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.
1. [10 pts] Convert the following infix expression into its equivalent postfix expression using a stack. Show the contents of the stack, AND the partial postfix expressions at the indicated points in the infix expression (points 1, 2 and 3). The stack boxes should just show the appropriate characters and NOTHING ELSE. You may draw another stack alongside for your work.

\[ A + K \times ( M + J / T - B ) / N \]

Indicate the partial postfix expression as obtained at various points indicated in the infix expression. The form of your answer is illustrated below for a hypothetical case:

<table>
<thead>
<tr>
<th>Partial Expression upto 1</th>
<th>Partial Expression upto 2</th>
<th>Partial Expression upto 3</th>
<th>Remaining part</th>
</tr>
</thead>
<tbody>
<tr>
<td>M R+</td>
<td>B P / + D - *</td>
<td>T * S L+</td>
<td>N -</td>
</tr>
</tbody>
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<td>A K</td>
<td>M J T / +</td>
<td>B - *</td>
<td>N / +</td>
</tr>
</tbody>
</table>
2. [5 pts] Write the in-order traversal of the following binary tree.

```
L
  K
   T
  A.
N
D
W
```

L K N D W A T

Partial points may be awarded.

(b) [5 pts] It is desired to delete node 24 from the following BST. Make corrections on this tree to show the new values.

This can have two solutions.
Grading: either 5 points or none
Solution 1:

```
   30
  24  50
 16  38  75
 10  22  35 60
 18  30  42 55
```

Solution 2:

```
   22
  24  50
 16  38  75
 10  22  30 60
 18  35  42 55
 48  65  78 90
```
3. (a) [4 pts] An array contains one million sorted integers. Let M be the maximum number of operations required to search for a specific integer using the most efficient algorithm. Given that \( \log 1000 \) is nearly 10, which one of the following figures would be closest to M?

Justify your answer.

a) 13  b) 20  c) 1000  d) 10000  e) 1000000

**Binary search \( \mathcal{O}(\log n) \).**

\[
\log 1000000 = \log 1000^2 p = 2 \log 1000 = 20
\]

[ Grading: 2 points if result is not justified ]

3. b) [4pts +5pts] Simplify the following expressions to the extent possible

\[
\sum_{j=50}^{99} 2j - \sum_{j=1}^{49} 2j
\]

\[
= 2 \left( \frac{99 \times 100}{2} \right) - 2 \left( \frac{49 \times 50}{2} \right)
\]

\[
= 9900 - 2450 = 7450
\]

[ grading: 4 pts, only 2 points if the second summation goes from 1 to 50, and the result is 6450 ]
\[ \sum_{j=1}^{n-1} \sum_{m=4}^{6j} 1 \]

\[ \sum_{j=1}^{n-1} [6j - 4 + 1] \]

\[ \sum_{j=1}^{n-1} [6j - 3] \]

[ grading: 3 points]

\[ \sum_{j=1}^{n-1} 6j - \sum_{j=1}^{n-1} 3 \]

\[ = 6 \frac{(n-1)n}{2} - 3 (n - 1) \]

\[ = 3 (n - 1) (n - 1) \]

[ grading: 2 more points]
4. [8 pts] Draw an AVL tree as the following integers are inserted in the order they appear in the sequence. If the tree becomes unbalanced, redraw the tree alongside after balancing.

31, 35, 56, 43, 63, 50

[ grading: 4 points for this tree ]

[ grading: 4 more points ]
5. [9 pts] The nodes of a linked list p have the following structure

```c
struct node {
    int data;
    struct *next;
};
```

p contains the elements 15, 23, 65, 46, 83, 40, 10, 76. Draw the linked list p, run the following code on p, and draw the linked lists p, q and r after the code is run.

```c
a = p;
b = p;
while (a != NULL) {
    c = b;
    a = a ->next;
    a ->data = a ->data + 10;
    b = b->next;
    a = a->next;
}
c->next = NULL;
q = b->next;
r = a;
```

p _15-23-65-46-83-40-10-76

at the end of while loop, we have
p _15-33-65-56-83-50-10-86
a points to NULL,
and b points to 83.

p _15 - 33 - 65 - 56 [4 pts]
q _50 - 10 - 86 [3 pts]
r _NULL [2 pts]