COMP 3270 Assignment 4 (100 points)

**Due by 11:59PM on Friday, July 29th, 2022**

Instructions:

1. Late submissions **will not** be accepted unless prior permission has been granted or there is a valid and verifiable excuse.
2. Think carefully; formulate your answers, and then write them out concisely using English, logic, mathematics and pseudocode (no programming language syntax).
3. Type your final answers in this Word document.
4. Don’t turn in handwritten answers with scribbling, cross-outs, erasures, etc. If an answer is unreadable, it will earn zero points. **Neatly and cleanly handwritten submissions are acceptable**.

**1. (15 points)** Show d and π values that result from running Breadth First Search on the directed graph below using vertex 3 as the start node.

d=infinity

d=3

π =nil

π =4

d=0

π =nil

d=1

π =3

π =5

π =3

d=2

d=1

**2. (10 points)** Show how Depth First Search works on the graph below by marking on the graph the discovery and finishing times (d and f) for each vertex and the classification of each edge. Assume that the for loops in DFS and DFS-VISIT consider vertices alphabetically.

d = 17, f = 20

d = 1, f = 15

d = 2, f = 6

d = 8, f =16

d = 18, f = 19

d = 13, f = 14

d = 9, f = 12

d = 3, f = 7

d = 4, f = 5

d = 10, f = 11

**3. (15 points)** List the vertices of the graph below in Topological Order, as produced by the Topological Sort algorithm. Assume that the for loops in DFS and DFS-VISIT consider vertices alphabetically.

**m(1/20), n(21/26), o(22/25), p(27/28), q(2/5), r(6/19), s(23/24), t(3/4), u(7/8), v(10/17), w(11/14), x(15/16), y(9/18), z(12,13)**

**Topological order: p n o s m r y v w z x u q t**

**4. (15 points)** Do Problem 24.1-1 (p. 654) (you do not have to do the last part, i.e., running the algorithm again after changing an edge weight).

A picture containing text, whiteboard

Description automatically generated

**5. (15 points)** Do Problem 24.2-1 (p. 657 of the recommended text). Show the results similar to Fig. 24.5.

Diagram

Description automatically generated

**6. (20 points)** Do Problem 24.3-1 (p. 662 of the recommended text).

A picture containing text, whiteboard

Description automatically generated

**(7) (10 points)** Supposethat a graph G has a Minimum Spanning Tree (MST) computed. How quickly can we update the MST if we add a new vertex and incident edges to G. Propose and outline a strategy and present an algorithm (you can reuse graph algorithms covered in class as building blocks as part of your solution) and evaluate its asymptotic complexity.

**By adding a new vertex and incident edges to G, the complexity would be O(E’), where E’ is the new set of edges that connect to the MST. An MST works by choosing the minimum weight edge, and if it doesn’t make a cycle, it is added to the tree. To see if and edge creates a cycle or not, we must see if adding the edge replaces two trees with a new tree, which is the union of two old trees. We must also see if the edge (x, y) creates a cycle if x and y are in the same tree. It takes O(E) to build the heap and O(ElogE) to detect the cycle, therefore, the asymptotic complexity is of O(ElogE).**