University of Ruhuna- Faculty of Technology
Bachelor of Information and Communication Technology Honours Degree

Level 2 (Semester I) Examination, July 2023
Academic year 2021/2022

Course Unit: ICT2113- Data Structures and Algorithms(Written)   **Duration: 2 hours.**

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Answer all **four(04)** questions.

Question 01

    a) Define what is a data structure with **two(02)** examples.

    b) Briefly describe **three (03)** characteristics of data structures.

    c) Sort the following numbers using the Selection sort. Write all intermediate steps clearly.
       20, 8, 5, 10, 7

    d) State **three (03)** differences between Bubble sort and Insertion sort algorithms.

    e) Write time complexity of the following code segments in Big O notation.

       I.   void printPairs(int arr[], int size)

```
{
    for (int i = 0; i < size; i++)
    {
        for (int j = 0; j < size; j++)
        {
            printf("%d = %d\n", arr[i], arr[j]);
        }
    }
}
```

       II.   for (int i = 0; i < n; i++)

```
for (int j = i+1; j > i; j--)
    for (int k = n; k > j; k--)
        printf("*");
```

f) Consider the following incomplete C code segment written to sort a set of integers using Insertion sort algorithm. Complete the code.

```c
void main()
{
int arr[20],i,n,j,k;

printf("\nEnter the number of elements in the array: "); scanf("%d",&n);
printf("\nEnter the elements of the array"); for(i < No of times to repeat) // Line A
{
printf("\n arr[%d] = ",i);
scanf("%d",&arr[i]);
}

int temp;

for(k < No of times to repeat) // Line B
{
............// Line C
...........// Line D
}

while((temp < arr[j]) && (j>=0))
{

............... // Line E
...............// Line F
}
arr[j+1]=temp;
}

printf("\nThe sorted array is: \n");

for(i=0;i<n;i++)
printf("%d\t",arr[i]);
}
```

Question 2

a) Write the content of the stack after applying the following operations. Write all intermediate steps. Assume that the stack is empty initially.

push (5), push(3), pop(), push(2), push(8), pop(), pop(), push(9), push(1), pop(), push(7), push (6), pop(), pop(), push(4), pop(), pop()

b) Evaluate the following expression using a stack. State the content of the stack at each intermediate step.

3, 5, 6, +, *, 2, 3, 9, /, +, *

c) Briefly describe the usage of stack for the following applications.
   I.   To reverse a word.
   II.   Web browsers.

d) Consider following linear queue. Draw **separate frames** and **output** when each of the following operations are applied one after the other. (Assume that the queue is empty initially)

| 7 | | |

↑ ↗
Front Rear
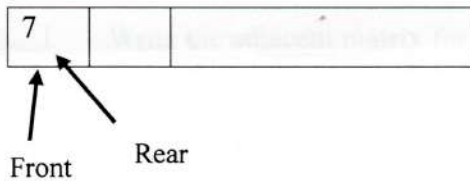
enqueue(5) -> enqueue(9) -> dequeue() -> enqueue(7) -> dequeue() -> front() -> dequeue()

->dequeue()-> isEmpty() -> enqueue(9) ->enqueue(6) -> size() -> enqueue(3)

->enqueue(5) -> dequeue()

Your answer should be as follows:

Operation	Output	Frame		
enqueue(3)	-	7		

e) What is a circular queue? Explain with an example.

Question 03

a)

    I.   Explain the importance of using pointers in linked lists.

    II.   Write *two(02)* advantages of using linked lists over arrays.

    III. Suppose the following function insertAfter() is written to insert a new node after a given node of a linked list. Complete the blank lines from Line A to Line D with suitable c statements.

```
void insertAfter(struct Node* prev_node, int new_data)
{
    if (............................) //Line A
    {
        printf("the given previous node cannot be NULL");
        return;
    }
    struct Node* new_node =.........................................; //Line B
    new_node->data = ...........................; //Line C
    .................................................; //Line D
    prev_node->next = new_node;
}
```

b) Insert the following data into an initially empty binary search tree in the order they are given.

51, 76, 60, 23, 94, 12, 38

    I.   Insert 100 to the above tree and draw the resultant tree.

    II.   Traverse the tree in b (I) in the following orders and write the output obtained.

        i.   Post Order

        ii. Pre Order

    III. What is the height of node 23?

    IV. How many internal nodes are there in the above tree?

    V.   Represent the following expressions in binary trees.

        i. $(a+b)*(c*(d+e))$

        ii. $A * B - (C + D) * (P / Q)$

Question 04

a) Briefly describe what is a Spanning tree and *two(02)* applications of a spanning tree.

b) Consider the weighted graph given below,
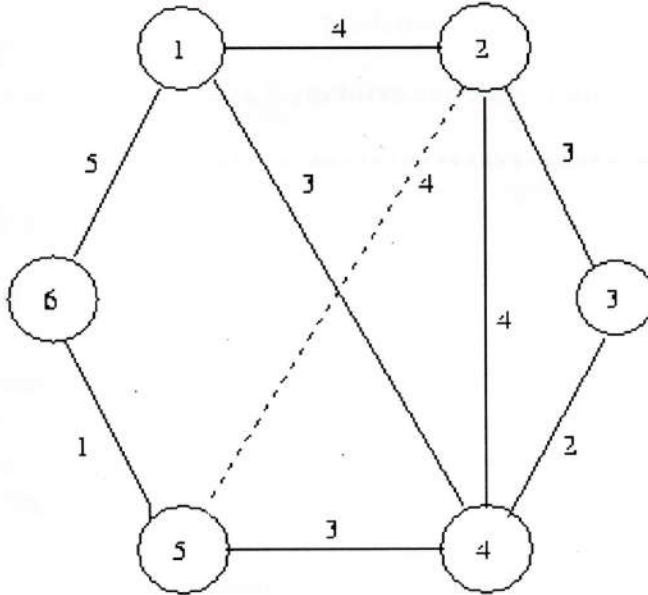
    I.   Write the adjacent matrix for the above weighted graph.

    II.   Write the adjacency list for the above graph without considering their weights.

c) State *three(03)* differences between Breadth first search and Depth first Search.

d) Consider the following max heap. Draw the resulting heap after deleting node 10 from the heap.
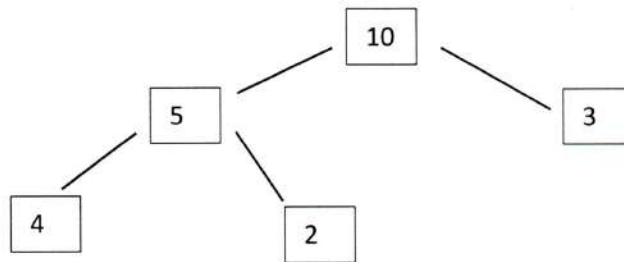
e) A hash function is a mathematical function that converts a numerical input value into another compressed numerical value. List down *two(02)* advantages and disadvantages of hashing.

-----------------------------End of the paper----------------------------------