PENINSULA COLLEGE
GEORGETOWN

FINAL EXAMINATION

Programme Name	:	**DIPLOMA IN COMPUTER SCIENCE**
Course Code & Name	:	**DCS1353 DATA STRUCTURES AND ALGORITHMS**
Duration	:	**3 HOURS**

INSTRUCTIONS TO CANDIDATES:

1. Please read the instructions given in the question paper **CAREFULLY.**
2. The question paper consists of **FOUR (4)** questions.
3. Answer **ALL** questions in the question paper.
4. Answers to the questions are to be written into the examination booklet.
5. Electronic dictionaries, lecture notes, files or any unauthorised materials except writing equipment are strictly prohibited.

This question paper must be submitted along with all used and/or unused rough papers and/ or graph papers (if any). Candidates are **NOT ALLOWED** to take any examination paper(s) used or unused out of the examination hall.

WARNING:

The Examination Board of Peninsula College Georgetown regards cheating as a very serious offence and will not hesitate to mete out the appropriate punitive actions according to the severity of the offence committed, and in the accordance with the clauses stipulated in the Students' Handbook, up to and including expulsion from Peninsula College Georgetown.

(*This booklet contains 5 printed pages including this page*)

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE ALLOWED TO DO SO

1. a) Describe the following worst-case running time of the following code in "big-Oh" notation in terms of the variable `n`. You should give the tightest bound possible.

i) (2 marks)

```
int f5(int n) {
  if (n > 1)
   return 3*f5(n/2) + 1
   return 0;
      }
```

ii) (2 marks)

```
int f4(int n) {
  if (n > 1)
  return 1 + 2*f4(n-1);
  return 0;
     }
```

iii) (2 marks)

```
int f7(int n) {
   s = 1;
     for (i=0; i<n; i++)
   s = s + f7(i);
   return s;
     }
```

iv) (2 marks)

```
int f3(int n {
   s = 0;
   for (int i = 0; i < n; ++i) {
     for (int j = 0; j < i*i; ++j) {
        s = s + j;
         }
       }
       return s;
 }
```

The Josephus Problem is a famous mathematical puzzle that goes back to ancient times. There are many stories to go with the puzzle. One is that Josephus was one of a group of Jews who were about to be captured by the Romans. Rather than be enslaved, they chose to commit suicide. They arranged themselves in a circle and, starting at a certain person, started counting off around the circle. Every nth person had to leave the circle and commit suicide. Josephus decided he didn't want to die, so he arranged the rules so he would be the last person left. If there were (say) 10 people, what number should he tell them to use for counting off? The problem is made much more complicated because the circle shrinks as the counting continues.

b) i) Explain **FIVE (5)** steps to solve Josephus' problem, where the count off (`k`) is by four, the total number of people (`n`) is 10 starts from 1 and continues clockwise. *(Note: Show your work)* (15 marks)

ii) Determine the last survivor (Josephus) position. (2 marks)

Total: [25 Marks]

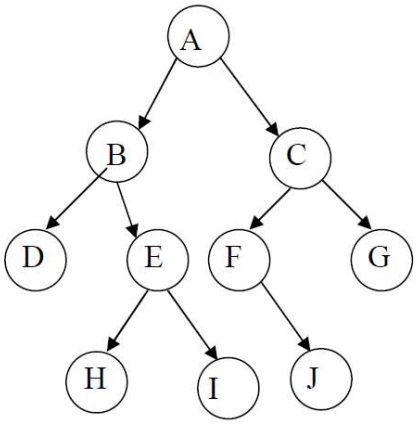

Figure 1

2. a) Determine the pre-order, in-order, and post-order traversal based on Figure 1 tree. (6 marks)

b) Copy Figure 1 and apply appropriate labels to identify each of the following key terms in relation to the tree. (Note: Show only **ONE (1)** label for each term)

i) Root (2 marks)

ii) Parent Node (2 marks)

iii) Child Node (2 marks)

iv) Siblings (2 marks)

v) Leaf Node (2 marks)

vi) Subtree (2 marks)

vii) Levels (2 marks)

c) Draw the following types of Binary Trees.

i) Full Binary Tree (2.5 marks)

ii) Complete Binary Tree (2.5 marks)

Total: [25 marks]

3.

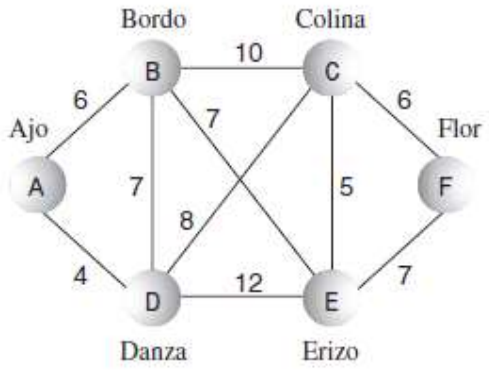

Figure 2: Weighted Graph

Suppose we want to install a cable television line that connects six towns in the mythical country of Magnaguena. Five links will connect the six cities, but which five links should they be? The cost of connecting each pair of cities varies, so we must pick the route carefully to minimize the overall cost. Figure 2 shows a weighted graph with six vertices, representing the towns Ajo, Bordo, Colina, Danza, Erizo, and Flor. Each edge has a weight, shown by a number alongside the edge. Imagine that these numbers represent the cost, in millions of Magnaguenian dollars, of installing a cable link between two cities. (Notice that some links are impractical because of distance or terrain.

a) Determine which **ONE (1)** algorithm or approach for finding the minimum-cost spanning tree based on Figure 2. (3 marks)

b) Analyze the graph in Figure 2 to Illustrate the optimal routes that connect the town while minimizing the overall cost. *(Note: Draw your answer).* (8 marks)

c) Name **THREE (3)** other algorithms that you know based on the Greedy methods. (6 marks)

d) Illustrate the following Graph.

i) A cyclic Graph (2 marks)

ii) Regular Graph (2 marks)

iii) Complete Graph (2 marks)

iv) Undirected Graph (2 marks)

Total: [25 marks]

4. a) Explain the following algorithms.

   i) Binary Search Algorithm (4 marks)

   ii) Breadth First Search (BFS) Algorithm (4 marks)

   iii) Depth First Search (DFS) Algorithm (4 marks)

In high school and college, students find (sometimes to their dismay) that they can't take just any course they want. Some courses have prerequisites for other courses that must be taken first. Indeed, taking certain courses may be a prerequisite to obtaining a degree in a certain field. To obtain your degree, you must complete the Senior Seminar and (because of pressure from the English Department) Comparative Literature. But you can't take Senior Seminar without having already taken Advanced Algebra and Analytic Geometry, and you can't take Comparative Literature without taking English Composition. Also, you need Geometry for Analytic Geometry, and Algebra for both Advanced Algebra and Analytic Geometry.

b) Determine **ONE (1)** type of graph that is suitable to represents the flow based on the scenario above. (2 marks)

c) Based on the scenario above, illustrate using the graph answered in 4(b) the sequence of pre-requisite courses necessary to obtain degree. (8 marks)

d) State **TWO (2)** examples of graph in real- life application. (3 marks)

Total: [25 marks]

- END OF QUESTIONS -