CS 271 NETWORKS & SYSTEMS SPRING 2024 MIDTERM I (SYSTEMS)
Instructor Calvin Deutschbein

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This exam will be timed for 60 minutes, with a no-excuse 30 minute extension.

It will be scored out of 200 Points.

It will make up 20% of Final Grade.

SECTION I: C LANGUAGE **60 Points**

Part 1: Multiple Choice: *4 Questions @ 5 Points each =* *20 Points*

What is the maximum value of x?

```
char x ;
```

A. 127
B. 128
C. 255
D. 256

What is the maximum value of x?

```
utint32_t x ;
```

A. 0x01000000
B. 0x011111111
C. 0x10000000
D. 0x111111111

How many times larger is y than x?

```
char x ; int16_t y ;
```

A. 2^0x - 2^4x
B. 2^4x - 2^8x
C. 2^8x - 2^16x
D. Greater than 2^16x

How many times larger is y's largest value than x's?

```
char x ; int16_t y ;
```

A. 2^0x - 2^4x
B. 2^4x - 2^8x
C. 2^8x - 2^16x
D. Greater than 2^16x

Part 2: Short Response: 4 Questions @ 10 Points each = 40 Points

Describe some of the functionalities and uses of libraries, such as stdlib.h or string.h.

Describe in your own words the usefulness and downsides of pointers.

What is printed by this program and why?

```
int inc(int *x) {*x += 1;}

int main()
{
      int x = 0, i = 10;
      while(i--) {inc(&x);}
      printf("%d\n", x);
}
```

What is printed by this program and why?

```
int inc(int x) {x += 1;}

int main()
{
      int x = 0, i = 10;
      while(i--) {inc(x);}
      printf("%d\n", x);
}
```

SECTION II: SYSTEMS **90 Points**

Part 3: Multiple Choice: *4 Questions @ 5 Points each =* *20 Points*

Which of the following commands compiles a C program into an executable?

A. ./prog.c
B. prog.c
C. cat prog.c
D. gcc prog.c

Which of the following commands shows the contents of a C file?

A. ./prog.c
B. prog.c
C. cat prog.c
D. gcc prog.c

Which of the following best describes `NULL`?

A. The integer value zero
B. A point value that has not been initialized
C. The “null terminator” in a null terminated string
D. The exit status of a program when main does not return 0

Which of the following best describes a gcc warning?

A. Code is compiled but the resulting program may be inefficient or leak memory.
B. Code is compiled but the program will have undefined behavior.
C. Code is not compiled and no program is generated.
D. Code is not compiled and the output program cannot be run.

Part 4: Debugging: *30 Points*

The function print_name may cause errors. Describe what, if any, and how to fix them.

```
struct name_struct
{
    char *fname;
    char *lname;
};
typedef struct name_struct *name;

// print first name and last name of n
void print_name(name n)
{
    printf("%s %s", n.fname, n.lname);
}
```

Part 5: Writing C *40 Points*

Write a C function that accepts as input two integers x and n and returns as output some integer that represents the x raised to the power of n. You should not use any library functions (such as pow) from math.h or any other libraries. It is declared as follows:

```
uint64_t exp(uint64_t x, uint64_t n);
```

You are encouraged, but not required, to use exponentiation by squaring:

$$x^n = \begin{cases} x\left(x^2\right)^{\frac{n-1}{2}}, & \text{if } n \text{ is odd} \\ \left(x^2\right)^{\frac{n}{2}}, & \text{if } n \text{ is even.} \end{cases}$$

The fastest student solution over random inputs will be awarded 40 points of extra credit.

SECTION III: MEMORY MANAGEMENT **50 Points**

Part 6: System Engineering *50 Points*

Provide your own implementation of the string.h function “strdup” using only functions in baseline C and in stdlib.h (which includes malloc). It is declared as follows:

```
char *strdup(char *s) ;
```

The entry “man strdup” reads as follows:

The **strdup**() function returns a pointer to a new string which is a duplicate of the string *s*. Memory for the new string is obtained with malloc, and can be freed with free.