Computer Science Foundation Exam

December 19, 2008

Computer Science

Section 1A

Name: Solution and Grading Criteria

SSN: _____

	Max Pts	Type	Passing Threshold	Student Score
Q1	**11**	**DSN**	**8**	
Q2	**10**	**ANL**	**7**	
Q3	**10**	**ALG**	**7**	
Q4	**10**	**ALG**	**7**	
Q5	**9**	**ALG**	**6**	
Total	**50**		35	

You must do all 5 problems in this section of the exam.

Partial credit cannot be given unless all work is shown and is readable. Be complete, yet concise, and above all be neat. Do your rough work on the last page.

1) (11 points) **Recursion**

Write a **recursive** function that takes in a string consisting entirely of lowercase letters, an integer representing the length of the string, and a character. Your function should return the number of letters in the first length characters of the string that come strictly before the target, alphabetically. For example, if the string is "computer", the length 8 and the target character is 'p', then the function should return 4 because the four letters in the string of length 8 that come before 'p' alphabetically are 'c', 'o', 'm', and 'e'.

```
int earlier_letter_count(char* str, int length, char target)
{
```

Correct Answer:

```
      if(length == 0)
            return 0;
      else if(str[length-1] < target)
            return 1 + earlier_letter_count(str, length-1, target);
      else
            return earlier_letter_count(str, length-1, target);
```

Grading Criteria:

Note: This problem can be solved in more than one way. Please use your judgment when applying these criteria.
Base case – 3 points
Making a decision based on the relation between target and a character in the string – 3 points
Making proper recursive calls to obtain the correct return value – 5 points

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```
}
```

2) (10 points) **Summations**

a) Consider the following code fragment:

