Final Exam– SAMPLE
Computer Programming 338
Dr. St. John
Lehman College
City University of New York
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Exam Rules

- Show all your work. Your grade will be based on the work shown.
- The exam is closed book and closed notes.
- When taking the exam, you may have with you pens or pencils, and an 8 1/2" x 11" piece of paper filled with notes, programs, etc.
- You may not use a computer or calculator.
- All books and bags must be left at the front of the classroom during this exam.
- All pseudocode is from `http://en.wikipedia.org/wiki/` unless otherwise noted.
- **Do not open this exams until instructed to do so.**

1. Write a method that takes an array of integers as input and sorts the array in **linear** time in the number of items, n. You may assume that there are only a fixed number, k, of different integers in the list and that $k < n$.

2. (a) Write a method that takes a queue of real numbers (i.e. `double`), and prints all the elements in the queue that are larger than 90, in the order of the queue. Assume that the queue is stored in a "by hand" implementation with the following classes:

```
public class myQueue {                public class Elem {
  Elem front;                           double data;
  Elem back;                            Elem next;
  myQueue() {front=back=null;}          Elem(double d) {data = d; next=null}
}                                     }
```

```
public static printLargeNumbers(myQueue q1)
```

   (b) Using the classes above, draw a picture of memory after each of the following blocks of code are executed one after another:

i.
```
Elem front = new Elem(90.5);
Elem back = front;
```
front □ back □

ii.
```
Elem t = new Elem(99.9);
back.next = t;
back = t;
```
front □ back □

iii.
```
Elem t = new Elem(50.6);
t.next = front.next;
front.next = t;
```
front □ back □

3. A palidrome is a word or phrase that is the same when written backwards or forwards. For example, “hannah” or “A man, a plan, a canal: Panama.” Write a method that takes a string as a parameter and returns true if the string is a palidrome and false otherwise. Your method should use a **stack** and ignore whitespace and punctuation.

4. Given the following array:

40	21	50	16	30	41	52	2	18	28

   Assume that it represents a binary tree with the following convention:
   `Parent(i) = i/2`, `Left(i) = 2i`, `Right(i) = 2i+1`

   (a) Draw the tree.

   (b) Is this a binary search tree? Why or why not?

   (c) Is this a heap? Why or why not?

   (d) Write a method that takes as a parameter a binary tree in the above array representation and prints out the leaves.

5. (a) Write a class, called `treeNode` that has three instance variables: `data` of type `String`, `left` of type `treeNode` and `right` of type `treeNode`. Your class should also have a constructor and a `toString()` method.

   (b) Write a method that takes as input a node and prints out the tree rooted at the node in **pre-fix** order.

6. Given a graph, stored in an adjacency array, write the pseudocode for the following methods:

   (a) **isolatedVertices**: returns the number of isolated vertices (i.e. those with no neighbors)

   (b) **path(u,v)**: returns true if there is a path between the nodes u and v, and returns false otherwise.

7. (a) Write the pseudocode for Dijkstra's algorithm:

   (b) Write the pseudocode to find the node with the maximal shortest path.
   (Hint: use Dijkstra's algorithm)

8. (a) Write a class, `myNode` that has as instance variables a string (called `data`) and a `myNode` (called `next`).

   (b) Write a method that takes takes as parameters a string and an array of `myNode`. Your method should store the string in a new node in the array by its length modulus the length of the array (i.e. if the length of the string is 25 and the length of the array is 20, it would be stored at index 5). If there is already an element at that index, you should use chaining to store it in a linked list at that location.

9. An edit distance between two strings is the minimal number of insertions and deletions it takes to convert one string to the other.

   (a) Using the following pseudocode for calculating the edit distance between the following two strings (the table $m[i,j]$ on the right might be useful in calculating this number):

```
EditDistance(s1,s2)
  int m[i,j]
  for i = 0 to length(s1)
    m[i,0] = i
  for j = 0 to length(s2)
    m[0,j] = j
  for i = 1 to length(s1)
      for j = 1 to length (s2)
        if ( s1.charAt(i) == s2.charAt(j) )
          delta = 0
        else
          delta = 1
        m[i,j] = min { m[i-1,j-1] + delta, m[i-1,j]+1, m[i,j-1]+1 }
  return ( m[length(s1),length(s2) )
```

	∅	h	e	l	p	m	e
∅							
h							
e							
l							
l							
o							

(b) What is the running time of the above method? Justify your answer.

10. (a) Recall that a `prefix code` is a code in which no codeword is also a prefix of some other codeword. Given the following frequencies for letter occurrences, write a prefix code for these letters:

α	β	γ	δ	ϵ	ϕ
30	5	23	8	2	4

(b) Write the pseudocode for a **greedy algorithm** that builds an optimal prefix code (i.e. one with minimal length for the encoded file).