

Master of Computer Applications

MCAC 103: Data Structures
Unique Paper Code: 223421103

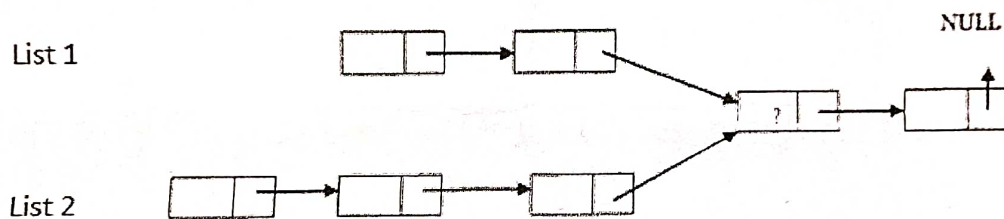
Semester-I
January-2024
Year of admission: 2023

Time: Three Hours

Maximum marks: 70

Note: Answer all the questions. Your code/ algorithm/ pseudocode MUST be well documented and interfaces must be clearly defined.

1. (a) The keys 33, 10, 9, 13, 12, and 45 are inserted into an initially empty hash table of length 12. The hash table utilizes open addressing with quadratic probing, and the hash function employed is $H(k) = k \bmod 12$, where k is the key value. What is the resultant hash table? [6]
- (b) Suppose there are two singly linked lists both of which intersect at some point and become a single linked list. The head or start pointers of both lists are known, but the intersecting node and lengths of lists are not known. Write a C++ function that returns the data available at the intersecting node. Additionally, specify the worst-case time complexity of your algorithm. For example, consider the diagram provided below. *List 1* could comprise n nodes before reaching intersection points, while *List 2* might consist of m nodes before reaching these intersections. Your function must print data marked with '?'. [8]



2. (a) The preorder traversal of a binary search tree is 15, 10, 12, 11, 20, 18, 16, 19. Which one of the following is the postorder traversal of the tree? [6]
 - (i) 20, 19, 18, 16, 15, 12, 11, 10
 - (ii) 10, 11, 12, 15, 16, 18, 19, 20
 - (iii) 19, 16, 18, 20, 11, 12, 10, 15
 - (iv) 11, 12, 10, 16, 19, 18, 20, 15
- (b) Write a C++ function that takes a queue of integers and an integer k , and reverses the first k elements of the queue. The remaining elements in the queue should remain in the same order. You may assume the availability of a class Stack (a stack implementation). [8]
3. (a) Show the red-black trees that result after successively inserting the keys 41, 38, 31, 12, 19, 8 into an initially empty red-black tree. [6]

- (b) Suppose you are given an n -element array A containing distinct integers that are listed in increasing order. Given a number k , write a recursive function in C++ to return a pair of integers in A that sum to k , if such a pair exists. What is the running time of your algorithm? [8]
4. (a) Draw the binary min heap by inserting the following elements in order: 77, 22, 9, 68, 16, 34, 13, 8 into an initially empty heap. [4]
- (b) Solve the following recurrence relation using the recursion tree approach.
 $T(n) = 2T(n/2) + \log n$ [5]
- (c) Consider an undirected graph $G = (V, E)$, with n vertices. Show how a one-dimensional array of length $\frac{n(n-1)}{2}$ can be used to represent G . [5]
5. (a) Suppose that we have numbers between 1 and 1000 in a binary search tree and want to search for the number 363. Which of the following sequences could not be the sequence of nodes examined? [6]
- (i) 2, 252, 401, 398, 330, 344, 397, 363.
 - (ii) 924, 220, 911, 244, 898, 258, 362, 363.
 - (iii) 925, 202, 911, 240, 912, 245, 363.
 - (iv) 2, 399, 387, 219, 266, 382, 381, 278, 363.
 - (v) 935, 278, 347, 621, 299, 392, 358, 363.
- (b) Describe, in pseudo-code, an $O(n + m)$ -time algorithm for computing all the connected components of an undirected graph G with n vertices and m edges. [8]