CS 216 Exam 1 – Spring 2002

Part 1 – Closed Book

Name _______________________  Section _______________________

Email Address _________________  Student ID # _________________

This exam is in two parts. Once you are finished with part 1, **hand it in**, and you will be given part 2. Part 1 is worth 73 points and Part 2 is worth 27 points. You will have an hour and fifty minutes total to complete both parts.

**Part 1:** Closed note, closed book. You are not to speak with anyone except the Instructor or a teaching assistant for any reason except an emergency during the exam. You may use calculators.

**Part 2:** Open book, open notes. You may not speak with anyone except the Instructor or a teaching assistant for any reason except an emergency during the exam. Calculators are allowed. You may not borrow notes or textbooks from other students.

Good Luck!

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<thead>
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<th>PART</th>
<th>MAX</th>
<th>SCORE</th>
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<tr>
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Define and *give an example* of each:

1. a) (2 points) abstract data type

   b) (2 points) container

   c) (2 points) LIFO data structure

   d) (2 points) Depth of a node in a binary search tree

2. (2 points) Give two criteria we use in deciding which data structure to use:

3. (2 points) Give two things that Big-O time comparison ignores (that in reality may have an affect on running time):
4. [2 points] You have a computer with 512 addressable words of memory. What is the smallest number of bits required to address all words in your computer?

5. [2 points each] In the Exam1 architecture, words are 8 bits long.
   a) Show how the number 10 would be represented in two's complement in an 8-bit word.
   
   b) Show how -6 would be represented in two's complement in an 8-bit word.
   
   c) Show how the result of adding 10 and -6 would be represented in an 8-bit word.

6. [3 points] Write the following infix expression as a prefix expression:
   \[ ((a + b) \times c) - d \]
7. (8 points total) Describe the running time of the following pseudocode in Big-Oh notation:

    int test(int n) {
        if (n < 10) {
            cout << "too small";
        } else {
            for (int i = 0; i < n; ++i) {
                cout << "just right";
            }
        }
        return n;
    }

a) for (int i = 0; i < n; ++i) {
    a = test(i);
}

b) for (int i = 0; i < 100 * n; ++i) {
    for (int j = 0; j < i; ++j) {
        cin >> b;
        a = a + b;
    }
}

c) for (int j = 0; j < 5000; ++j) {
    b = a * c;
    for (int i = 0; i < j; ++i) {
        a = a + b;
    }
    for (int i = 0; i < n; ++i) {
        c = b + c;
    }
}

d) for (int i = 0; i < n; ++i) {
    for (int j = 0; j < i * i; ++j) {
        sum = sum + i;
    }
    for (int k = 0; k < n; ++k) {
        a[k] = a[k] + sum;
    }
}
8. (6 points) What is the representation of each of the following in the indicated radix? Be sure to show your work.

a) \(256_7\) in decimal

b) \(1230_4\) in hex

c) \(9G_{18}\) in radix 10

9. (6 points) Consider the positive binary integer represented in two’s complement: 

\[0000001101010101_2\]

a) Express this binary number in octal

b. Express this binary number in hexadecimal

c. Negate the number (i.e. give the two’s complement representation of a negative version of the same number) Use the same number of bits.
10. (4 points) Let $T$ be a binary search tree whose is

Inorder traversal is: 0 1 2 3 4 5 6 7 8 9

Preorder traversal is: 1 0 6 2 5 3 4 7 9 8

Draw $T$. Please draw a circle around your final answer.
11. (3 points each) I tell you that the STL vector class is implemented as an array. For each operation give 1) How you think the operation is most likely implemented in the STL vector, 2) WHAT exactly is the worst case scenario and 3) what is the worst case Big-Oh running time of this scenario.

a) Reading an element of a vector with the [ ] operator.

b) push_back(T val) – inserts a copy of val after the last element in the vector.

c) size() – returns the size of the vector.

d) insert(iterator pos, T val) – inserts a copy of val prior the element in the list referred to by pos.
12. (3 points) Given the following tree:

Is it an AVL tree? If not, circle the node(s) where the AVL property is violated. Why or why not (must answer for any credit)?

13. (4 points) Your friend has to write code to make sure that the parenthesis in an arithmetic expression are balanced, i.e. for every left parenthesis there is a matching right parenthesis. She wants to use a tree to do this. You argue that if all you want to do is match parentheses, then a stack will work fine.

How will you use a stack to do this?
14. (3 points) When we say: $T(N)$ is $O(f(N))$ we mean:

a) For all values of $N$, $T(N)$ has a value $< f(N)$.

b) For values of $N \geq$ some positive constant $n_0$, $T(N)$ has a value $< f(N)$.

c) For all values of $N \geq$ some positive constant $n_0$, $T(N)$ is within a constant factor of $f(N)$.

d) For all values of $N \geq$ some positive constant $n_0$, $T(N) = f(N)$.

15. a) (2 points) Write an equation to calculate the address of $A[i]$ in a one-dimensional array:

b) (2 points) Write an equation to calculate the address of $A[i][j]$ in a two-dimensional array stored in row-major order:
16. (6 points) Assume we are using the 32-bit IEEE single precision floating point format as described in class and used in lab.

What positive decimal floating point number is represented by the following 32 bits? SHOW YOUR WORK!

0101 0001 1000 1000 0000 0000 0000 0000
17. (15 points) Write a routine that given two sorted lists A and B, will produce a new list
C that consists of the intersection of the elements in the two lists.

a) (5 points) Explain your general idea of how you would do this. Assume that A,B, and
C are stored in STL vectors. Recall the following about STL vectors:

- \texttt{size( )} – returns the number of elements in the vector
- \texttt{A[ i ]} – accesses the value stored in position i of A.
- \texttt{push\_back( val )} – inserts a copy of val after the last element in the vector

b) (2 points) What is the worst case Big-Oh running time of your solution and why? \textit{Be}
\textit{sure to state what N is.}
c) (8 points) Write a C++ function to create the intersection list C. You will be graded mostly on the correctness of the ideas of your solution rather than exact C++ syntax, but your solution should be clear. Correct C++ code is the best way to ensure we understand your solution.

```cpp
vector<int> intersection ( vector<int> A, vector<int> B) {
```
18. (6 points) A palindrome is a string that reads the same forwards as backwards. Describe how you would implement a function that, given a string, determines whether it is a palindrome. Your function can use only one stack and one queue. Your function should return true if the string is a palindrome and false otherwise.

For example:

```
palindrome(“abba”) → true
palindrome(“bbba”) → false
```
18. (6 points) Describe how you would implement a stack using a single queue. Specifically describe how you would implement push and pop.

Pledge for the open and closed book exam: On my honor, I have neither given nor received unauthorized aid on this exam.

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Sign your name