# Computer Science Foundation Exam

**August 14, 2009**

# Computer Science

# Section 1A

**Name:**__________________________________________________

**PID:** __________________________________________________

| | 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 prints the contents of a linked list in reverse order. Make use of the list node struct and function header below.

```
struct listnode {
     int data;
     struct listnode* next;
};

void print_reverse(struct listnode* head)
{
```

**Solution:**

```
     if(head == NULL)
          return;

     print_reverse(head->next);
     printf("%d ", head->data);
```

**Grading Criteria:**

There are many ways to approach this problem. Be reasonable when grading.
Base case – 3 points
Printing the node in the proper place in the function – 4 points
Making a proper recursive call – 4 points

**2)** (10 points) **Summations**

**a)** Consider the following code fragment:

```
prod = 0;
for(i = 0; i <= n + 7; i++) {
      prod = prod * 5 * i;
      for(j = i - 5; j <= i + 5; j++) {
            prod = prod * n * j * 3;
      }
}
```

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

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

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

**Solution:**

**a)**

$$\sum_{i=0}^{n+7}\left(2+\sum_{j=i-5}^{i+5}3\right)$$

**b)**

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

**Grading Criteria:**

**a)**

Correct bounds on the outer summation – 2 points

Correct bounds on the inner summation – 2 points

Answer is otherwise correct – 1 point

**b)**

Properly dealing with the inner summation – 2 points

Properly dealing with the outer summation – 2 points

Simplifying the resulting 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 expressions.

**1 2 3**

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

**Solution:**

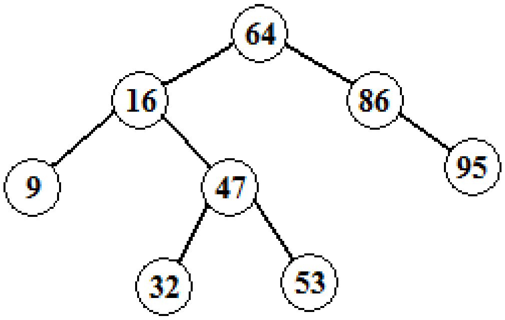
| | | |
|---|---|---|
| | | |
| | | **-** |
| | | **(** |
| **/** | ***** | ***** |
| **(** | **-** | **-** |
| 1 | 2 | 3 |

Resulting postfix expression:

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

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

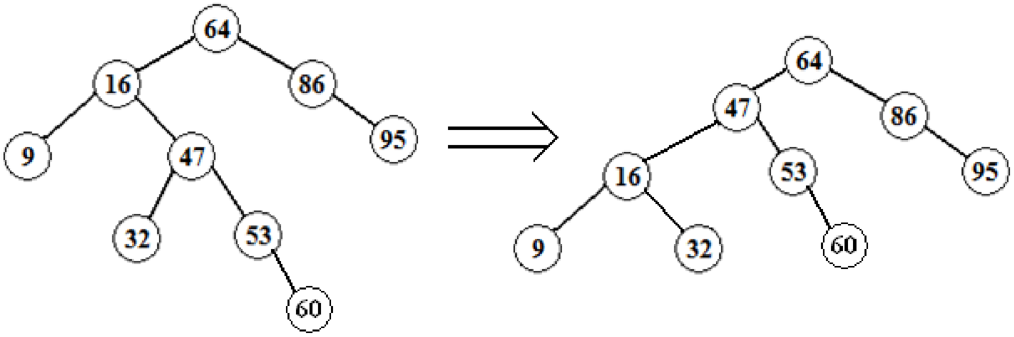
**4)** (10 points) **AVL Trees** Consider the AVL tree below:



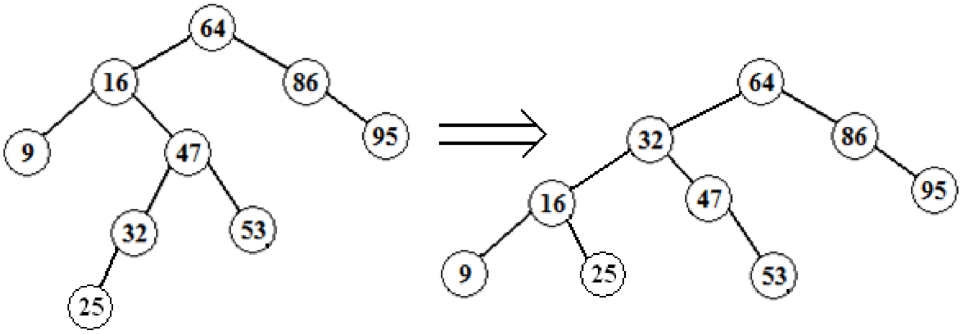
**a**) Show the state of the tree after node containing the value 60 is inserted. Be sure to perform any necessary rotations.
**b)** Show the state of the tree after node containing the value 25 is inserted into the original tree (i.e. ignore **part a** when answering this part). Be sure to perform any necessary rotations.

---

**Solution:**
**a)**

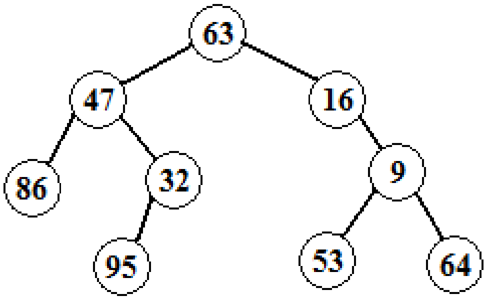


**b)**



**Grading Criteria:**
5 points per part:
Preserving BST order property – 2 points
Maintaining AVL balance properties – 1 point
Rotating correctly – 2 points
Note: Showing the pre-rotation tree is not required for a correct answer

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



Give the preorder, inorder, and postorder traversals of the binary tree shown above.

**Solution:**
**Preorder:**
63 47 86 32 95 16 9 53 64
**Inorder:**
86 47 95 32 63 16 53 9 64
**Postorder:**
86 95 32 47 53 64 9 16 63

**Grading Criteria:**
3 points per traversal