HNUid

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Hainan University

2024/2025 Academic Year

Semester Midterm Exam *(Practice)*

Subject:《Y05335/COMPX201》

(Suitable for major)

College: _____ Major and Class: _____

Name: _____ HNU ID: _____

Test instructions:

1. Please be sure to write the answers on the answer sheet provided.
2. This course is a closed book examination.
3, There are two sections to this test. Answer ALL questions in Section A and ALL questions in Section B.
4. The duration of the test is 100 minutes (1 hour + 40 minutes).

THIS EXAMINATION PAPER MUST BE HANDED IN

SECTION A: 20 marks

Answer ALL Questions by selecting the most correct answer. Each question carries 2 marks. Please answer these questions in the answer sheet provided.

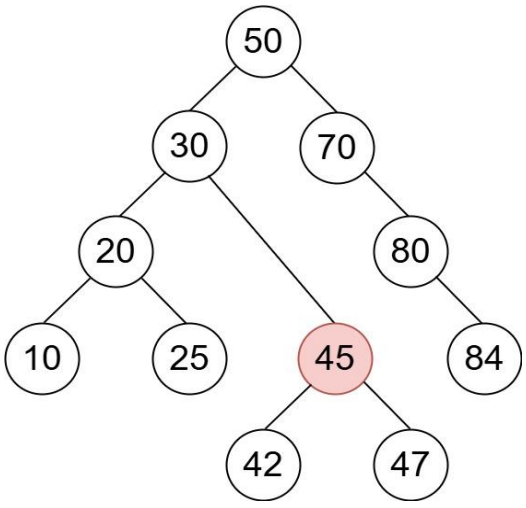
1. Consider the following Java code

```
public int factorialR(int n){
    if(n == 1){
       return 1;
    }
    else{
       return n*(factorial(n-1));
    }
}
```

Which part of the code corresponds to the stopping condition of recursive methods?

a. `return 1;`
b. `factorialR(int n)`
c. `return n*(factorial(n-1));`
d. `if(n == 1){ return 1; }`

2. Consider the following binary search tree:



What is the depth of the node with value 45?

a. 0
b. 3
c. 2
d. 1

3. In ā red black tree, what color is used to mark leaf nodes?
    a. Red.
    b. Black
    c. Leaf nodes are not colored
    d. None of the above

4. In a b-tree of order 7, every node has a maximum of ..... values
    a. 5
    b. 8
    c. 7
    d. 6

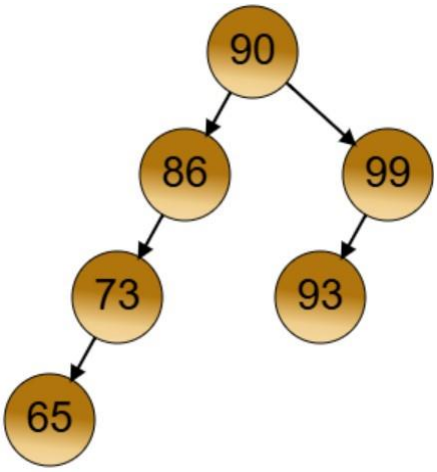
5. Which of the following best describes the `peek` operation in a stack?
    a. Remove and return the top element of the stack.
    b. Add a new element to the top of the stack.
    c. Return the top element of the stack without removing it.
    d. Check if the stack is empty.

6. In a linked list, there is a node whose reference (or pointer) does not point to any other node but instead points to `null`.
   What is the correct name for this node?
    a. Head node
    b. Internal node
    c. Root node
    d. Tail node

7. In Java, if a public class is named `Main`, what should be the name of the file in which it is defined?
    a. Main.class
    b. Main.package
    c. Main.jv
    d. Main.java

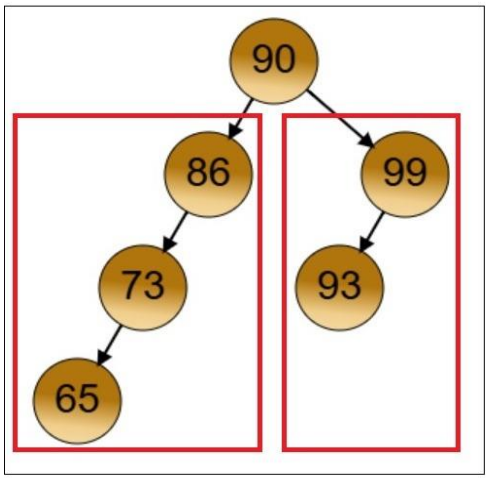
8. A data structure is described as a restricted linked list where new items can only be added at one end, and old items are only removed from the opposite end.
   Which of the following data structures is being described?
    a. Stack
    b. Queue
    c. Binary search tree
    d. Linked

