INDIAN INSTITUTE OF INFORMATION TECHNOLOGY KOTTAYAM

Department of Computer Science and Engineering

END SEMESTER EXAMINATION- NOVEMBER, 2024

ICS 215 Data Structures II

Date & Time: 20-11-2024, 9:30 AM - 12:30 PM

Course Instructors: Dhakshayani J., Lidiya L. T., Nandini J. W.

Max marks: 100

Semester:III

Batch: 1, 2 & 3

Answer all Questions.

Part A (Each Question carry 10 marks, 10*4=40 marks)

1. How can Klee's Algorithm be adapted to correctly calculate the union length of segments when multiple segments overlap? Explain with an example.

2. i) Explain how the Brian Kernighan's algorithm efficiently counts the number of set bits (1's) in the binary representation of an integer? Give an example. [7 marks]

   ii) Write an efficient algorithm/pseudocode to count the number of unique rectangles formed using N unit squares, $N=6$. [3 Marks]

3. Write an algorithm/pseudocode to swap two numbers using bitwise operations, without employing a third variable.

4. Solve the following using Gauss Jordan method:

$$3x_1 + 2x_2 - x_3 = 1$$
$$2x_1 - 2x_2 + 4x_3 = -2$$
$$-x_1 + 0.5x_2 - x_3 = 0$$

Also, write an algorithm/pseudocode for the Gauss Jordan method to solve a system of linear equations.

Part B (Each Question carry 15 marks, 15*4=60 marks)

Write an efficient algorithm/pseudocode for each question in this section

5. Given an integer array *nums*, return *true* if any value appears at least twice in the array, and return *false* if every element is distinct.
   Example:
   Input: nums = [1,2,3,1]
   Output: true
   Explanation: The element 1 occurs at the indices 0 and 3.

6. Given a string *s*, consider all duplicate sub-strings: (contiguous) sub-strings of *s* that occur 2 or more times. The occurrences may overlap. Return any duplicated sub-string that has the longest possible length. If *s* does not have a duplicated sub-string, the answer is " ".
   Example 1:
   Input: s = "banana"
   Output: "ana"
   Example 2:
   Input: s = "abcd"
   Output: " "

P.T.O

7. Given two strings *needle* and *haystack*, return the index of the first occurrence of *needle* in *haystack*, or -1 if *needle* is not part of *haystack*.

Example 1:

Input: haystack = "sadbutsad", needle = "sad"

Output: 0

Explanation: "sad" occurs at index 0 and 6. The first occurrence is at index 0, so we return 0.

Example 2:

Input: haystack = "lightweight", needle = "lighto"

Output: -1

Explanation: "lighto" did not occur in "lightweight", so we return -1.

8. Lewis Carroll, the author of Alice's Adventures in Wonderland, created a type of word puzzle known as "doublets" or "word links." In these puzzles, you are asked to transform one word into another by changing just one letter at a time. Each intermediate word must also be a valid word present in the dictionary. For example, to change WITCH into FAIRY, the transformation would go: witch → winch → wench → tench → tenth → tents → tints → tilts → tills → fills → falls → fails → fairs → fairy. Two words are said to be equivalent if a valid reduction exists between them.

As the input to the algorithm, you are given a dictionary and two words whose equivalence to each other are to be tested. The output of the algorithm should be YES/ NO based on whether the two words can be reduced to each other. (Hint: Try reducing the dictionary into a graph)

* * * **Best wishes** * * *

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY KOTTAYAM

Department of Computer Science and Engineering

MID SEMESTER EXAMINATION- September, 2024

ICS 215 Data Structures II

Date & Time: 24-09-2024, 9:30 AM - 11:00 AM	Max marks: 50
Course Instructors: Dhakshayani J., Lidiya L.T., Nandini J. W.	Semester:III
	Batch: 1, 2 & 3

Answer all Questions.

Part A (Each Question carry 6 marks, $5 * 6 = 30$ marks)

1. Write an algorithm to find the length of union of line segment in $O(n \log n)$. Explain with an example.

2. Given n integer coordinates, write an efficient algorithm for the sum of the Manhattan distance between all pairs of coordinates.

3. Given a sorted array $arr[]$ consisting of N integers, representing points on a line and an integer K, design an efficient algorithm to find any point P between the first and last point such that the sum of distances of all given points from P is equal to K. If no such point exists, then the algorithm should return "nil".

