00361

THE OPEN UNIVERSITY OF SRI LANKA
DEPARTMENT OF COMPUTER SCIENCE
B.Sc. DEGREE PROGRAMME : LEVEL 03
CPU1142/CSU3302- DATA STRUCTURES & ALGORITHMS
FINAL EXAMINATION – 2017/2018

**DURATION: Two Hours (2 Hours)**

**Date: 04.04.2019** **Time: 1.30p.m. – 3.30 p.m.**

## Answer FOUR (4) Questions ONLY.

## QUESTION 01

1) What are the two types of traversal methods that can be used with graphs? Explain each type with an example.

2) Write codes in C programming language to do the following.
   a. To create a data structure to implement a **list**. The structure should contain a variable to store the **next** position of the **list** and a variable to hold node **info** of type **int** in the **list**. Declare a list with the name "**nodeList**".
   b. Write a function in C to **create** a new node. Use **nodeList newNode()** as the function header.
   c. Write a function in C to **insert** a node at the beginning of "**nodeList**". Use **nodeList headInsert(nodeList *head, int data)** as the function header. (**head** is the pointer to the starting node and "**data**" is an "int" that needs to be inserted to the list).

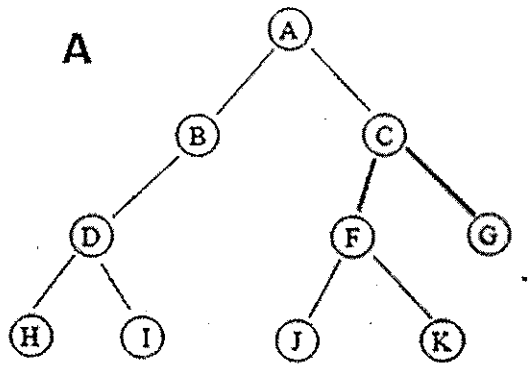
3) Briefly explain ***O*** (Big Oh) notation, **Θ** (Big Theta) notation and **Ω** (Big Omega) notations.

4) Using **Big O** notation, determine the running time of the following **C** program section. State any assumptions you make.

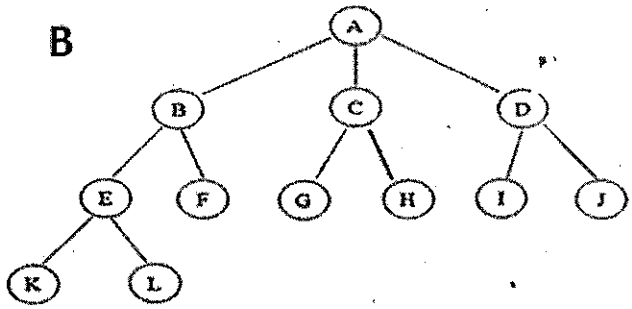
```
for(i=0;i<n;i++) printf("%d\n",i);
for(j=0;j<n;j++) printf("%d\n",j);
```

5) Define a "**strictly binary tree.**" Are the following trees strictly binary trees? Give reasons.

A

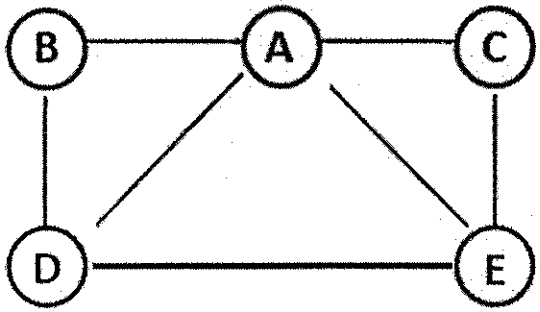



B




## QUESTION 02

1) Show the **adjacency matrix** representation of the following graph.




2)

a) Construct a binary search tree for the following set of integers.

50, 30, 40, 70, 90, 60, 20, 10, 35, 65, 95, 15, 38, 63, 92

b) What will be the output when you traverse the above binary tree, which you constructed in part (a) above in the following orders?

i. Pre-order
ii. In-order
iii. Post-order

c) Is the binary search tree you constructed in part (a) above a complete binary tree?

d) State the nodes with a single child of the binary search tree which you constructed in part (a) above.

3) Briefly describe the following methods of **designing algorithms**.

   a) Divide and conquer method
   b) Greedy method
   c) Reduction method

4) What is **external** sorting and state the **two** types of external sorting algorithms.

## QUESTION 03

1) Write a function in C programming language to implement the **Bubble Sort**. Use **void BubbleSort (int numbers[], int array_size)** where the array named "**numbers[]**" has the elements to be sorted and "**array_size**" gives the number of elements.

2) What is the running time of the bubble sort (use **Big O** notation)?

3) What will be the output of the following function, if we pass "**6**" as the value for **n**?

```
int fib(int n)
{
if (n == 0)
return 0;
else if (n == 1)
return 1;
else
return fib(n-1) + fib(n-2);
}
```

4) Write codes in C programming language to do the following.

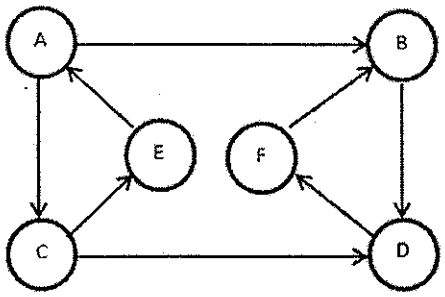
   a) To create a data structure of a **stack** by using **pointer implementation**.
   b) To **push** an element to the **stack**.

## QUESTION 04

1) Represent the following expression by using a binary tree.

