

**BENEDICT XVI CATHOLIC INTERNATIONAL INSTITUTE OF HIGHER EDUCATION**

**NEGOMBO, SRI LANKA**

**SCHOOL OF COMPUTING**

**Bachelor of Science Honours in Information Technology**

**Academic Year 2023/2024**

**Year 2 Semester I – End Semester Examination – February 2024**

**BSIT 21033 Data Structures and Algorithms**

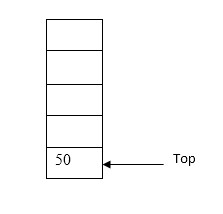
**Instructions:**

* This is a three **(03)** hour exam.
* This paper contains four questions on seven pages.
* Answer all the Questions.
* Calculators are not allowed.

# Question 1 (25 marks)

1. Consider the Stack in Figure 1 and draw the Stack frames after executing each statement given below.

int a = 8, b = 9;

Figure 1: Stack

1. theStack.push(12);
2. theStack.push(a);
3. theStack.push(a + b);
4. theStack.pop();

25

1. theStack.push(b);
2. theStack.push(a-b);
3. theStack.push(b);

# 

# (5 Marks)

1. Find the errors in the push method implemented below and correct them

public void push (int j) {

if (top == maxSize)

system.out.println(“Stack is full”);

else { stackArray[top] = j;

top++

} (3marks)

1. Assume that a stack class has already been implemented with push(), pop() and peek() methods. It is used to store characters. Write a code segment to insert the following characters to a ’myStack’ object created from the stack class.

‘A’ , ‘B’, ‘C’, ‘D’ (5 marks)

b)

1. How do you find out whether a circular queue is full? (2 Marks)
2. How do you find out whether a linear queue is full? (2 Marks)
3. Consider the remove() method implemented for a circular queue provided below. The code contains errors. Write the line numbers with errors and correct them.
   1. Public int remove
   2. {

3. if (rear == -1)

4. {

1. System.out.println(“Queue is empty”);
2. return false;
3. }

8. else

9. {

1. int temp = queueArray[front++];
2. nItems--;
3. return temp;

13. }

14.}

# Marks)

1. getSize() method a of a circular queue class returns the no of items in the no of items in the queue. Implement the getSize() method of the circular queue class. (2 marks)

# Question 2 (25 marks)

1. Consider the following LinkedLists and write a code segment that would change the LinkedList from Diagram X to Diagram. (First and P0…. Pn are references to given links)

(6 marks)

**First**

Cording

Club

BCI

you

builds

Diagram X

**First**

BCI

Cording

Club

builds

you

Diagram Y

b) Consider the following double link list and illustrate and write the steps to be followed if the link P0 is to be deleted.

first null

65

45

87

11

P0

1. Illustrate the steps and write the statements to be followed to delete the first link.

(3 marks)

1. Illustrate the steps and write the statements to be followed to insert a new link as the first link. (3 marks)

c) Consider the following binary search tree and answer the questions

45

10

30

55

80

78

* 1. If the value 72 is inserted into this tree, which node becomes its parent? (1 mark)
  2. If the value 48 is inserted into this tree, which node becomes its parent? (1 mark)
  3. List all non-leaf nodes in this tree. (1 mark)
  4. If node 25 is deleted which node should be its replacement node? (1 mark)
  5. Find the depth of this tree (1 mark)
  6. Is this a complete binary tree (1 mark)

89

75

20

* 1. If the value 72 is inserted into this tree, which node becomes its parent? (1 mark)
  2. If the value 48 is inserted into this tree, which node becomes its parent? (1 mark)
  3. List all non-leaf nodes in this tree. (1 mark)
  4. If node 25 is deleted which node should be its replacement node? (1 mark)
  5. Find the depth of this tree (1 mark)
  6. Is this a complete binary tree (1 mark)
  7. If the value 72 is inserted into this tree, which node becomes its parent? (1 mark)
  8. If the value 48 is inserted into this tree, which node becomes its parent? (1 mark)
  9. List all non-leaf nodes in this tree. (1 mark)
  10. Find the depth of this tree (1 mark)
  11. Is this a complete binary tree (1 mark)

d)

92

* 1. If the value 72 is inserted into this tree, which node becomes its parent? (1 mark)
  2. If the value 48 is inserted into this tree, which node becomes its parent? (1 mark)
  3. List all non-leaf nodes in this tree. (1 mark)
  4. If node 25 is deleted which node should be its replacement node? (1 mark)
  5. Find the depth of this tree (1 mark)
  6. Is this a complete binary tree (1 mark)

78

* 1. If the value 72 is inserted into this tree, which node becomes its parent? (1 mark)
  2. If the value 48 is inserted into this tree, which node becomes its parent? (1 mark)
  3. List all non-leaf nodes in this tree. (1 mark)
  4. If node 25 is deleted which node should be its replacement node? (1 mark)
  5. Find the depth of this tree (1 mark)
  6. Is this a complete binary tree (1 mark)