9. Consider the unbalanced AVL tree below

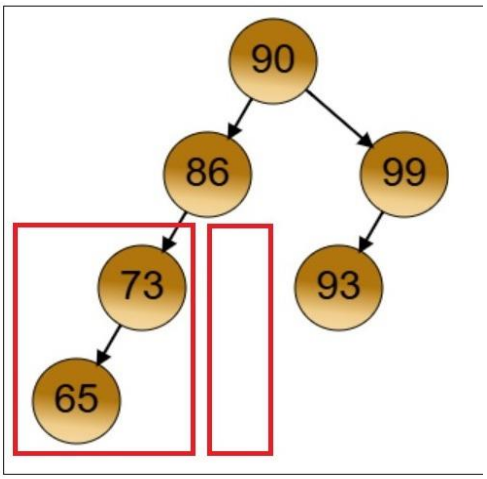


Where is the is the imbalance?

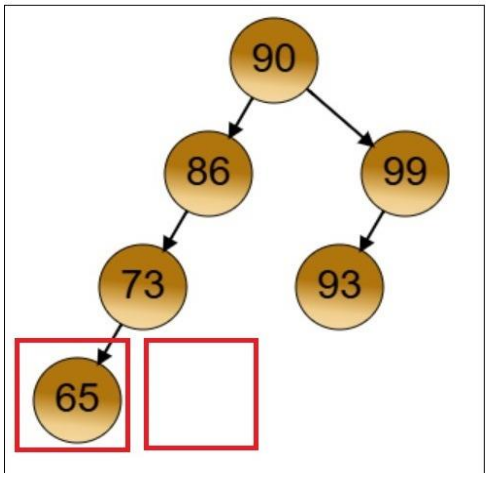
a



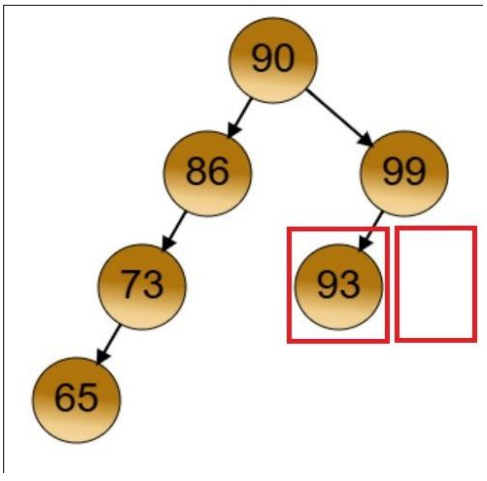
b



c



d



10. Which traversal method is most commonly used to create a copy of a binary search tree?
    a. Pre-order traversal
    b. In-order traversal
    c. Post-order traversal
    d. Level-order traversal

SECTION B: 70 marks

Answer ALL questions. Please answer these questions in the answer booklet provided.

1. Linked Lists, Stacks and Queues (20 marks)

Given the following partial implementation of a queue data structure in Java using a linked list:

```
public class Queue{
       private class Node {
          int value;
          Node next;
       }
       private Node head;
   }
```

a. Write a public method `enqueue(x)` that creates a new node with the value `x` and adds it to the end of the queue.

(5 marks)

b. Write a public method `isEmpty()` that checks whether the queue is empty.

(5 marks)

c. Write a public method `hasNode(x)` that checks whether the queue contains a node with the value `x`.

(5 marks)

Use the problem statement below to answer questions (d) and (e)

You are tasked with designing a customer support ticketing system for a company.

In this system:

- Customers submit support tickets that are added to a processing list.
- Tickets are handled in the order they were received, and each ticket must be addressed before any newer ones.
- The support agents handle one ticket at a time, from the front of the list, and new tickets continue to arrive at the back.

d. Identify the most appropriate data structure to manage the support ticket queue from the two options below:

(i) Stack
(ii) Queue

(2 marks)

e. Justify your answer by briefly explaining why the selected data structure is better suited for this scenario.

(3 marks)

2. Binary Search Trees **(25 marks)**

a. You are given a class Node that represents a node in a binary search tree:

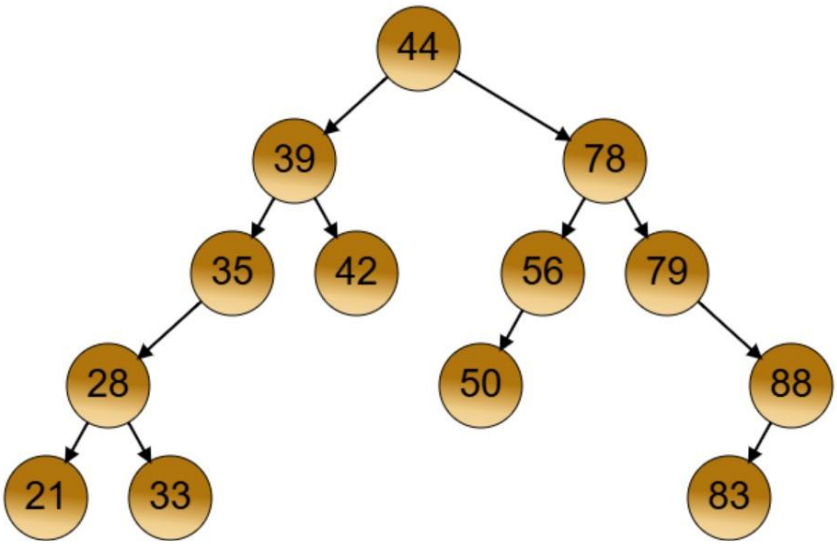
```
public class Node {
    int value;
    Node left;
    Node right;

    public Node(int v) {
        value = v;
        left = right = null;
    }
}
```

