COLLEGE OF BUSINESS, PEACE, LEADERSHIP AND GOVERNANCE

NCSC 411: DATA STRUCTURES AND ALGORITHMS

END OF FIRST SEMESTER EXAMINATIONS

NOVEMBER 2021

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TIME: 5 HOURS

INSTRUCTIONS

Answer one question.

Start each question on a new page

Credit will be awarded for logical, systematic and neat presentations

QUESTION ONE

A1.

(Credit Limit Calculator) Develop a C program that will determine if a department store customer has exceeded the credit limit on a charge account. For each customer, the following facts are available:

a) Account number

b) Balance at the beginning of the month

c) Total of all items charged by this customer this month

d) Total of all credits applied to this customer's account this month

e) Allowed credit limit

The program should input each of these facts, calculate the new balance (= *beginning balance*

+ *charges – credits*), and determine if the new balance exceeds the customer's credit limit. For those customers whose credit limit is exceeded, the program should display the customer's account number, credit limit, new balance and the message "Credit limit exceeded."   [20 marks]

A2.

Consider the following AVL tree
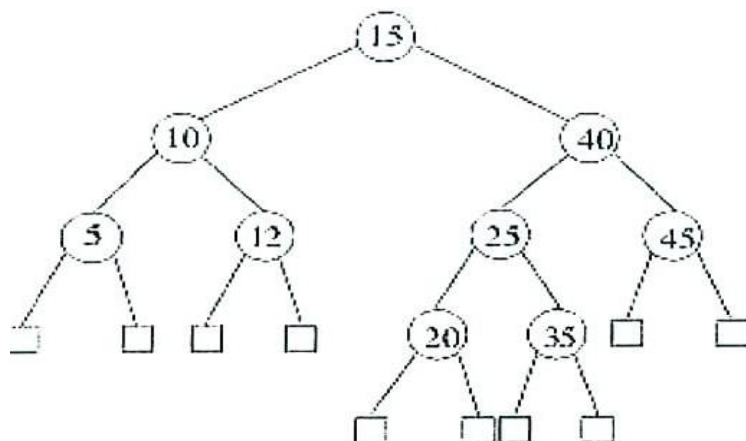
a)   Insert the key 25 into the tree and rebalance if needed .Draw the final tree and intermediate trees you need. Use appropriate algorithms for inserting and rebalancing.   [5 marks]

b)   Remove the value 40 from the original tree and rebalance it if needed. Draw the final tree and intermediate trees you need. Use appropriate algorithms for inserting and rebalancing.
                                                                                                                              [5 marks]

c) An ordered dictionary D is implemented with an AVL tree T. Design an algorithm for performing the operation findAll(k) to return all the entries in D with keys to k. What is the time complexity (in Big-Oh notation) of your algorithm [10 marks]

d) Use the definition of Big-Oh to prove that $0.01 nlog(n) - 200n + 6$ is $O(nlog(n))$ [10 marks]

A3

(a) (i) Explain the various tree traversal & predict a binary tree with

Preorder : ABCDEFGHI & Inorder : BCAEDGHFI. [10 marks]

(ii) Formulate an algorithm to insert an element in a binary tree. [10 marks]

(b)(i) Formulate an algorithm to search an element in a binary tree. [10 marks]

(ii) Explain binary search tree and give its time complexity. [10 marks]

A5.

Write a single C statement to accomplish each of the following:

a) Assign the sum of x and y to z and increment the value of x by 1 after the calculation.

b) Multiply the variable product by 2 using the *= operator.

c) Multiply the variable product by 2 using the = and * operators.

d) Test if the value of the variable count is greater than 10. If it is, print "Count is greater

than 10."

e) Decrement the variable x by 1, then subtract it from the variable total.

f) Add the variable x to the variable total, then decrement x by 1.

g) Calculate the remainder after q is divided by divisor and assign the result to q. Write

this statement two different ways.

h) Print the value 123.4567 with 2 digits of precision. What value is printed?

i) Print the floating-point value 3.14159 with three digits to the right of the decimal point.

What value is printed?

[10 marks]

Question Two

B1.

(Sales Commission Calculator) One large chemical company pays its salespeople on a commission basis. The salespeople receive $200 per week plus 9% of their gross sales for that week. For example, a salesperson who sells $5000 worth of chemicals in a week receives $200 plus 9% of $5000, or a total of $650. Develop a program that will input each salesperson's gross sales for last week and will calculate and display that salesperson's earnings. Process one salesperson's figures at a time. [20 marks]

B2.

