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University of Swaziland
Department Of Computer Science
Main Examination May 2016

Title of paper : **Data Structures**

Course number : **CS342**

Time Allowed : **Three (3) hours**

Instructions:

- **Each question carries 25 marks.**
- **Answer any four (4) questions.**

This paper may not be opened until permission has been granted by the invigilator.

QUESTION 1

a) Explain the meaning of the following terms. **[10]**

i) Data structure
ii) Abstract data type (ADT)
iii) Running time of an Algorithm
iv) AVL tree
v) Hashing

b) For each of the following six program fragments, give an analysis of the running time (Big-Oh will do). **[15]**

i)
```
sum = 0;
for( i = 0; i < n; ++i )
        ++sum;
```

ii)
```
sum = 0;
for( i = 0; i < n; ++i )
        for( j = 0; j < n; ++j )
                ++sum;
```

iii)
```
sum = 0;
for( i = 0; i < n; ++i )
        for( j = 0; j < n * n; ++j )
                ++sum;
```

iv)
```
sum = 0;
for( i = 0; i < n; ++i )
        for( j = 0; j < i; ++j )
                ++sum;
```

v)
```
sum = 0;
for( i = 0; i < n; ++i )
        for( j = 0; j < i * i; ++j )
                for( k = 0; k < j; ++k )
                        ++sum;
```

vi)
```
sum = 0;
for( i = 1; i < n; ++i )
        for( j = 1; j < i * i; ++j )
                if( j % i == 0 )
                        for( k = 0; k < j; ++k )
                                ++sum;
```

QUESTION 2

a) What is stack? Describe the operations of stack data structure. [5]

b) Write a function to reverse a singly linked list in O(N) time using constant extra space. [5]

c) Write the pseudo-code for an algorithm that uses a stack to evaluate post-fix expressions of the following form: [7]

6 5 2 3 + 8 * + 3 + *

Trace the execution of the algorithm on this example.

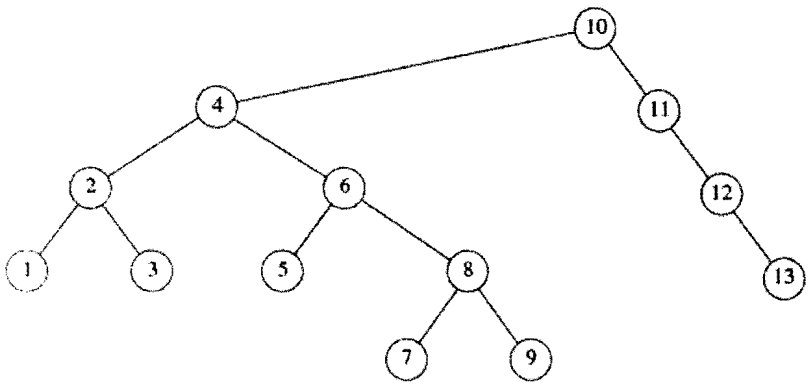
d) Define a queue? List and describe the operations of a queue data structure. [5]

e) What is Circular Linked List? What are Advantages and Disadvantages of Circular Linked List [3]

QUESTION 3

a) For the below tree: [5]

i) Which node is the root?
ii) List the children.
iii) List the siblings.
iv) Compute the depth.
v) Compute the height.



b) Using C++ notation, define the structure of a binary tree. [7]

c) Show the result of inserting 3,1,4,6,9,2,5,7 into an initially empty binary search tree. [6]

d) What is 2-3 tree? Write the algorithm for inserting into a 2-3 tree. [7]

QUESTION 4

a) What is Priority queue (Heap)? Write the procedure to insert into a binary heap. [5]

b) Show the result of inserting 10, 12, 1, 14, 6, 5, 8, 15, 3, 9, 7, 4, 11, 13 and 2 one at a time into an initially empty binary heap. [10]

c) Show the result of using the linear-time algorithm to build a binary heap using the same input as in (b). [8]

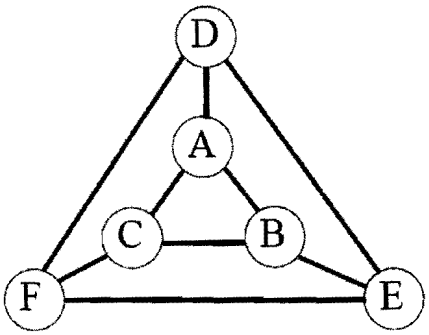
d) What is d-heap? Draw a d-heap where d=3. [2]

QUESTION 5

a) Define the terms (i) Adjacency Matrix of a Graph (ii) Minimum Spanning Tree. [4]

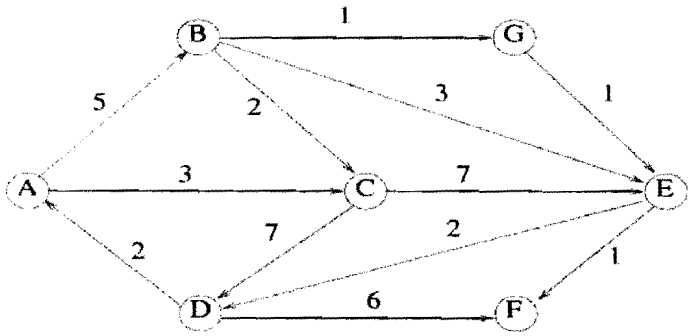
b) Write the pseudo-code for Breadth First Search (BFS) and Depth First Search (DFS) [8]

c) Consider the following undirected Graph: [6]



Draw a BFS tree and DFS tree for the Graph starting at the node A.

d) Find the shortest weighted path from A to all other Vertices for the following Graph. [7]



End of Question Paper