26

38

72

60

* 1. If the value 72 is inserted into this tree, which node becomes its parent? (1 mark)
  2. If the value 48 is inserted into this tree, which node becomes its parent? (1 mark)
  3. List all non-leaf nodes in this tree. (1 mark)
  4. If node 25 is deleted which node should be its replacement node? (1 mark)
  5. Find the depth of this tree (1 mark)
  6. Is this a complete binary tree (1 mark)

90

55

41

* 1. If the value 72 is inserted into this tree, which node becomes its parent? (1 mark)
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  3. List all non-leaf nodes in this tree. (1 mark)
  4. If node 25 is deleted which node should be its replacement node? (1 mark)
  5. Find the depth of this tree (1 mark)
  6. Is this a complete binary tree (1 mark)

43

* 1. If the value 72 is inserted into this tree, which node becomes its parent? (1 mark)
  2. If the value 48 is inserted into this tree, which node becomes its parent? (1 mark)
  3. List all non-leaf nodes in this tree. (1 mark)
  4. If node 25 is deleted which node should be its replacement node? (1 mark)
  5. Find the depth of this tree (1 mark)
  6. Is this a complete binary tree (1 mark)

74

* 1. If the value 72 is inserted into this tree, which node becomes its parent? (1 mark)
  2. If the value 48 is inserted into this tree, which node becomes its parent? (1 mark)
  3. List all non-leaf nodes in this tree. (1 mark)
  4. If node 25 is deleted which node should be its replacement node? (1 mark)
  5. Find the depth of this tree (1 mark)
  6. Is this a complete binary tree (1 mark)

1. If I need to delete node 38, how do I do that? Describe the process. (5 marks)
2. Implement a method called **descOrder()** to display the values in the tree in descending order s (3 marks)

# Question 3 (25 marks)

1. Following is the **Naïve-String-Matcher** algorithm, which finds the occurrence(s) of a pattern string within another string or body of text.

***Naïve-String-Matcher*** (T, P)

* 1. n = T.length
  2. m = P.length
  3. for s = 0 to n-m

4. if P[1..m] = T[s+1..s+m]

5. then print "Pattern occurs with shift" s

Given the text and pattern as follows;

Text ***T*** Pattern ***P***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| a | b | b | a | c | d | a | a | b |

|  |  |  |
| --- | --- | --- |
| a | a | a |

1. How many comparisons would occur in this algorithm? (3 marks)
2. How many valid and invalid shifts would occur in this algorithm? (2 marks)
3. Discuss the **Best case** of the **Naïve-String-Matcher algorithm** and state the time complexity. (2 marks)
4. Discuss the **Worst case** of the **Naïve-String-Matcher algorithm** and state the time complexity. (2 mark)

b)

1. If the modulo value is *q* = 100, how many spurious hits and valid hits do the **Rabin**

**-Karp matcher** encounter in the text T = 203410052006 when looking for pattern *P* = 100? (4 marks)

1. How do you reduce the number of spurious hits for the scenario in b (i)? (2 marks)
2. What should the situation be if the worst-case scenario occurs in the Rabin-Karp algorithm? (2 marks)

c)

1. Draw the state transition diagram for a string-matching automation for the pattern

P = ***aba*** and take the input alphabet as {*a,b,c*} (7 marks)

1. What does the “Optimal Solution” mean in the Greedy method? (1 mark)

# Question 4 (25 marks)

1. The following quicksort algorithm has errors. State the line numbers with errors and rewrite the correct algorithm. (PARTITION algorithm is given below)

(5 marks)

**QUICKSORT** (Arr, low, high) **if** high < low

p = **PARTITION**(Arr, low, high)

**QUICKSORT** (Arr, low, p)

**QUICKSORT** (Arr, p, high)

**PARTITION(*A*, *p*, *r*)**

1 *x* = *A*[*r*]

2 *i* = *p* - 1

1. **for** *j* = *p* **to** *r* - 1
2. **if** *A*[*j*] ≤ *x*

5 *i* = *i* + 1

1. exchange *A*[*i*] with *A*[*j*]
2. exchange *A*[*i* + 1] with *A*[*r*]
3. **return** *i* + 1
4. Describe the worst case of the of the quick sort algorithm using a diagram (2 marks)
5. Describe the operation of PARTITION on the 8-element array given below. (8 marks)

3

5

6

4

7

1

2

8

1. Using RAM model analysis, find out the number of steps needed to run the below-mentioned code segment.

for (i=1 to n)

for (j=0 to 10)

a = a+5

print a

(4 marks)

1. The pseudocode for the insertion sort algorithm is given below. Describe the states of sorting the array given below using the insertion sort.

**INSERTION-SORT(A)**

**1 for** j **=** 2 **to A.**length

**2** key**=** A[j]

**3 //** Insert A[j] into the sorted sequence A[1..j-1]

**4** i **=** j - 1

**5** **While**i **>** 0 **and** A[i] **>** key

**6** A[i+1] **=** A[i]

**7** i **=** i-1

**8** A[i+1]  **=** key

1

3

4

6

5

2

(6 marks)

# ~ End of the Paper ~