Introduction to Computers and Programming

Fall 2017

Midterm Writing Exam

1. Which of the following are keywords in C? 4 points

   (a) `for`
   (b) `if`
   (c) `main`
   (d) `printf`
   (e) `while`

2. Suppose that we call `scanf` as follows: 4 points

   ```
   scanf("%d%f%d", &i, &x, &j);
   ```

   If the user enters: `10.3 5 6`

   what will be the values of `i`, `x`, and `j` after the call? (Assume that `i` and `j` are `int` variables and `x` is a `float` variable.)

   The values of i, x, and j will be 10, .3, and 5, respectively.

3. Show the output produced by each of the following program fragments. Assume that `i`, `j`, and `k` are `int` variables. 6 points

   ```
   (a) i = 1;
       printf("%d ", i++ - 1);
       printf("%d", i);
   (b) i = 10; j = 5;
       printf("%d ", i++ - ++j);
       printf("%d %d", i, j);
   (c) i = 7; j = 8;
       printf("%d ", i++ - --j};
       printf("%d %d", i, j);
   (d) i = 3; j = 4; k = 5;
       printf("%d", i++ - j++ + --k);
       printf("%d %d %d", i, j, k);
   ```

   (a) 0 2
   (b) 4 11 6
   (c) 0 8 7
   (d) 3 4 5 4

4. Supply parentheses to show how a C compiler would interpret each of the following expressions. 6 points

(a) `a * b - c * d + e`
(b) `a / b % c / d`
(c) `- a - b + c - + d`
(d) `a * - b / c - d`

(a) ((a * b) - (c * d)) + e
(b) ((a / b) % c) / d
(c) (((-a) - b) + c) - (+d)
(d) ((a * (-b)) / c) - d

5. Give the values of `i` and `j` after each of the following expression statements has been executed. (Assume that `i` has the value 1 initially and `j` has the value 2.) 6 points

(a) `i += j;`
(b) `i--;`
(c) `i * j / i;`
(d) `i % ++j;`

(a) The value of i will be 3; the value of j will be 2.
(b) The value of i will be 0; the value of j will be 2.
(c) The value of i will be 1; the value of j will be 2.
(d) The value of i will be 1; the value of j will be 3.

6. The following program fragments illustrate the short-circuit behavior of logical expressions. Show the output produced by each, assuming that `i`, `j`, and `k` are `int` variables. 6 points

```
(a) i = 3; j = 4; k = 5;
    printf("%d ", i < j || ++j < k);
    printf("%d %d %d", i, j, k);
(b) i = 7 ; j = 8; k = 9;
    printf("%d ", i - 7 && j++ < k);
    printf("%d %d %d", i, j, k);
(c) i = 7; j = 8; k = 9;
    printf("%d ", (i = j) || (j = k));
    printf("%d %d %d", i, j, k);
(d) i = 1; j = 1; k = 1;
    printf("%d ", ++i || ++j && ++k);
    printf("%d %d %d", i, j, k);
```

(a) 1 3 4 5
(b) 0 7 8 9
(c) 1 8 8 9
(d) 1 2 1 1

7. Is the following `if` statement legal? 4 points

```
if(n >= 1 <= 10)
    printf ("n is between 1 and 10\n") ;
```

If so, what does it do when `n` is equal to 0?

Yes, the statement is legal. The condition being tested is equivalent to (n >= 1) <= 10. When the condition is evaluated, the value of n >= 1 is 0 or 1. Either value is less than 10, so printf is called and the message "n is between 1 and 10" is printed, regardless of the value of n.

8. What output does the following program fragment produce? 4 points

```
i = 9384;
do {
   printf("%d ", i);
   i / = 10;
} while (i > 0);
```

9384 938 93 9

9. What output does the following `for` statement produce? 4 points

```
for (i = 10; i >= 1; i /= 2)
    printf("%d ", i++);
```

10 5 3 2 1 1 1 ... (the sequence of 1's repeats forever)

10. What output does the following program fragment produce? 4 points

```
int i, sum = 0;
for (i = 0; i < 10; i++) {
   if (i % 2)
      continue;
   sum += i;
}
printf ("%d\n", sum);
```

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11. Assume that a program contains the following declarations: 6 points

```
char c = '\1';
short s = 2;
int i= -3;
long m = 5;
float f = 6.5f;
double d = 7.5;
```

Give the value and the type of each expression listed below.

(a) `c * i` (c) `f / c` (e) `f - d`
(b) `s + m` (d) `d / s` (f) `(int) f`

(a) -3, int
(b) 7, long
(c) 6.5, float

(d) 3.75, double
(e) -1.0, double
(f) 6, int

12. Suppose that the function `f` has the following definition: 4 points

```
int f(int a, int b) { ... }
```

Which of the following statements are legal? (Assume that `i` has type `int` and `x` has type `double`.)

(a) `i = f(83, 12);`
(b) `x = f(83, 12);`
(c) `i = f(3.15, 9.28);`
(d) `x = f(3.15, 9.28);`
(e) `f(83, 12);`

All statements are legal; statement (e) discards the value returned by the function.

13. What will be the output of the following program? 4 points

```
#include <stdio.h>
void swap(int a, int b);
int main(void) {
   int i = 1, j = 2;
   swap(i, j);
   printf("i = %d, j = %d\n", i, j);
   return 0;
}
void swap(int a, int b) {
   int temp = a;
   a = b;
   b = temp;
}
```

i = 1, j = 2. (The arguments to swap are passed by value, so even though the values of a and b are swapped, the values of i and j are not.)

