UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING

APS105 — Computer Fundamentals
Final Examination — April, 2002

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 pages are provided at the end of the examination. If you use these pages, please indicate clearly what you have done.

The examination has 12 pages.

The marks allocated to the questions, out of a total of 140, are shown in the question headings.

You must use the Java programming language to answer programming questions. You may use any of the methods from the `Math`, `String`, and `Stdin` classes.

Name _____

Student Number _____ ecf login _____

MARKS

1	2	3	4	5	6	7	8	Total
/20	/12	/8	/20	/20	/20	/20	/20	/140

1. [20 Marks]

Each part of this question is worth two marks.

(a) Given that `x` is of type `double` and `n` is of type `int`, write an expression that would assign to `n` the value of `x`, rounded to the nearest integer.

(b) Write a statement that will assign to the `int` variable `guess` a random value in the range $1 \leq \text{guess} \leq 10$.

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

```
for (int i = 3; i > -5; i--);
  System.out.println('**');
```

(d) What is the difference between a class and an object?

(e) Trace a binary search as it seeks the value 60 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	23	28	31	34	38	42	47	50	51	55	61	66	73	75	84

(f) Suppose that an array initially contains the values {5, 4, 1, 6, 2}. If the array is to be sorted into ascending order using selection sort, show the contents of the array as it would appear after each of the first two passes of the sort.

(g) What is the difference between a field that is declared to be `public` and a field that is declared to be `private`?

(h) What is a stack?

(i) Evaluate the postfix expression: 2 5 × 8 4 ÷ 3 + -

(j) Convert the expression (6 + 4) ÷ (8 - 2 × 3) to prefix form.

2. [12 Marks]

Ackermann's function, $a(m, n)$ is defined for non-negative integers m and n as follows:

$$a(m,n) = \begin{cases} n+1 & \text{if } m = 0 \\ a(m-1,1) & \text{if } m > 0 \text{ and } n = 0 \\ a(m-1, a(m, n-1)) & \text{otherwise} \end{cases}$$

1. Evaluate each expression. You must show your work for full credit.

   (a) $a(0,0)$

   (b) $a(1,0)$

   (c) $a(1,1)$

   (d) $a(2,1)$

2. Complete the definition of the method whose header is show below so that it returns the value of Ackermann's function. Assume that the values of `m` and `n` are valid.

```
public static int a (int m, int n)
```

3. [8 Marks]

Suppose that we want a class Dog in which each dog has a name, a breed, and an age (in years). The fields of the class are

```
private String name;
private String breed;
private int age;
```

(a) Write an appropriate constructor with three parameters.

(b) Write an equals method for the Dog class. Two Dog objects should be considered equal if the breeds are the same and the ages differ by one year or less.

(c) Write a toString method for the class. As an example, for an object representing a three year old Samoyed named "Toby", the method should return `"Toby - Breed: Samoyed, Age: 3"`

4. [20 Marks]

Complete the definition of the method `printStars` whose heading is shown below. The method should print a pattern of asterisks and blanks that is `height` lines high and `width` spaces wide. The pattern should be similar to that on the flag of the United States. For example, the call

```
printStars(5,9);
```

should print a pattern like the following:

```
* * * * *
 * * * *
* * * * *
 * * * *
* * * * *
```

Notice that the first character on the first line should be an asterisk, not a blank. If either `height` or `width` are less than one, the method should print nothing.

```
public static void printStars (int height, int width)
 {
```

5. [20 Marks]

Complete the definition of the method compress so that it returns a modified version of its String parameter, s. The modified string should contain the first occurrence of each character in s but all repeated occurrences should be removed. For example, if s = "Here is the sample string", then the method should return the string "Her isthampltng"

```
public static String compress (String s)
 {
```

6. [20 Marks]

Lacsap's Triangle is a triangular array of numbers in which each row starts and ends with the row number and each interior value is the sum of the two values on either side of it in the preceding row. The following diagram shows the first five rows of Lacsap's Triangle.

```
          1
        2   2
      3   4   3
    4   7   7   4
  5   11  14  11  5
```

Write a method that has a single `int` parameter, `n`. The method should print the values in the first `n` rows of Lacsap's Triangle. If $n < 0$, the method should print nothing. For simplicity, do not try to print the triangle in the symmetrical form shown here.

7. [20 Marks]

The nodes of a linked list contain points in the Cartesian plane, with each node in the list having the following fields:

```
class Node
 {
  char label;     // a single letter such as 'A', 'B', etc.
  int x;          // x-coordinate of point
  int y;          // y-coordinate of point
  Node link;
 }
```

The `Node` class is an inner class of the class `List` that has a single field called `head`, a reference to the first node in a list.

You are to complete the definition of the method `shortestSegment` so that it returns the string containing the endpoints of the shortest line segment that can be formed using the points in a list. For example, if the points with labels `'B'` and `'E'` are closest, the method should return either `"BE"` or `"EB"`. You may assume that the distances between all pairs of points are different. Your method should *not* create any new data structure.

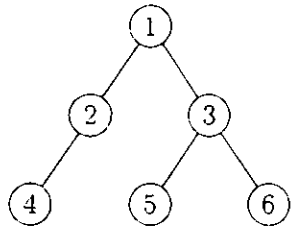
```
public String shortestSegment ()
```

8. [20 Marks]

Complete the definitions of the methods `print` whose headers are shown below. The methods should print the contents of a binary tree in parenthesized form as follows:

(<left subtree>)<item>(<right subtree>)

Here, <left subtree> is the contents of the left subtree printed in parenthesized form, <item> is the `info` field of the root, and <right subtree> is the contents of the right subtree printed in parenthesized form. An empty tree (or subtree) should produce no output. As an example, the tree



would be printed as: `((4)2)1((5)3(6))`

```
class Tree
 {
  private Node root;

  public void print ()
   {




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

    void print ()
     {
```

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