4. You are attending a conference where every participant shakes hands with every other participant exactly once. The task is to find the total number of handshakes if there are n participants in the conference. Further, discuss the relationship between the handshake problem and the triangular number concept.

5. Given a simple polygon defined by its vertices, write an algorithm to determine the number of integral points located inside the polygon. Analyse the algorithm and justify the runtime of the algorithm.

Part B (Each Question carry 10 marks, $2 * 10 = 20$ marks)

6. An inversion in an array $A[1..n]$ is a pair of indices (i, j) such that $i < j$ and $A[i] > A[j]$. The number of inversions in an n-element array is between 0 (if the array is sorted) and $(n\ C_2)$ (if the array is sorted backward). Describe and analyze an algorithm to count the number of inversions in an n-element array in $O(n \log n)$ time.

7. Give an efficient algorithm for computing the minimum spanning tree with respect to a set of points in $2-D$ space. Each point is represented as (x_i, y_i) where, x_i, y_i are some integers and the distance/weight between any pair of points is the Manhattan distance between the points.

∗ ∗ ∗ Best wishes ∗ ∗ ∗

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY KOTTAYAM
Department of Computer Science and Engineering

Indian Institute of
Information Technology
Kottayam

FIRST MID SEMESTER EXAMINATION- SEPTEMBER, 2023
COURSE TITLE: ICS215 – DATA STRUCTURES II

Time: 05.09.2023 – 09:30 to 11:00 AM

Course Instructor(s): Jobin Jose/ Divya Sindhu Lekha/E. Silambarasan

Max. Marks: 50

Batch: ADM2022

Answer all Questions   [5*10=50 Marks]

[2 Marks]

1. A) Write a brief note on computational geometry.

   B) Implement Klee's algorithm and find the length of the union of line segments
   [8 Marks]
   {{2,5}, {4,8}, {9,12}}.

2. A) Write a program to calculate Count paths with a distance equal to Manhattan's
   [5 Marks]
   distance (2,6) and (4,9).

   B) Write a program to analyze pairs of the same Manhattan distance and Euclidean
   distance. Points are {{1,3}, {1,2}, {2,3}}.
   [5 Marks]

3. Give the *Brute force* and *Greedy* implementations of finding the sum of Manhattan
   distances between all pairs of points among n integer coordinates. Analyze the
   complexity in both implementations.
   [10 Marks]

4. A) Write a program to calculate the Maximum Manhattan distance between a
   distinct pair from 4 coordinates, {(-1, 2), (-4, 6), (3, -4), (-2, -4)}.   [5 Marks]

   B) Write a program to find the integer points (x, y) with a Manhattan distance of
   at least N. Show the solution for N=6 and N=7 with a pictorial representation of
   coordinates.
   [5 Marks]

5. A) Write a program to find a point such that the sum of the Manhattan distances
   is minimized, given N points in K-dimensional space where $2 \leq N \leq 10^5$ and $1 \leq K \leq 5$. Give its complexity. Solve the same for the following 4 points in 4-
   dimensional space: {1, 6, 9, 6}, {5, 2, 5, 7}, {2, 0, 1, 5}, {4, 6, 3, 9}   [6 Marks]

   B) Discuss at least 3 properties of line segments. Write a program to find whether
   the directed segment p_0p_1 is clockwise from p_0p_2.
   [4 Marks]

******ALL THE BEST******

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY KOTTAYAM
Department of Computer Science and Engineering

Indian Institute of
Information Technology
Kottayam

SECOND MID-SEMESTER EXAMINATION- OCTOBER, 2023
COURSE TITLE: ICS215 – Data Structures II

Date & Time: 05.10.2023 & 02:30 – 04:00 PM   Max. Marks: 50

Course Instructor(s): Dr. Jobin Jose, Dr. Athira, Dr. E. Silambarasan   Batch: ADM2022

Answer all Questions   **[5*10=50 Marks]**

1. a. Write a program to count integral points inside a triangle and trace the program for (0,8), (8,0), and (0,0).   **[5 Marks]**

   b. Write a program to find the hamming distance between 214 and 178 and trace the program with the given data.   **[5 Marks]**

