is an acronym of $s$. For example, if $s$ is “United Parcel Service”, the function returns a pointer to the string “UPS”. If $s$ is “American Airlines”, the function returns “AA”.

(7 points)
(extra space)