Given the following binary search tree:

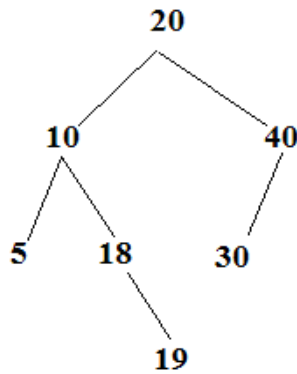Figure 1   Figure 2   Figure 3
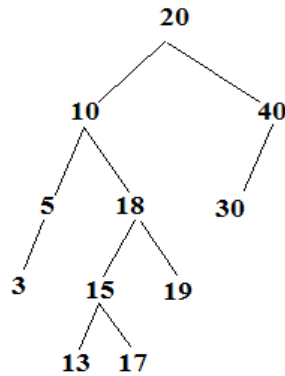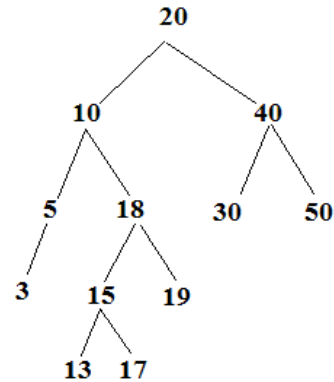
B2.1 Draw the AVL tree in **Figure 1** after <u>insert</u> the element 25   [5 marks]

B2.2 Convert **Figure 2** into AVL tree   [5 marks]

B2.3 Convert **Figure 3** into AVL tree and then draw the AVL tree after <u>Delete</u> the element 20.

[10 marks]

B3.

B3.1. Based on the given sequence, construct a Binary Heap step by step through "**insert one element at a time**."   [8 marks]

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
---	1	3	5	7	9	20	18	16	14	12	10	8	6	4	2

B3.2. Based on the given sequence, use "**BuildHeap operation**" to construct a Binary Heap step by step: [8 marks]

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
---	1	3	5	7	9	20	18	16	14	12	10	8	6	4	2

B3.3. Draw the Binary Heap in (B3.1) after **one** deleteMin operation   [2 marks]

B3.4. Draw the Binary Heap in (B3.2) after **one** deleteMin operation   [2 marks]

B4.

(a) (i) What is open addressing hashing? Describe any one technique. [10 marks]

(ii) Explain the operations on bit vector representation of sets. [10 marks]

(b) (i) Explain the smart union algorithm. [10 marks]

(ii) Discuss the use of sets in tree representation of sets in client-server environment. [10 marks]


C1.

(Salary Calculator) Develop a program that will determine the gross pay for each of several employees. The company pays "straight time" for the first 40 hours worked by each employee and pays "time-and-a-half" for all hours worked in excess of 40 hours. You're given a list of the employees of the company, the number of hours each employee worked last week and the hourly rate of each employee. Your program should input this information for each employee, and should determine and display the employee's gross pay. [20 marks]

C2.

Given a Tree looks like below, answer the following questions:

C2.1 Please Show the "Postorder" traversal output

C2.2 What's the result of "Breadth First Search (BFS)"?
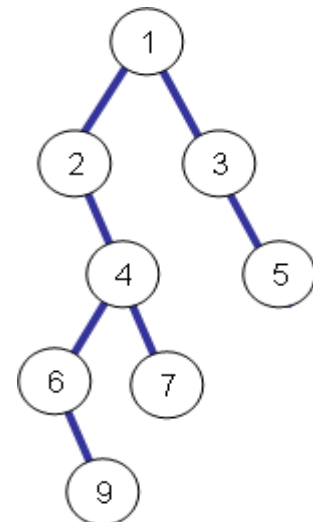
C2.3 What is the output of the following function?

```
Void PrintPreorder (root) {
    if root != null
        print(root->data);
        PrintPreorder(root->left);
        PrintPreorder(root->left);
        print(root->data);
        PrintPreorder(root->right);
    endif;
}
```
[3x5 =15 marks]

C3.

(a) (i) Write Dijkstra's algorithm for shortest path. [10 marks]

(ii) Explain topological sorting with an example. [10 marks]

(b) (i)Explain divide and conquer technique with an example. [10 marks]

(ii) Explain Asymptotic complexity classes. [10 marks]

C4

A person invests $1000.00 in a savings account yielding 5% interest. Assuming that all interest is left on deposit in the account, calculate and print the amount of money in the account at the end of each year for 10 years. Use the following formula for determining these amounts:

$a = p(1 + r)^n$

where:

p is the original amount invested (i.e., the principal)

r is the annual interest rate

n is the number of years

a is the amount on deposit at the end of the nth year.

Write a C Program to calculate the Compound Interest using the above given information

[25 marks]

END OF EXAMINATION