2. a. Write a program to find the total area of overlapping rectangles and trace the program for the input r1:(3,2), (5,6), and r2:(4,4), (6,9) to find the output.   **[5 Marks]**

   b. Write a program to convert decimal to binary. **Note**: Use only Bitwise operators.   **[5 Marks]**

3. a. Write a program to count the number of set bits by using Brain Kernighan's approach and trace the program for input 71 to find the output.   **[5 Marks]**

   b. Write a program to convert cipher text to plain text by using an additive cipher and trace the given Cipher text: "vgbjmdoc" to plaintext if Key: 21.
   algorithm   **[5 Marks]**

4. a. Write a program to find the number of lattice points on the circle circumference with the center beginning with an origin for $x^2+y^2=225$ by applying Fermat's two-square algorithm and tracing it.   **[7 Marks]**

   b. Write a program for swapping two numbers using bitwise operators. **Note:** Build-in Methods are not allowed.   **[3 Marks]**

5. a. Write a program to do parity checks by using an efficient approach and trace the program for the input 7985 to find the output.   **[5 Marks]**

   b. Write a program to convert a plain text to cipher text by using Affine cipher and trace the given Plaintext: "algorithms" to cipher text with additive key: 4, and Multiplicative key: 3.   **[5 Marks]**

*********All The Best**********

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY KOTTAYAM
COMMON TO ALL DEPARTMENTS

<u>END SEMESTER EXAMINATION - November 2023</u>
COURSE TITLE: ICS 215 - Data Structures - II

Date/Time: 28.11.2023 / 09:30 AM – 12:30 PM   Max. Marks: 100
Course Instructor(s): Jobin Jose/Athira B/E. Silambarasan   Batch: ADM2022

<u>Answer all Questions</u>   10 * 10 = 100

1. Given two rectangles, find if the given two rectangles overlap or [10] not. A rectangle is denoted by providing the x and y coordinates of two points. consider $L_1 = (0,10)$, $R_1 = (10,0)$, $L_2 = (5,5)$, $R_2 = (15,0)$ are the coordinates of the rectangles. If it is overlapping find the total area. Write a program to implement this scenario and trace it.

2. Given a circle of radius r in 2-D with origin or $(0, 0)$ as the center. [10] Write a program to find the total lattice points on the circumference of the given circle $x^2+y^2=2560$ using Fermat's two-square method and trace the same.

3. Write a program to find the *number of integral points exactly* [10] with the interiors of the triangle with vertices *(0,0), (4,3), and* *(21,0)* and trace for its correctness.

4. An amount of Rs. 65000 is invested in three bonds at the rates of [10] 6%, 8% and <u>10%</u> per annum respectively. The total annual income is Rs. 4800. The income from the third bond is Rs 600 more than that from the second bond. Write a system of linear equations that represents the situation. Write a program and trace to determine the price of each bond using Gauss Jordan method.

5. A bowl of cornflakes, a cup of milk, and an egg provide 16 grams [10] of protein. A cup of milk and two eggs provide 21 grams of protein, and two bowls of cornflakes with two cups of milk provide 16 grams of protein. How much protein is provided by one unit of each of these three foods? Write a system of linear equations that represents the situation. Write a program and trace to solve your system of linear equations using the LU decomposition method.

1

P.T.O

6. A boy is walking along the path $y=ax^2+bx+c$ through the points [10] (-6,8), (-2, -12) and (3,8). He wants to meet his friend at point (7,60) will he meet his friend. Write a system of linear equations that represents the situation. Write a program and trace it to find the matrix inverse.

7. Write a program and trace how to solve the given linear [10] equations by using the Seidel Method.
83x+11y-4z=95
7x+52y+13z=104
3x+8y+24z=71

8. Write a program for Playfair cipher and trace the Plain text: [10] "Information" with the key "place". **Note:** The program should have an Encryption and Decryption part.

9. a. Write a program for Columnar cipher and trace the Plain text: [5] "The nose is pointing down and the houses are getting bigger" with the key "display". **Note:** The program should have an Encryption and Decryption part.

b. Write a program to convert the decimal to binary using a bitwise [5] operator and trace the program using -85.

10. a. Write a program to check the Prime number of set bits in binary [5] representation and trace the program using the number 185.

b. Write a program to implement bit stuffing in a frame sequence. [5] **Note:** Bit stuffing is Insert an extra bit 0 after 5 consecutive 1's. Trace the program using the number 905313022.

*********ALL THE BEST**********