14. 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: 4 points

```
bool has_zero(int a[], int n) {
   int i;
   for(i = 0; i < n; i++)
      if(a[i] ==0)
         return true;
      else
         return false;
}
```

The function will execute a return statement after looking at the first element of the array. If a[0] is 0 then true is returned, otherwise false is returned. Here's the corrected version:

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

  for (i = 0; i < n; i++)
    if (a[i] == 0)
      return true;

  return false;
}
```

15. The following program outline shows only function definitions and variable declarations.

    6 points

```
int b, c;
void f(void) {
   int b, d;
}
void g(int a) {
   int c;
   {
      int a, d;
   }
}
int main (void) {
   int c, d;
}
```

For each of the following scopes, list all variable and parameter names visible in that scope. If there's more than one variable or parameter with the same name, indicate which one is visible.

(a) The f function
(b) The g function
(c) The block in which a and d are declared
(d) The main function

(a) b, c, and d are visible. Local b hides external b.
(b) a, b, and c are visible. Local c hides external c.
(c) a, b, c, and d are visible. Block a hides parameter a.
(d) b, c, and d are visible. Local c hides external c.

16. If i is a variable and p points to i, which of the following expressions are aliases for i?

    4 points

(a) `*p`
(b) `&p`
(c) `*&p`
(d) `&*p`
(e) `*i`
(f) `&i`
(g) `*&i`
(h) `&*i`

(a) and (g) are aliases. (*Note:* (h) is not an alias because it is illegal to apply the indirection operator to a non-pointer.)

17. The following function supposedly computes the sum and average of the numbers in the array `a`, which has length `n`. `avg` and `sum` point to variables that the function should modify. Unfortunately, the function contains several errors; find and correct them. 4 points

```
void avg_sum(double a[], int n, double *avg, double *sum) {
    int i;
    sum = 0.0;
    for(i = 0; i < n; i++)
        sum += a[i];
        avg = sum / n;
}
```

Several * operators are missing from the body of the function. Here is the corrected version:

```
void avg_sum(double a[], int n, double *avg, double *sum)
{
  int i;

  *sum = 0.0;
  for (i = 0; i < n; i++)
    *sum += a[i];
  *avg = *sum / n;
}
```

18. Suppose that the following declarations are in effect: 6 points

```
int a[] = {5, 15, 34, 54, 14, 2, 52, 72};
int *p = &a[1], *q = &a[5];
```

(a) What is the value of `*(p+3)`?
(b) What is the value of `*(q-3)`?
(c) What is the value of `q - p`?
(d) Is the condition `p < q` true or false?
(e) Is the condition `*p < *q` true or false?

(a) 14
(b) 34
(c) 4
(d) true
(e) false

19. What will be the contents of the `a` array after the following statements are executed? 4 points

```
#define N 10
int a[N] = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10};
int *p = &a[0], *q = &a[N-1], temp;
while (p < q) {
      temp = *p;
      *p++ = *q;
      *q-- = temp;
}
```

The loop reverses the contents of a. After the statement is executed, a will contain the following data: 10, 9, 8, 7, 6, 5, 4, 3, 2, 1.

20. Suppose that a is a one-dimensional array and p is a pointer variable. Assuming that the assignment p = a has just been performed, which of the following expressions are illegal because of mismatched types? Of the remaining expressions, which are true (have a nonzero value)? 4 points

```
(a) p == a[0]
(b) p == &a[0]
(c) *p == a[0]
(d) p[0] == a[0]
```

(a) Illegal
(b) Legal, true
(c) Legal, true
(d) Legal, true

21. Suppose that we call scanf as follows:

`scanf("%d%s%d", &i, s, &j);` 4 points

If the user enters `12abc34 56def78`, what will be the values of i, s, and j after the call? (Assume that i and j are int variables and s is an array of characters.)

i = 12, j = 56, s = "abc34"

22. Suppose that str is an array of characters. Which one of the following statements is not equivalent to the other three? 4 points

(a) `*str = 0;`
(b) `str[0] = '\0';`
(c) `strcpy(str, "");`
(d) `strcat(str, "");`

(d) is not equivalent to the others. (a), (b), and (c) make str empty; (d) concatenates an empty string to the end of str.

23. What will be the value of the string s1 after the following statements have been executed? 4 points

```
strcpy(s1, "computer");
strcpy(s2, "science");
if(strcmp(s1, s2) < 0)
```

```
        strcat(s1, s2);
    else
        strcat(s2, s1);
    s1[strlen(s1)-6] = '\0';

    "computers"
```

24. What does the following program print? 4 points

```
#include <stdio.h>
int main (void) {
    char s[] = "Hsjodi", *p;
    for(p = s; *p; p++)
        --*p;
    puts(s);
    return 0;
}
```

The program prints "Grinch", followed by a new-line. The loop replaces each character of s with its alphabetic predecessor.

25. Translate the following program into a single `for` statement. 4 points

```
int i = 1;
while (i <= 128) {
    printf("%d ", i);
    i *= 2;
}
```

```
for (i = 1; i <= 128; i *= 2)
 printf("%d ", i);
```