Computer Science Foundation Exam

March 9, 2001

Section I A

solutions
(1, 20%) a) Show the array $X$ after the procedure has completed execution (2pts each)?

<table>
<thead>
<tr>
<th>Array X</th>
<th>15</th>
<th>12</th>
<th>5</th>
<th>7</th>
<th>11</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>position</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

b) What value will the variables $a$ and $b$ contain when the algorithm is finished (4pts each)?

<table>
<thead>
<tr>
<th>a</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>8</td>
</tr>
</tbody>
</table>

(2, 14%) a) $\begin{array}{c} 7 \\ 2 \\ 4 \\ - 3 \end{array} ^{A} \ast ^{B} 5 + ^{A} 8 ^{C} 4 / ^{A} 6 ^{C} + - = 3$

\[
\begin{array}{|c|c|}
\hline
& 3 \\
\hline
& -2 \\
\hline
& 7 \\
\hline
A & & \\
\hline
& 8 \\
\hline
& -1 \\
\hline
& 7 \\
\hline
B & & \\
\hline
& 6 \\
\hline
& -2 \\
\hline
& 7 \\
\hline
C & & \\
\hline
\end{array}
\]

b) output from print statements:

<table>
<thead>
<tr>
<th>2</th>
<th>7</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>first output</td>
<td>second output</td>
<td>third output</td>
<td>fourth output</td>
</tr>
</tbody>
</table>

(3, 20%) a) For an $O(n!)$ algorithm, one data set with $n = 4$ takes 72 seconds.

How long will it take for a data set with $n = 5$? \[360 \text{ seconds}\]

b) For an $O(2^n)$ algorithm, one data set with $n = 7$ takes 96 seconds.

If you used a different-sized data set and it took 12 seconds, how large must that data set be? \[n = 4\]

c) For an $O(n^3)$ algorithm, a friend tells you that it took 192 seconds to run on her data set. You run the same program, on the same machine, and your data set with $n = 6$ takes 648 seconds.

What size was her data set? \[n = 4\]

d) What is the Order of this pseudocode segment? \[O(n^2)\]

e) What will be the value of $x$ when the for loops end? \[2n^3 + 5n^2 + 2n\]
Write a recursive function, called prob4, that will correctly print the index positions of all the occurrences of a specified character c, within the first m locations of an array X. You may assume that X is a global array which includes locations that range from 1 to n and is already populated with characters. Assume that m ≤ n. The initial call is prob4(c, m). You may use pseudocode, C, Java or Pascal syntax but points will be deducted if your meaning is not clear.

Two of the many ways that this can be done:

```plaintext
procedure prob4(c : char, m : integer) {
    if (m > 0) {
        if (X[m] == c)
            print("Found ", c, " at ", m)
        prob4(c, m-1)
    }
}
```

OR

```plaintext
procedure prob4(c : char, m : integer) {
    if (m > 0) {
        prob4(c, m-1)
        if (X[m] == c)
            print("Found ", c, " at ", m)
    }
}
```
(5, 18%) Find the closed form or exact value for the following:

(\textit{n is an arbitrary positive integer}): 

\begin{align*}
\text{a) } \sum_{i=0}^{47} (3i + 1) &= 3432 \\
\text{b) } \sum_{i=1}^{2k-2} (2i + 5) &= 4k^2 + 4k - 8 \\
\text{c) } \sum_{i=25}^{75} (4i - 3) &= 10047
\end{align*}
Given the following Binary Tree, answer the questions below:

a) Is this a valid Binary Search Tree? (circle one)  
   Yes

b) List the nodes of this tree in the order that they are visited in a preorder traversal:

   30 14 8 12 29 65 46 52 89 83

   first node visited
   last node visited

c) Perform the following procedure on the tree above, listing the output in the spaces below and leaving any unused spaces blank. Assume that the procedure is initially called with P6(root, 30)

   12 29 14 52 89