UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING

APS105 — Computer Fundamentals
Final Examination — April, 2007

Examiner: John Carter

Duration: 2.5 h

Exam Type: A
This is a "closed book" examination; no aids are allowed.

Calculator Type: 4
No calculators are allowed.

All questions are to be answered on the examination paper. If the space provided for a question is insufficient, extra space is provided at the end of the examination. If you use this extra space, please indicate clearly which question(s) you have answered there.

The examination has 12 pages, including this one.

The marks allocated to the questions, out of a total of 135, are shown in the question headings.

You must use the C programming language to answer programming questions.

Name _____

Student Number _____ ecf login _____

MARKS

1	2	3	4	5	6	7	8	9	10	Total
/10	/20	/15	/15	/15	/15	/15	/7	/8	/15	/135

1. [10 Marks]

Circle the correct answer for each of the following statements. You will get one mark for each correct answer, you will get zero for each question left blank, and you will lose half a mark for each incorrect answer.

(a) **True or False:** The value of `(int) 1.5 * 5 % 3` is 2.

(b) **True or False:** In C, the expression `7 < n < 3` will have the value zero for any value of `n`.

(c) **True or False:** A `do` statement is always executed at least once.

(d) **True or False:** The declaration `int list[10];` automatically initializes the elements of `list` to zero.

(e) **True or False:** The *scope* of a variable is the range of values that the variable can take.

(f) **True or False:** In C, the only form of parameter passing is call by value.

(g) **True or False:** If `list` has been declared as an array, then `list+3` is a synonym for `&list[3]`.

(h) **True or False:** Recursive methods are usually more efficient than non-recursive ones.

(i) **True or False:** An ordered linked list can be searched using a binary search.

(j) **True or False:** Insertion sort is an $O(n \lg n)$ sort.

2. [20 Marks]

Each part of this question is worth two marks.

(a) Write $\sqrt{\ln(x^3)}$ as a C expression.

(b) Write a statement that will assign to the `int` variable `choice` a random value from the set $\{25, 50, 75, 100\}$.

(c) Simplify the following expression as much as possible: `!(x == 0 && !(y != 0))`

(d) How many asterisks will be printed by the following fragment?

```
for(i = 2; i > -2; i--);
  printf("***\n");
```

(e) Write 1342_5 as a base 10 numeral.

(f) Trace a binary search as it seeks the value 52 in the array called `list` shown below. To show your trace, print the value of the array element examined at each stage of the search.

index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
`list`	28	38	42	44	48	50	53	69	71	74	77	81	83	88	97

(g) Suppose that an array initially contains the values `{6,4,9,2,7}`. If the array is to be sorted into ascending order using selection sort, show the contents of the array after each of the first two passes of the sort.

(h) Suppose that an array initially contains the values `{36,45,11,13,51,54,26}`. If the array is to be sorted into ascending order using quicksort as discussed in class, show the contents of the array after the first pass of the sort.

(i) What two features are common to every recursive process?

(j) Arrange in ascending order: $O(n \lg n), O(1), O(2^n), O(n^2)$

3. [15 Marks]

Three positive integers a, b, and c with $a < b < c$ form a *Pythagorean triplet* if $a^2 + b^2 = c^2$. For example, 3, 4, and 5 form a Pythagorean triplet since $3^2+4^2 = 5^2$. Write a program that first prompts the user for a positive integer (repeatedly if necessary). Once the user has provided a positive integer, the program then finds and prints all Pythagorean triplets whose largest member is less than or equal to that integer.

4. [15 Marks]

Complete the definition of the function `nearest` so that it returns the *index* of the value in the array `list` that is nearest to the value of `item`. The value of the parameter `listLength` is the number of items in the array `list`.

For example, if `list` = {50.3,17.2,21.0,25.5} and `item` = 22.1 then the function should return 2.

```
int nearest (double list[], int listLength, double item)
```

5. [15 Marks]

Complete the definition of the function `bestRally` whose header is shown below. The parameter `price` gives a list of the daily closing prices of a stock and the parameter `listLength` gives the length of the `price` array. A *rally* for a stock is defined as a period in which the closing price of the stock either increases or stays the same. The function should return the difference in the price of the stock in the rally with the largest increase in price. If the stock price never rises, the function should return zero.

```
double bestRally (double price[], int listLength)
```

6. [15 Marks]

Complete the definition of the function `longest` so that it returns the length of the longest word in the string `s`. Assume that `s` consists only of words separated by one or more blanks with no leading or trailing blanks.

```
int longest (char *s)
```

7. [15 Marks]

Write a function that uses a variation of selection sort to find and print the five smallest values of an array in ascending order. The function should have two parameters: an `int` array called `list` and an `int` variable called `listLength`, the number of items in the list. If `listLength` is less than five, the function should print all the items in `list` in ascending order. Your function should be reasonably efficient.

8. [7 Marks]

Consider the recursive method whose definition is:

```
int f (int n)
{
  int result = 0;
  if (n != 0)
    if (n % 10 == 0)
      result = f(n/10);
    else
      result = 1 + f(n-1);
  return result;
}
```

(a) Evaluate `f(3)`.

(b) evaluate `f(203)`.

(c) State in a few words (no more than ten) what `f(n)` determines for an arbitrary value of n.

9. [8 Marks]

Write a recursive function `squareSum` that has one parameter: an `int` value n. You may assume that n is non-negative. The function should return the sum of the squares of the digits of n. For example, `squareSum(413)` should return the value 26 because $4^2 + 1^2 + 3^2 = 26$. Note that your method *must* be recursive; no credit will be given for a non-recursive solution.

10. [15 Marks]

Suppose that linked lists are maintained in the usual way seen in class with node structures defined as follows:

```
typedef struct node
{
  int info;
  struct node *link;
}Node, *NodePointer;
```

Complete the definition of the function `reverse` whose header is shown below. The function should reverse the order of the nodes in the list whose head is pointed to by the parameter `headPointer`. You may, if you wish, assume the existence of a function `newNode` that allocates memory for a node and returns a pointer to that node.

```
void reverse (NodePointer *headPointer)
```

Extra Space *Please specify which question(s) you are answering on this page.*