Problem 5 (50 marks)

Answer the following questions in one or two sentences:

a. How can we construct a tree where all nodes (i.e., subtrees) have the same degree?

5a)

By intruding a special abstraction called empty tree, which is a sentinel (we use NIL).

// 4

b. What is the difference between l-value and r-value references?

5b)

l-value references avoid copies (and are used when copying is required) // 4

r-value references allow for move semantics // 2

c. What is a key concept of an abstract data types?

5c)

Representation transparency, that is, different implementations can satisfy the same interface. // 4

d. How do we define mutual dependent classes in C++?

5d)

Forward declaration to break cycles. //2

Add headers of all mutual dependent classes to implementation. // 2

e. What must a value-based data type define in C++?

5e)

Proper copy semantics // 2

f. What is an object adapter?

5f)

Object adapter is a design pattern, it defines a wrapper that encapsulates a delegate object to map client operations to operations provided by the delegate object (the adaptee) // 6

g. What is the difference between copy constructor and assignment operator and how do we guarantee safe operation?

5g)

Copy constructor initializes object // 2

Assignment operator overrides object, // 2

Must free memory and protect object against accidental suicide // 4

h. What is the best-case, average-case, and worse-case for a lookup in a binary tree?

5h)

O(1), O(log n), O(n) // 6

i. What are reference data members and how do we initialize them?

5i)

Aliases to existing objects, use member initializer // 2

j. You are given n-1 numbers out of n numbers. How do we find the missing number n_k, $1 \leq k \leq n$, in linear time?

5j)

A simple for loop builds sum(n-1 numbers) = v, which is (n), sum(n) = n(n+1)/2, which is O(1)

nk = sum(n) - v, which is O(1) // 8