Write a recursive method named `searchRecursive(Node currentRoot, int x)` that returns `true` if a node with the value `x` exists in the binary search tree rooted at `currentRoot`, and `false` otherwise.

(10 marks)

b. Consider the binary search tree below



i. Perform a pre-order traversal of the binary search tree and write down the resulting node values

(4 marks)

ii. Insert the following values into the tree in the given order: 77, 94, 37, 43
Redraw the new binary search tree after all insertions.

(4 marks)

iii. From the tree you created in (ii), delete the following nodes with the following values in the given order: 50, 44, 79, 43
Redraw the new binary search tree after all deletions.

(4 marks)

c. Explain how binary search trees support logarithmic search times.

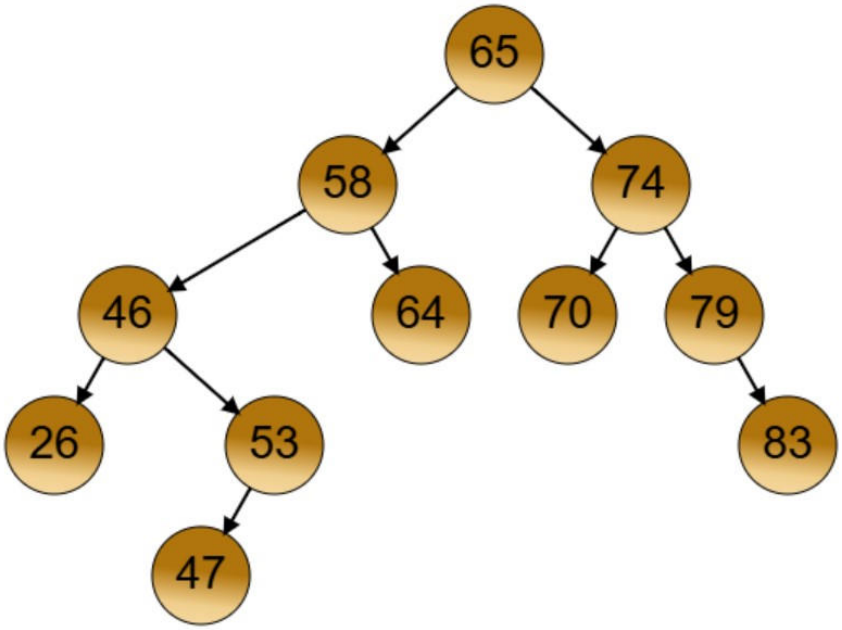
(3 marks)

3. Recursion and Height Balancing (AVL, red-black and b-trees) (25 marks)

a. List and explain the three requirements that must be satisfied for a method to be considered a properly designed recursive method.

(5 marks)

b. Consider the following unbalanced AVL tree



i. Where is the imbalance?

(2 marks)

ii. What is the balance factor

(2 marks)

iii. What type of imbalance is it?

(2 marks)

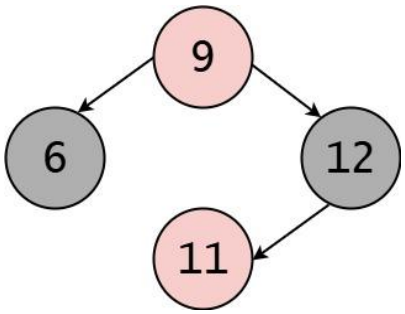
iv. What is the correct rotation to fix the imbalance?

(2 marks)

v. Perform the correct rotation to balance the AVL tree and redraw the balanced tree

(4 marks)

c. Consider the red-black tree below



Which property (if any) of red-black trees is violated? Describe the violation, correct it, and redraw the resulting tree.

(3 marks)

d. Draw the resulting B-tree of order 5 after inserting the numbers 1 through 15 into an initially empty B-tree.
Ensure that all B-tree properties are properly maintained throughout the insertion process.

(5 marks)

Section A: Answer Sheet

Please provide your answers to Section A on this answer sheet. Place a cross (X) in the appropriate square to indicate your answer.

	a	b	c	d
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

THIS ANSWER SHEET MUST BE HANDED IN