University of Maryland
College Park

Department of Electrical and Computer Engineering

Final Examination

ENEE 114
Programming Concepts for Engineering

Thursday, May 13, 2004
8:00 am – 10:00 am

2. It is your responsibility to write legibly. Unclear answer will be marked as wrong.
3. It is crucial to show all your work on the provided paper. Partial credits may be granted based on your work if it is not fully correct.
4. Manage your time, as the problems are not sorted by their difficulties.

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1. (10 points, 1 point each, no partial credit) **Operators.**

Give the values of the following expressions. Write your answer on the provided area. If you believe any expression has syntax errors, write “error”.

Note: The expressions are independent.

```
int x = 16, y = 2, z = 5;
float a = 4.2, b = 8.0, c = 0.25;
```

1) \( x + y \ast z \)

answer: __________

2) \( x \% z + y \)

answer: __________

3) \( y++ - z \)

answer: __________

4) \( (\text{float}) z/y \)

answer: __________

5) \( (a < b) \ ? x + y - z : x - y + z \)

answer: __________

6) \( y == b*c \)

answer: __________

7) \( ! z > x \)

answer: __________

8) \( (a <= b) && (b < z) || (x > y) \)

answer: __________

9) \( z = y - 2 \)

answer: __________

10) \( (x/y) && (y-z) \)

answer: __________

2. (20 points, 2 points each) Answer the following questions.

1) What is the number of comparisons for problem 8) in the above question?
   Answer: __________
   What if we change the expression to \( (x > y) || (a <= b) && (b < z) \)?
   Answer: __________

2) What are the data types of the following variables?

   ```
   #define PI 3.1416
   #define POINTER int *
   typedef int COLOR;
   int main(void)
   {
     COLOR a[7];
     POINTER b, c;
     ...
   }
   ```

   Answer:

   PI: __________
a: __________
b: __________
c: __________

3) What is the statement to print out the integer \( x \) (\( 0 <= x <= 999999999 \)) as a 9-digit student ID on a field with width of 12 characters? You should put 0’s in front if \( x \) has less than 9 digits. For example, 000123456 for \( x = 123456 \).

   Answer: ____________________________

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4) What is the output of the following code segment?

```c
char dollar[] = "$$\$";
for (i=0; i<3; i++)
    printf("%*.*s\n", 3+i, 3, dollar);
```

Output:
```
   $   $   $
   $   $   $
   $   $   $
```

5) What is the prototype for a function that takes two integers as input, swaps their values, and returns the smaller number of the two? (Note: just give the one-line function prototype, you do not need to implement the function.).

Answer: `int smaller(int a, int b)`

6) The following function prototype displays strings s1 and s2 alternatively. For example, if s1 = “ABC”, s2 =”123”, it displays “A1B2C3”.

```c
void display (const char *s1, const char *s2);
```

What is the statement to call this function to display “AaBbCc”, given the following string declaration?
```
char a[] = "abc";
char *p = "ABC";
```

Answer: `display(p, a);`

7) What is the output of the following code segment?

```c
void increase(int x)
{ static int i = 0;
    x = i +x;
    i++;
    printf("x=%d, i=%d\n", x, i);
}

int main(void)
{ int i = 0;
    for (; i < 4; ++i)
        increase (i);
    return 0;
}
```

Output:
```
x=5, i=1
x=6, i=2
x=7, i=3
x=8, i=4
x=9, i=5
x=10, i=6
x=11, i=7
x=12, i=8
```
8) Implement the following recursive function that computes (and returns) the value of $n! = 1 \times 2 \times 3 \times \ldots \times (n-1) \times n$ for a given integer $n > 0$.

```c
int fact (int n);
```

9) For the following structure `Card` defined on the right, what is the (one-line) statement that dynamically allocates memory space for five cards? Use variable `hand` as the pointer that points to these five cards.

```c
struct Card {
    int rank;
    char suit;
};
```

Answer: _____________________________________________________

10) In GLUE UNIX system, what is the command to compile program `final.c` and produce an executable with name `final.o`?

Answer: _____________________________________________________

3. (15 points) **Loops and arrays.**

   1) Define a 2-dimensional integer array of 4 by 5 that stores values 1, 2, ..., 20 in whichever order you like. Define another array of the same size and copy the first array to the second one by `for` loop(s).
2) Give the exact output of the following program. Write your answer on the provided area, with one letter (including space and punctuations) per space.

```c
#include <stdio.h>
int main(void)
{
    int i=0, done=0, temp;
    int a[] = {5, 3, 8, 2, 7};
    while (!done)
    {
        printf("Start:\n");
        done = 1;
        for (i = 0; i < sizeof(a)/sizeof(a[0])-1; i++)
            if ( a[i] > a[i+1])
            {
                temp = a[i];
                a[i] = a[i+1];
                a[i+1] = temp;
                done = 0;
                printf("%d, ", a[i]);
            }
        printf("end.\n");
    }
    printf("Size_of_a=%d\n", sizeof(a)/sizeof(a[0]));
    i = 0;
    do
    {
        printf("%d, ", a[i]);
        i++;
    } while (i < sizeof(a)/sizeof(a[0]) - 1);
    return 0;
}
```