```
for(i = 5; i <= n + 5; i++) {
      for(j = 1; j <= i - 3; j++) {
            sum += j*n + i*n;
      }
      sum -= i * i * n;
}
```

Write (but don't solve) a summation to describe the number of multiplications performed by that code fragment in terms of the variable *n*.

Correct Answer:

$$\sum_{i=5}^{n+5}\left(2+\sum_{j=1}^{i-3}2\right)$$

Grading Criteria:
Correct bounds on the outer summation – 2 points
Correct bounds on the inner summation – 2 points
Answer is otherwise correct – 1 point

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b) Obtain a simplified closed form solution for the following summation:

$$\sum_{i=1}^{n}\left(\sum_{j=1}^{i}3i+\sum_{j=1}^{n}3i\right)$$

Hint: $\sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6}$

Correct Answer:

$$=\sum_{i=1}^{n}\left(3i^2+3in\right)=3\sum_{i=1}^{n}i^2+3n\sum_{i=1}^{n}i=3\frac{n(n+1)(2n+1)}{6}+3n\frac{n(n+1)}{2}$$

$$=\frac{n(n+1)}{2}(2n+1+3n)=\frac{n(n+1)(5n+1)}{2}$$

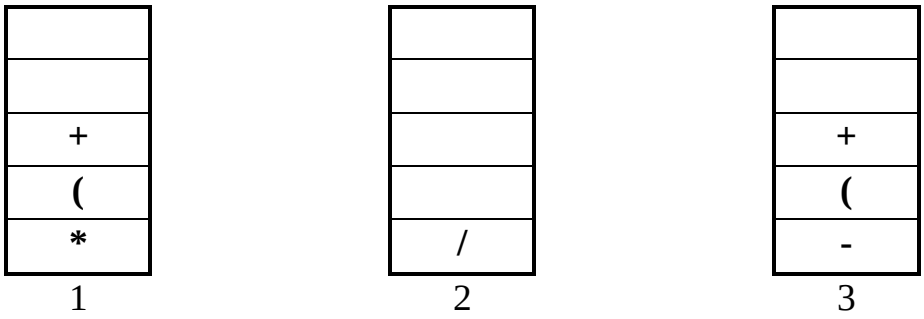
Grading Criteria:
Obtaining closed forms for the inner summations – 1 point
Splitting the outer summation into pieces – 1 point
Correctly applying formulas to obtain a correct closed form – 2 points
Simplifying the closed form – 1 point

3) (10 points) **Stack Applications**

Transform the following infix expression into its equivalent postfix expression using a stack. Show the contents of the stack at the indicated points 1, 2 and 3 in the infix expression.

							1				**2**					**3**		
A	*****	**(**	**B**	**+**	**C**	*****	**D**	**)**	**/**	**E**	**-**	**(**	**F**	**+**	**G**	**)**		

Correct Answer:



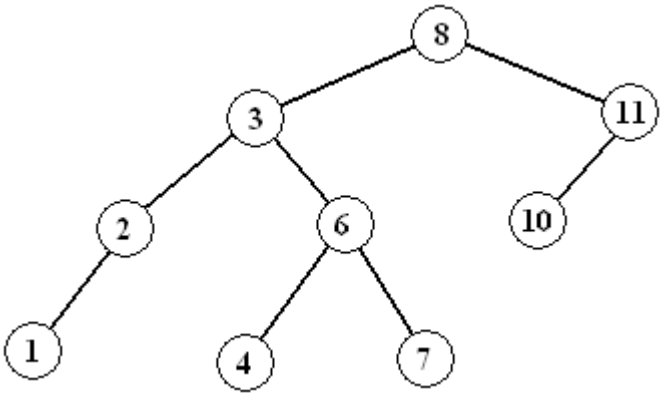
Resulting postfix expression:

A	B	C	D	*	+	*	E	/	F	G	+	-						

Grading Criteria:
Each correct stack – 2 points
Resulting expression – 4 points

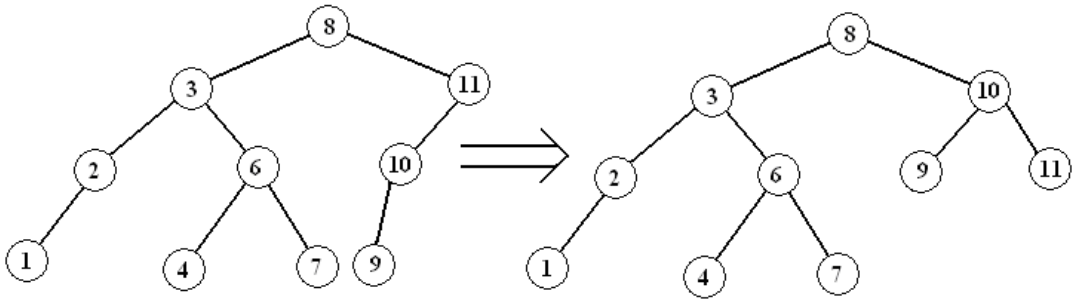
4) (10 points) **AVL Trees**

Consider the following AVL tree:



a) Show the result of inserting a node with value 9 into the tree. Be sure to perform any necessary rotations to maintain the AVL tree properties.

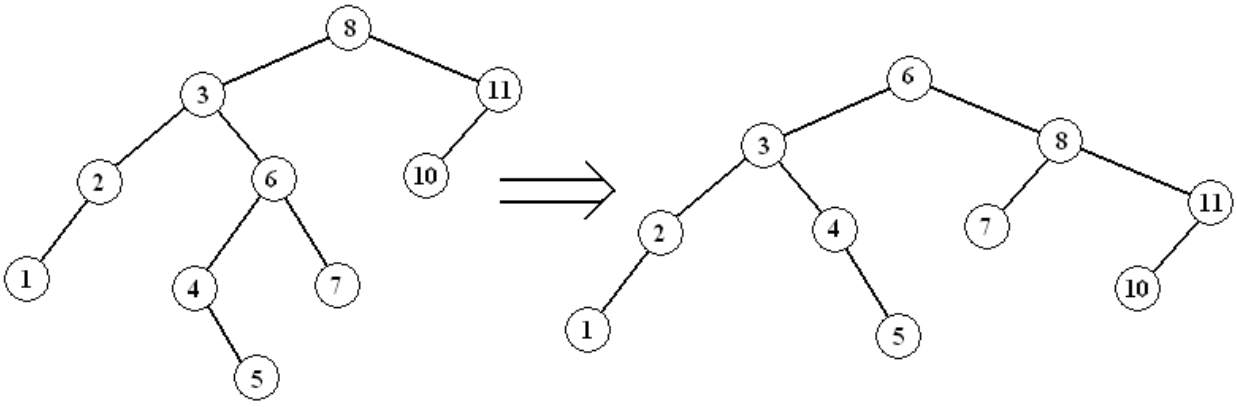
Correct Answer:



Grading Criteria:
Inserting 9 into the correct spot – 2 points, Correctly performing a single rotation – 3 points

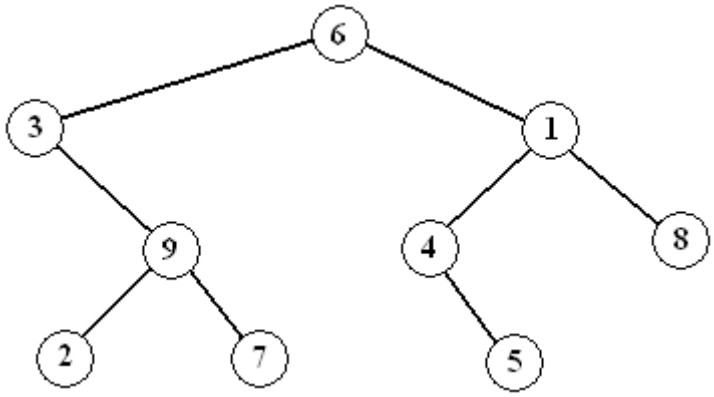
b) Show the result of inserting a node with value 5 into the original tree (i.e. ignore part a for the purposes of this question). Be sure to perform any necessary rotations to maintain the AVL tree properties.

Correct Answer:



Grading Criteria:
Inserting 5 into the correct spot – 2 points, Correctly performing a double rotation – 3 points

5) (9 points) **Binary Trees Traversals**



Give the prefix, infix, and postfix traversals of the binary tree shown above.

Correct Answer:
Prefix: 6 3 9 2 7 1 4 5 8
Infix: 3 2 9 7 6 4 5 1 8
Postfix: 2 7 9 3 5 4 8 1 6

Grading Criteria:
3 points each
