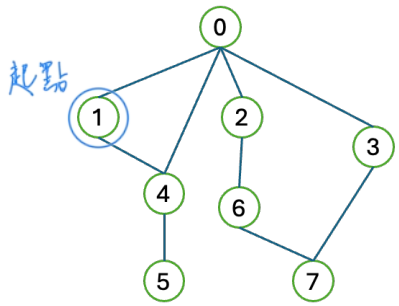
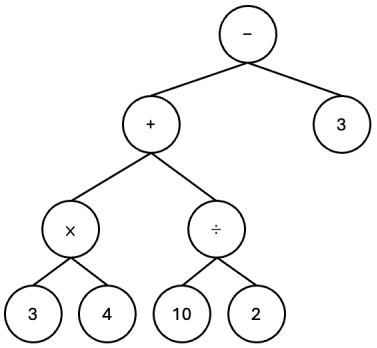
Course: Data Structures (CSE CS203A, 114-1)
Take-Home Quiz IV: Tree/Heap/Graph

Due: December 16, 2025, 17:00 (Room R1102)

Important Notice: You must print this take-home quiz sand **write your answers by hand with a pen**.

Student ID: Student Name:

Q1 Figure	Q2 Figure
	

Q1. (30 pts) Explain Breadth-First Search (BFS) on the graph and provide the BFS traversal order for the graph shown in Q1 Figure.

A1: Breadth-First Search (BFS)，類似於樹的 Level-order traversal，從指定節點開始，先訪問所有與其有直接相鄰的鄰居（距離為1），然後再訪問鄰居的鄰居（距離為2），以此類推，向外擴散。

※ 此演算法使用 Queue 來記錄待訪問的節點，保證 FIFO（先進先出）的順序，確保按層級訪問。

※ 由於 Graph 可能有 Cycles，與 Tree 不同，BFS 必須維護一個 visited [] 陣列來標記已訪問過的節點，以免無窮迴圈。

visit	1	0	4	2	3	5	6	7
Queue	[0,4]	[4,2,3]	[2,3,5]	[3,5,6]	[5,6,7]	[6,7]	[7]	[ ]
Result	1	1,0	1,0,4	1,0,4,2	1,0,4,2,3	1,0,4,2,3,5	1,0,4,2,3,5,6	1,0,4,2,3,5,6,7

∴ Q1 Figure BFS traversal order: 1 → 0 → 4 → 2 → 3 → 5 → 6 → 7 ※

Q2. (30 pts) In tree traversal, one common method is inorder traversal. Please use inorder traversal to print the arithmetic expression represented by the expression tree in Q2 Figure, and then evaluate it to compute the final result.

A2: Inorder Traversal (中序走訪)：Left (左子樹) → Root (根節點) → Right (右子樹)

Root: -
- Left
  - Left: 3×4
  - Root: +
  - Right: 10÷2
- Right: 3

⇒ ((3×4)+(10÷2))-3 = (12+5)-3 = 14 ※

Q3. (40 pts) A binary tree is a fascinating data structure with many variations, including binary search trees, AVL trees, red-black trees, complete binary trees, and max/min heaps. These variations can be classified as shape-based (structural constraints) or criteria-based (rules such as ordering). Choose one shape-based tree and one criteria-based tree, and provide a brief description of each.

A3:

I. Shape-based Tree (基於形狀): Complete Binary Tree (完全二元樹)
除了最後一層可能例外，其他每一層都可能被填滿，且最後一層所有節點都必須盡可能靠左排列。
這種結構適合用 Array 來儲存，因為不會有記憶空洞。

II. Criteria-based Tree (基於規則): Binary Search Tree (BST, 二元搜尋樹)
BST 具有特定的排序規則，對於樹中的每一個節點其左子樹所有值都小於該節點，右子樹的所有
值都大於該節點，這使得搜尋資料的時間複雜度在平衡狀態下可達 O(log n)。