UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING

APS105 — Computer Fundamentals
Final Examination — April, 2005

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 130, are shown in the question headings.

You must use the Java programming language to answer programming questions. Unless specifically directed otherwise, you may use any of the methods from the Math, String, and In classes.

Name _____

Student Number _____   ecf login _____

MARKS

1	2	3	4	5	6	7	8	9	10	Total
/10	/20	/15	/10	/15	/15	/5	/10	/15	/15	/130

1. [10 Marks]

Circle the correct answer for each of the following statements. Each correct answer is worth one mark. Each incorrect answer will result in a deduction of one mark.

(a) **True** or **False**: The part of a computer that performs arithmetic is called the ALS.

(b) **True** or **False**: The output of the Java compiler is known as *Java script*.

(c) **True** or **False**: A `double` value is stored using 32 bits.

(d) **True** or **False**: The relational expression `"sam".compareTo("sum") > 0` evaluates to `true`.

(e) **True** or **False**: Methods may have more than one `return` statement.

(f) **True** or **False**: Java arrays are always indexed from zero.

(g) **True** or **False**: A method is said to be *overloaded* if it has more than one parameter.

(h) **True** or **False**: The value of the expression `"Toronto".substring(2).indexOf('o')` is 1.

(i) **True** or **False**: A queue is a linear list in which all insertions and deletions are done at one end of the list.

(j) **True** or **False**: Any algorithm used to traverse a binary tree must be recursive.

2. **[20 Marks]**

Each part of this question is worth two marks.

(a) Evaluate: `((int) 1.2*7) / 4`

(b) Write $\dfrac{1}{\sqrt{2\pi}}e^{-x^2}$ as a Java expression.

(c) Write a statement that will assign to the `int` variable `rounded` the value of the `double` variable `x` rounded to the nearest 100. As an example, if x = 7654.321, then the statement should assign `rounded` the value 7700.

(d) Simplify the expression `!(p != q && r >= s)` as much as possible.

(e) Trace a binary search as it seeks the value 54 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	36	37	43	51	57	60	64	70	72	81	85	88	92	97

(f) Suppose that a class `Person` has been defined. Write a fragment that will create an array of 20 `Person` objects.

(g) Suppose that an array initially contains the values {6,8,9,2,4}. 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 {27,40,54,13,60,15,20}. 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) Linear lists can be stored in arrays or linked lists. Give one advantage of linked lists over arrays and one advantage of arrays over linked lists.

(j) The diagram shows a binary tree. A preorder traversal of the tree, printing values at the nodes, would print those values in the following order: 9 8 2 6 4 7 3 1. Place the values in their correct positions in the tree.
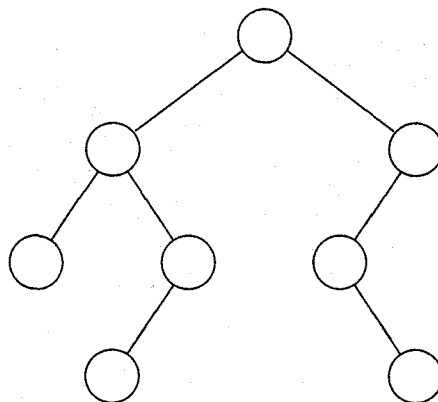
3. [15 Marks]

Write a Java method `checkSum` that has a single `int` parameter n which you may assume is positive. The method should return the value found by adding the first, third, fifth, ... digits of n and subtracting the second, fourth, sixth, ... digits of n. The table below gives examples.

n	Evaluate	Return
827463	$8 - 2 + 7 - 4 + 6 - 3$	12
5	5	5
73	$7 - 3$	4
142	$1 - 4 + 2$	-1

4. [10 Marks]

Suppose that we want to create a class `Pet` in which each object has the following fields:

```
private String species;      // "cat", "dog", etc.
private int age;             // in years
private char sex;            // 'F' or 'M'
```

(a) Write an appropriate constructor with three parameters.

(b) Write an `equals` method for the class. Two `Pet` objects should be considered equal if they are of the same species, have the same sex, and have ages no more than one year apart.

(c) Write a `toString` method for the class. Sample strings for objects of the class are: `"3 year old male fish"` and `"5 year old female dog"`.

5. [15 Marks]

Complete the definition of the method `longestWord` whose header is shown below. The method should return the longest word in the string `s`. Assume that `s` consists only of words separated by single blanks and that there are no blanks at the beginning or end of `s`. If there is more than one word of the maximum length, return the first one.

```
public static String longestWord (String s)
```

6. [15 Marks]

Complete the definition of the method `occurrences` whose header is shown below. The method should return a count of the number of times that the sequence stored in the array `pattern` occurs in the array `list`.

As an example, if `pattern = {4,7,4}` and `list = {1,4,7,4,7,4,3,8,4,7,4}` then the method should return the value 3.

```
public static int occurrences (int[] pattern, int[] list)
```

7. [5 Marks]

A function f is defined for non-negative integers m and positive integers n as follows:

$$f(m,n) = \begin{cases} m & \text{if } m < n \\ 0 & \text{if } m = n \\ f(m-n, n) & \text{if } m > n \end{cases}$$

(a) Find the value of each expression.

   i. $f(2,5)$

   ii. $f(7,1)$

   iii. $f(11,4)$

(b) State in a few words (no more than ten) the value of $f(m,n)$.

8. [10 Marks]

A *palindrome* is a string that is identical to its reversal. As examples, "radar", "deed", and "$$* *$$" are all palindromes. Write a definition of a recursive method isPalindrome that returns true if and only if its single String parameter s is a palindrome. Note that your method *must* be recursive; no credit will be given for a non-recursive solution.

9. [15 Marks]

Suppose that linked lists are represented in the usual way seen in class (as outlined below). Assuming that lists are maintained in increasing order of info fields and that all entries in a list are unique, complete the definition of the method intersection so that it returns the list that contains the items found in both the implicit List object and the list other. If the lists have no elements in common, the method should return a List object whose head field has the value null. You should not assume the existence of any other methods.

```
class List
{
  private Node head;

  class Node
  {
    int info;
    Node link;

    Node (int i, Node n)
    {
      info = i;
      link = n;
    }
  }
  public List intersection (List other)
```

10. [15 Marks]

A binary search tree can be organized in *ascending* order with all keys in the left subtree of any node less than those in the right subtree but it can also be organized in *descending* order with all keys in the left subtree greater than those in right subtree. Complete the definitions of the methods `reverse` whose headers are shown below. The methods should assume that the tree on which they are operating is organized as a binary search tree in ascending order by `info` fields. The methods should alter the tree so that it becomes a binary search tree organized in descending order.

```
class Tree
{
  private Node root;

  public void reverse ()
  {




  }
  class Node
  {
    int info;
    Node lChild;
    Node rChild;

    void reverse ()
    {




    }
  }
}
```

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