Please read the instructions and questions carefully. You will be graded for clarity and correctness. You have 120 minutes to complete this exam, so focus on those questions whose subject matter you know well. This is a closed note and book exam. Write legibly and check your answers before handing it in.

Short Answer – some will be one or two words – no more than 1 sentence. (40/100 points)

1. (5pts) An interface that obscures details of an implementation to simplify its use is called an:

2. (5pts) What command do you use to list the processes running in UNIX?

3. (5pts) What function do you use to set every byte of a region of memory to the same value?

4. (5pts) What is the type and meaning of the value returned by sscanf()?

5. (5pts) In a single function call, how would you convert the variable “long x” to network byte order?

6. (5pts) What does it mean for I/O to be non-blocking?

7. (5pts) What command and parameters would be used to send a SIGHUP to all processes named httpd?
8. (5pts) What is the purpose of the \texttt{wait()} function?

\textbf{Long Answer - no more than 4 sentences (20/100 points)}

9. (10pts) What is the purpose of the n-variants of the C string functions?

10. (10pts) Explain what a stack frame is, where it is, and what goes in it.
Programming/Word Problems - take your time and answer clearly and completely. (40/100 points)

void func(void) {
    void *ptr;
    char *a;
    uint32_t *b;
    uint16_t *c;
    uint64_t *d;

    ptr = malloc(100);
    a = (char *)ptr; a++;
    b = (uint32_t *)a; b += 4;
    c = (uint16_t *)b; ++c;
    d = (uint64_t *)c; d -= (2<<2);

    printf( "a = %d\n", (int)((char *)a-(char *)ptr) );
    printf( "b = %d\n", (int)((char *)b-(char *)ptr) );
    printf( "c = %d\n", (int)((char *)c-(char *)ptr) );
    printf( "d = %d\n", (int)((char *)d-(char *)ptr) );
}

11. (10pts) Consider the function `func()` above. What is the output when this function is run? (Show your work)

    a = ____________________
    b = ____________________
    c = ____________________
    d = ____________________
12. (10pts) Compute the value of each of the following C expressions. All values are 8-bit unsigned integers. (Show your work). [2pts each]

(a) 0xff & 0x12 =

(b) 0xff | 0x22 =

(c) 0xff >> 0x6 =

(d) 0xff ^ 0x43 =

(e) ~0x29 =
13. (10pts) You are to write code for the client side of a network connection, one step at a time. To do
this, create statements that complete the following tasks (don’t worry about checking errors for the
purposes of answering this question). You are given the following variables to work with.

- `int sock;`
- `struct sockaddr_in caddr;`
- `char send_buffer[] = {0xa, 0xb, 0xc, 0xd, 0xe, 0xf};`

(a) Initialize the `caddr` address structure for the IP address “192.168.11.12” and port 1234, using
an appropriate function call to parse the IP address. [2pts]

(b) Create a TCP socket. [2pts]

(c) Connect to the server. [2pts]

(d) Send the buffer `send_buffer` to the server. [2pts]

(e) Close the connection. [2pts]
14. (10pts) Suppose you are creating a Makefile for the program exam. You are given the following facts about exam:

- exam is built from a.o, b.o, and links with libpsu.a
- a.c includes b.h
- b.c includes b.h
- b.h includes c.h

(a) Write a declaration to turn on all warnings for the compiler. [2pts]

(b) Write a production rule to compile a.o. [2pts]

(c) Write a production rule to compile b.o. [2pts]

(d) Write a production to create exam (assuming the previous productions are used). [4pts]