Output:

```
-- -- -- -- -- -- -- --
-- -- -- --
-- -- -- -- --
-- -- -- --
-- -- -- --
-- --
-- --
-- --
-- --
```

4. (10 points, 4 points for 1) and 6 points for 2)) **Structures.**

1) A point on the 2-dimensional plane has two co-ordinates (x,y). Define a structure named **point** that has two floating point numbers as element.
2) The distance between two points \( p_1 = (x_1,y_1) \) and \( p_2 = (x_2,y_2) \) on the plane is given by the following formula: \( \text{dist}(p_1,p_2) = \sqrt{(x_1-x_2)^2 + (y_1-y_2)^2} \)

Implement the function \textbf{dist} that takes two points as arguments and returns their distance. \textit{(hint: The square root function is included in library <math.h> with the following prototype: \textbf{float sqrt(float x);}.)}

5. (15 points) \textbf{Strings.}

1) Implement the following \textbf{reverse()} function that reverses a given string. For example, it changes string \( S = \text{“ABC123”} \) to \text{“321CBA”}. \textit{(hint: you may want to find the length of the string first.)}

\textbf{void reverse (char * S)}
2) Give the exact output of the following program. Write your answer on the provided area, with one letter (including space and punctuations) per space.

```c
#include <stdio.h>
int main(void)
{ char mySentence[] = "She_sells_sea_shells.", newSentence[40];
  char * p = mySentence, *q = newSentence;
  *q++ = '$';
  for (; *p != '0'; ++p)
    if (*p == 'e')
      *q++ = 'E';
    else
      { if (*p == '_')
         { *q++ = 'n';
           *q++ = '$';
         }
       else
         *q++ = *p;
      }
  *q = '0';
  printf("Original_Sentence:\n%s\n", p);
  printf("%s\n", &newSentence[0]);
  return 0;
}
```

Output:

```
__ __ __ __  __ __ __ __ __ __ __ __  __ __ __ __  __ __ __ __
__ __ __ __  __ __ __ __ __ __ __ __  __ __ __ __  __ __ __ __
__ __ __ __  __ __ __ __ __ __ __ __  __ __ __ __  __ __ __ __
__ __ __ __  __ __ __ __ __ __ __ __  __ __ __ __  __ __ __ __
__ __ __ __  __ __ __ __ __ __ __ __  __ __ __ __  __ __ __ __
__ __ __ __  __ __ __ __ __ __ __ __  __ __ __ __  __ __ __ __
```

6. (15 points, 4 points each for 1) and 2), 7 points for 3)) Linked list.

Given the NODE and ROOT structures defined on the right (the same as that we have defined in the lecture and in the textbook), implement the following functions.
You can assume that the linked list is non-empty and a new NODE can be created successfully.

1) `void insert_at_head(ROOT *r, DATA *d);`
   Insert a new NODE with data pointed by pointer d at head of the list.
2) `void display_list(ROOT r);`
   Traverse the list and print out the data field.
3) `void delete_node (ROOT *r, DATA d);`
   Delete the first occurrence of DATA value d from the list.

(Write your answer on the next page.)

```c
#include <stdio.h>
#include <stdlib.h>
typedef int DATA;
typedef struct node
{ void * data;
  struct node * next;
} NODE;
typedef struct
{ long num;
  NODE * head;
  NODE * tail;
} ROOT;
```
7. (15 points) **Debug.**

The following program asks the user to
1) enter 10 integers
2) sort them in the decreasing order
3) output them

However, there are some bugs in it, please fix.

Cross the statement that is incorrect that write the correct one in the box.
The line numbers are for your reference, you should not consider them as bugs.

```
(1) #include <stdio.h>
(2)
(3) void bubble_sort(int a[], int n)
(4) { int cur, next;
(5)   for (cur = 0; cur < n; cur++)
(6)     for (next = cur + 1; next <= n; next++)
(7)       if (a[cur] > a[next])
(8)         { 
(9)           a[cur] = a[next];
(10)          a[next] = a[cur];
(11)        }
(12)   }
(13)
(14) void show(int a[], int n);
(15) { int i;
(16)   for (i=0; i<n; i++)
(17)     printf("%d ", a[i]);
(18)   return 0;
(19) }
(20)
(21) int main(void)
(22) { int a[10], i;
(23)   printf("Enter 10 integers:\n");
(24)   for (i=0; i<10; i++)
(25)     scanf("%d", a[i]);
(26)   sort(a,10);
(27)   show(a[], 10);
(28)
(29)   return 0;
(30) }
```

**Correction:**

Line 1: `#include <stdio.h>`