End – SEMESTER EXAMINATION
PG

Session: July-December, 2024 Semester:1st Time: 3 Hrs. Full Marks: 100

Course Code: MCS102 Course Title: Advance Algorithms

Section A

ANSWER All QUESTIONS

1. ***ANSWER All QUESTIONS [(i) to (x) => 1×10=10 & (xi) to (xv)=> 2×5=10]***

(i) Which collision resolution technique involves maintaining a linked list of collided keys?
a) **Linear probing** b) Quadratic probing
b) Chaining d) Double hashing

(ii) Which of the following is a valid heap?
a) 16 14 10 4 7 9 3 2 8 1 b) 16 14 10 8 7 9 3 2 4 1
c) 16 14 10 8 1 9 3 2 4 7 d) 16 14 3 4 1 9 10 8 2 7

(iii) Which of the following symbol table implementation is best suited if access time is to be minimum?
a) Linear List b) Search Tree
c) Hash table d) Self Organisation list

(iv) In a _____ the left and right subtrees for any given node, differ in height by more than one.
a) Balanced Binary Tree b) Weight balanced binary tree
c) Height balanced tree d) Binary search tree

(v) Suppose we store n keys in a hash table of size $m=n^2$ using a hash function h randomly chosen from a universal class of hash functions. Then the probability is _____ that there are any collisions.
a) Greater then ⅕ b) Greater then ½
c) Less then ⅕ d) Less then ½

(vi) Which of the following string matching algorithms has a time complexity of O(m+n) in the worst case, where mmm is the length of the pattern and n is the length of the text?
a) Brute Force b) Knuth-Morris-Pratt (KMP)
c) Rabin-Karp d) Boyer-Moore

(vii) What is the primary advantage of the Rabin-Karp algorithm over the brute-force approach for string matching?
a) Lower space complexity b) The ability to handle multiple patterns simultaneously
c) Faster worst-case performance d) Simpler implementation

(viii) In the Knuth-Morris-Pratt (KMP) algorithm, the preprocessing phase involves constructing a table. What does this table represent?
a) The hash values of substrings b) The number of character comparisons
c) The length of the longest prefix that is also a suffix d) The positions of mismatches

(ix) What is the primary goal of Huffman encoding in data compression?
a) To represent each character with a fixed-length binary code
b) To minimize the average length of codes assigned to characters
c) To increase redundancy in data representation
d) To store data in hexadecimal format

(x) Which of the following is true about the structure of the Huffman tree?
a) It is always a balanced binary tree.
b) The character with the highest frequency is stored at the root.
c) Characters with higher frequencies are closer to the root.
d) The left and right subtrees always have equal height.

(xi) Suppose we are given n keys, m hash table slots, and two simple uniform hash functions h_1 and h_2. Further suppose our hashing scheme uses h_1 for the odd keys and h_2 for the even keys. What is the expected number of keys in a slot?

(xii) A complete n- ary tree is a tree in which each node has n children or no children. Let I be the number of internal nodes and L be the number of leaves in a complete n-ary tree. If L=41, and I=10. What is the value of n?

a) 3 b) 4
c) 5 d) 6

(xiii) Postorder traversal of a given binary search tree T produces following sequence of keys: 3, 5, 7, 9, 4, 17, 16, 20, 18, 15, 14. Find the sequences of keys can be the result of an in-order traversal of the tree T?

(xiv) A hash function h defined h(key)=key mod 7, with linear probing, is used to insert the keys 44, 45, 79, 55, 91, 18, 63 into a table indexed from 0 to 6. What will be the location of key 18?

(xv) Consider the array A=<4, 1, 3, 2, 16, 9, 10, 14, 8, 7>. After building heap from the array A, the depth of the heap and the right child of max-heap are _____ and _____ respectively. (Root is at level 0).

2. ***ANSWER ANY 4 QUESTIONS*** ***4 ×5=20***

(i) Let T(n) be the number of different binary search trees on n distinct elements. Then

$$T(n) = \sum_{k=1}^{n} T(k-1)T(x)$$

Find the value of x

(ii) Given bellow are the preorder and in-order traversals of a binary tree. Draw the actual tree and its post-order traversal. 5

Preorder: A B D I F J C F G K
In-order: D I B E J A F C K G

(iii) Suppose a string is encoded using Huffman codes as follows:

Encoded String: 1101001011110

Using the provided Huffman codes:
A: 110, B: 10, C: 0, D: 111, E: 101
Decode the string back to the original sequence of characters.

(iv) Discuss the impact of load factor on the performance of a hash table and explain the concept of rehashing.

(v) Consider a B-tree with degree m. that is, the number of children, c, of any internal node (except the root) is such that $m \leq c \leq 2m-1$. Derive the maximum and minimum number of records in the leaf nodes for such a B-tree with height h.$h \geq 1$. (Assume that the root of a tree is at height 0).

Section B

ANSWER ANY 3 QUESTIONS ***3 ×20 =60***

1. A hash table of size 10 is used to store the following keys:
23, 43, 13, 27, 57

(a) Insert these keys into the hash table using the division method ***h(k)=k mod 10*** with **linear probing** to resolve collisions. Show the state of the hash table after each insertion. *(8 marks)*

(b) Given a hash function ***h(k)=k mod 7*** and a hash table of size 7, insert the following keys using **chaining**:
50, 700, 76, 85, 92, 73, 101

(i) Illustrate the state of the hash table. *(8 marks)*

(ii) Analyze the time complexity of search and insert operations in a hash table using chaining in the best-case and worst-case scenarios. *(4 marks)*

2. Given the following characters and their frequencies:

A: 10, B: 15, C: 30, D: 40, E: 5

(a) Construct a Huffman tree for the given data. Show all intermediate steps in the construction process. *(10 marks)*

(b) Derive the Huffman codes for each character and calculate the average code length. *(5 marks)*

(c) Compare the size of the compressed file (using the generated codes) with the size of the original file if fixed-length codes were used. Assume the file contains 200 occurrences of the above characters. *(5 marks)*

3. You are given a **text** string T="31415926535" and a **pattern** string P="265".

(a) Use the Rabin-Karp algorithm with a simple hash function
H(s)=sum of ASCII values of characters in ***s mod 11*** to find all occurrences of P in T. Show the computation of the hash values for the pattern and all relevant substrings of the text. *(10 marks)*

(b) Discuss how the Rabin-Karp algorithm handles hash collisions and why it is effective for detecting multiple patterns simultaneously. *(5 marks)*

(c) Given a text string T = "abcabcabcabc" and a pattern P = "abcabc", manually perform a dry run of the Knuth-Morris-Pratt (KMP) algorithm to find all occurrences of P in T. Show the intermediate steps and results. *(5 marks)*

4. (a) Construct the AVL tree for a calendar where nodes are enter in the following order:- *(10 marks)*

MARCH, MAY, NOVEMBER, AUGUST,APRIL, JANUARY, DECEMBER, JULY, FEBRUARY, JUNE, OCTOBER, AND SEPTEMBER

(b) Construct a **B-tree** of order 3 (minimum degree t=2) by inserting the following keys in the given order:

10, 20, 5, 6, 12, 30, 7, 17

(i) Show the B-tree after each insertion step. Clearly indicate when node splits occur. *(7 marks)*

(ii) Explain the properties of a B-tree that are maintained during the insertion process. *(3 marks)*