((A*B)+(C/D))$((E/F)+(G*H))

2) Show the **multi-list representation** of the following graph.




3) Using the graph in part (**2**) above, show the order of vertices visited in the "**Depth first**" and "**Breath first**" traversals. Select "**A**" as the starting node.

4) Graphically show the steps of sorting the following data set by using the **Selection sort**.

| 40 | 70 | 50 | 30 | 20 | 100 | 90 | 60 |
|---|---|---|---|---|---|---|---|

## QUESTION 05

1) What is **Linear Programming?** Give one example.

2) Write codes in C programming language to do the following.

   a) To create a data structure of a **doubly linked list** by using **pointer implementation**.
   b) To **insert** an element at the beginning of the **doubly linked list**.

3) Consider the following expression in **Infix** form and convert it into **Postfix** form. Clearly show the **7 steps** required for the conversion.

A/B$C*(D+E)/F-G$H

4) Following is a function in C programming language for some operation.

```
int function ()
{
int x;
if(q.front == q.rear)
{
printf("queue underflow \n");
exit(1);
}
q.front = (q.front + 1)% MAXSIZE;
x = q.items[q.front];
return x;
}
```

By analyzing the above function, answer the following questions.

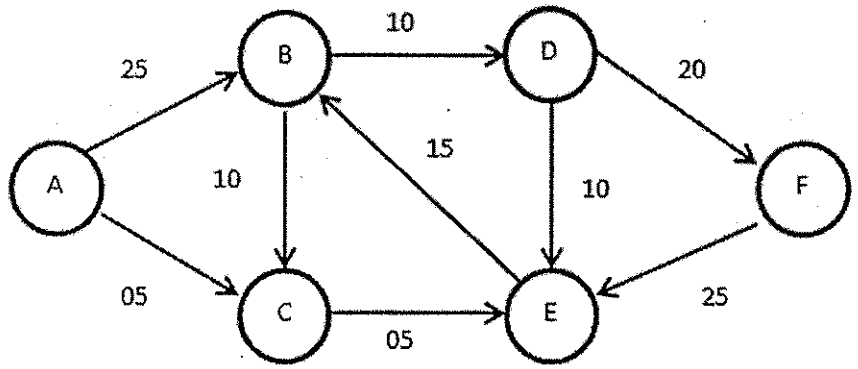
a) What is the data structure that this function belongs to?
b) What type of implementation method is used to create the data structure that you mentioned in section (a)?
c) Which type of operation can be performed using the above function?

## QUESTION 06

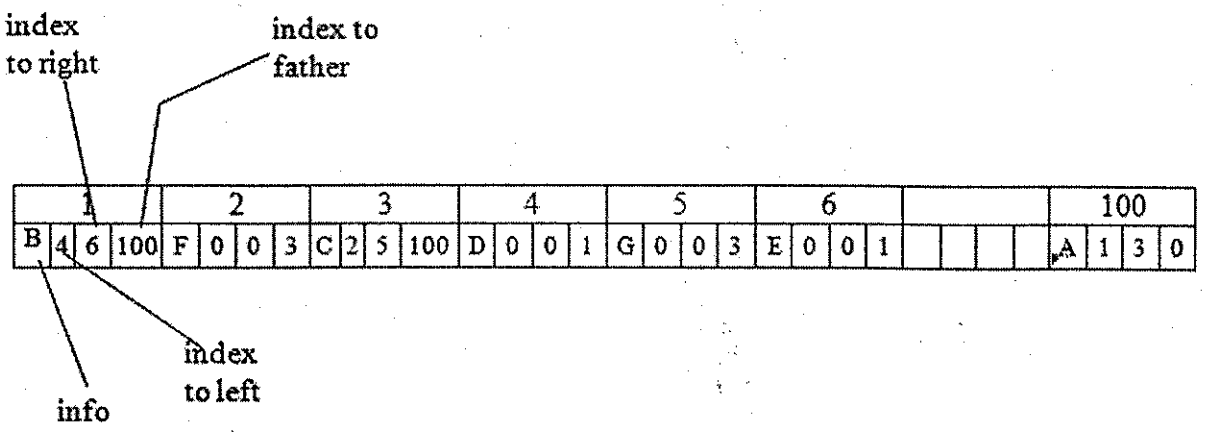
1) Using **Big O** notation, determine the running time of the following **C** program section. State any assumptions you make.

```
for(i=1;i<n;i++)
  for(j=i;j<n;j++) printf("(%d,%d)\n",i,j);
```

2) Show the **adjacency matrix** representation of the following graph.



3) Array representation of a binary tree is as follows.




| | 1 | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | | | | | 100 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | 4 | 6 | 100 | F | 0 | 0 | 3 | C | 2 | 5 | 100 | D | 0 | 0 | 1 | G | 0 | 0 | 3 | E | 0 | 0 | 1 | | | | | A | 1 | 3 | 0 |

a) Draw the relevant binary tree according to the above array representation.
b) Mention the degree of each node of the binary tree which you constructed in part (a) above?

4) Consider the running times **O(f(n))** and **O(g(n))** where

$$f(n) = n^8 \text{ if } n \text{ is even}$$
$$n^4 \text{ if } n \text{ is odd}$$

$$g(n) = n^2 \text{ if } n \text{ is even}$$
$$n^6 \text{ if } n \text{ is odd}$$

Consider that **f(n)** and **g(n)** are placed sequentially.

a) Calculate the time complexities for both cases: **odd n** and **even n** separately for both f(n) and g(n).
b) What is the name of the **rule** that is required to calculate the time complexity?