1.  Short answer questions:

(a) Compare the typical contents of a module's header file to the contents of a module's implementation file. Which of these files defines the interface between a module and a program? (50 words or less)

(b) What is a pointer and how is it related to an array? (25 words or less)

(c) What is a string? (25 words or less)

2.What does the following program print?

```c
#include <stdio.h>

int main()
{
   char s[] = "Hsjodi", *p;

   for (p = s + 5; p >= s; p--)
      --*p;
   puts(s);
   return 0;
}
```

3.(a) Describe the behaviour of the following program:

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

#define FOREVER         1
#define STOP        17

void f();

int main(){
  while (FOREVER)
    f();
  return 0;
}

void f(){
  static int cnt = 0;
  printf("cnt = %d\n", ++cnt);
  if (cnt == STOP)
    exit(0);
}
```

(b) How does static modify the scope and lifetime of cnt in function f?

4. Explain how the static keyword modifies the storage class and linkage of the variables i and j in the following program fragment:

```
#include <stdio.h>

static int i;

void foo(int i)
{
   static int j;

   printf("%d\n", i + j++);
}
```

5. Write a function that orders the stored values of three characters. Suppose, for example, that c1, c2, and c3 are character variables having the values 'C', 'B', and 'D', respectively. Then the function call order_chars(&c1, &c2, &c3) should cause the stored values of c1, c2, and c3 to be 'B', 'C', and 'D', respectively.

6. (a) Write a complete C program called `reverse.c` that echoes its command-line arguments in reverse order. Running the program by typing

```
reverse void and null
```

should produce the following output:

```
null and void
```

(b) Write a one-line UNIX command to:

- compile the program in (a) and produce an executable file called `reverse`

- run `reverse` with arguments `holidays the for home` and send the output to a file called `greeting`

- run `reverse` with arguments `holidays the for home` and send the output to the `lpr` command (which prints the contents of its input)

7.(a) Consider the following series of Linux commands:

```
$ cat test
This file has
two lines
$ wc -w test
  5 test
$ mkdir tempdir
$ mv test tempdir
$ ls tempdir | wc -w
```

What is the output of the last command?

8. The following function is supposed to return TRUE if any element of the array a has the value 0 and FALSE if all elements are nonzero. Sadly, it contains an error. Find the error and show how to fix it:

```
#define TRUE 1
#define FALSE 0

typedef int Bool;

Bool has_zero(int a[], int n)
{
  int i;

  for(i = 0; i < n; i++)
    if(a[i] == 0)
      return TRUE;
    else
      return FALSE;
}
```

9. Consider the following program:

```c
#include <stdio.h>

    float avg(float, float);

    int main(){
      int x, y;

      printf("Enter two numbers: ");
      if(scanf("%d %d", &x, &y) != 2){
        printf("Error reading input!\n");
        return 1;
      }
      printf("The average of %d and %d
is: %f\n", x, y, avg(x,y));
      return 0;
    }

    float avg(float i, float j)
    {
      return (i + j)/2;
    }
```

What output is produced if the input is the two
integers 3 and 4? What would happen if the
function declaration (second line: float avg(float,
float);) was removed?

10. Which one of the following file types never need to be placed under source control, and why?

(a) C source code

(b) Object file produced by a compiler

(c) C header file

(d) Executable file produced by a compiler

(e) Text file containing documentation for a program

11. Suppose a program consists of three source files, `main.c`, `llist.c`, `btree.c`, and header files `llist.h` and `btree.h`. `llist.c` and `btree.c` are linked list and binary tree modules, respectively, which are both called by `main.c`.

(a) Which header files should be included in each of `main.c`, `llist.c`, `btree.c`? Explain why in each case.

(b) Write a UNIX makefile for this program, assuming that the executable file is called `demo`.

12. Let f be the following function:

```
int f(char *s, char *t){
    for (; *s == *t; s++, t++)
        if (*s == '\0')
            return 0;
    return *s - *t;
}
```

(a) What is the value of f("apples", "oranges")?

(b) What is the value of f("hello", "hello")?

(c) In general, what value does f return when passed two strings s and t?

13. Consider the following structure data type for a node in a linked list:

```
typedef struct node{
   int value;
   struct node *next;
} nodeT;
```

(a)Fix the two errors in the following function, which inserts a node at the front of a linked list:

```
nodeT *insertFront(nodeT *list, int d)
{
  nodeT *aux;

  aux->value = d;
  aux->next = list;
  return;
}
```

(b) Implement the following function that counts the nodes in a linked list:

```
unsigned int count_list(nodeT *list);
```