

[This question paper contains 4 printed pages.]

Your Roll No.....

K

Sr. No. of Question Paper : 5746
Unique Paper Code : 2342011104
Name of the Paper : Object Oriented Programming Using Python
Name of the Course : B.Sc. (H) – DSC
Semester : I
Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **all** questions from **Section-A**.
3. Attempt any **four** questions from **Section-B**.
4. Attempt **all** parts of a question together.

Section: A

- Q1 (a) Draw a flowchart to compute the factors of a given number. (5)
- (b) Write python statements for the following (6)
- i. Initializing x to 7 and incrementing the value by 1
 - ii. Assign a string to the variable str and print the subset of characters of the string.
 - iii. Store the integer division of x and y in z
- (c) Write a function to check whether a given number is prime or not. (5)
- (d) Give the output of the following code snippet: (6)
- i.

```
L=[12,13,14,15]
sum=0
for x in L:
    sum+=x
print(sum)
```
 - ii.

```
str='Hello'
print(str[::-1])
```
 - iii.

```
S1={1,2,34}
S2={4,34,6}
S3=S1.intersection(S2)
print(S3)
```
- (e) Given the following dictionary (8)
- ```
d={'Gita':45,'Siya':78,'Sarika':90}
```
- Write python statements for the following: (2+3)
- i. Retrieve the student name with the maximum marks (3)
  - ii. Create the list of names and marks separately from the dictionary d.
  - iii. Display the list of names and marks in the following format  
Name marks\_obtained

**Section B**

- Q2 (a) Write a function in python reverse(lst) that takes list lst as a parameter and (5)  
returns the reverse of lst in a new list.

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- (b) Write a program to generate the following pattern where the height of the pattern, 'h', (5)  
is input from the user.

```
A
BB
CCC
DDD
```

(5)

- (c) Give the output of the following code:
- i. `print(56**2//18%3)`
  - ii. `print(10!=9 and 38>=38)`
  - iii. `print('Welcome'*4)`
  - iv. `print('1' in 'Hello')`
  - v. `print(16^23)`

- Q3 (a) Write a function that takes a string as input and returns the number of characters, vowels (5)  
and words as a tuple.

- (b) Let's assume a string-  
`str1= 'house no123 ,Rajnagar Extension, Uttar Pradesh',`  
What will be the output on executing each of the following statements:

- i. `print(str1.find('no'))`
- ii. `print(str1.split(' '))`
- iii. `print(str1[:2])`
- iv. `print(str1.isalpha())`
- v. `print(str1.replace('e', 'u'))`

(5)

- (c) Write a program using function to swap two numbers with and without using a (5)  
temporary variable.

- Q4 (a) Given the output of the following code snippets (9)

- i. 

```
c=[23,45,67,89,90,123]
t=()
for x in c:
 if(x%2!=0):
 t=t+(x,)
print(t)
```
- ii. 

```
subject='computer'
subject=list(subject)
ch=subject[0]
for i in range(0,len(subject)-1):
 subject[i]=subject[i+1]
 subject[len(subject)-1]=ch
print(' '.join(subject))
```
- iii. 

```
Fruits=('lemon','orange','grapes','apple','pineapple','kiwi')
```

```
Vegetables={'spinach','cauliflower','lady finger'}
print(Fruits and Vegetables)
print(Fruits or Vegetables)
print(Fruits.add('Pomegranate'))
```

- (b) Write a program that takes a sentence as input and computes the frequency of vowels in it. Create a dictionary 'd' to store the vowels and their frequency present in the sentence. (6)

- Q5 (a) Write a function that reads the file 'file1.txt' and copies odd-numbered lines to another file, 'file2.txt'. Use appropriate exception handling during the file operations. (5)

- (b) Consider the following function computeSquareRoot(): (6)

```
import math
def computeSquareRoot():
 try:
 a=int(input('Enter the value'))
 result=math.sqrt(a)
 except ValueError:
 print('value error')
 except TypeError:
 print('typeerror')
 except:
 print('unexpected error')
 else:
 print(result)
 finally:
 print('End task')
```

computeSquareRoot()  
Determine the output for the above function call when the value entered for a= 'h', a='13' and a='-56'.

- (c) Find the error in the following code snippet: (4)
- ```
F1=open('A1.txt')
F1.write('welcome')
```
- Rewrite the above code with the use of exception handling.

- Q6 (a) Write a program to define the class Student to store the student records. The Student class should have the following attributes: (10)

```
Rollno: integer
Name: string
Course: string
Subjects: list
Marks: list
Percentage: real
```

Write the following member functions:

```
def __init__(): to initialize the class data members.
def read(): To read the values for the class data members.
```

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`def __str__()` : to return the string representation of the class data members
`def computePercentage()` : To compute the percentage of marks obtained in the subjects.

Write the main function with suitable python statements for the following:

Create an object `s1` initialized with the suitable values.

Create an object `s2` and use read function to take the input from the user.

Use `computePercentage()` with both `s1` and `s2` to compute the average of the marks obtained.

Display `s1` and `s2` objects.

- (b) Give an output of the following code:

(5)

```
def display(l, n):
    if (n >= 0):
        print(l[n] * 2)
        display(l, n - 1)
l = [1, 2, 3, 4]
n = len(l)
display(l, n - 1)
```

- Q7 (a) Given the following class Shape as follows:

(10)

```
class Shape:
    def __init__(self, shapetype, x, y):
        self.shapetype = shapetype
        self.side1 = x
        self.side2 = y
    def computeArea():
        pass
```

Inherit the classes rectangle and triangle from the class Shape. Both the derived classes should invoke the `init()` function of shape to initialize `shapetype`, `side1` and `side2`. Override `computeArea()` in the rectangle and triangle class to compute and display the area of the rectangle and triangle. Write the main function to create the objects `o1` and `o2` of class rectangle and triangle. Invoke `computeArea()` to display the area of the rectangle and circle.

- (b) Given the following function definition:

(5)

```
def pow(a=4, b=2):
    pro=1
    for i in range(b):
        pro=pro*a
    print(pro)
```

Compute the function calls as given below:

`pow()`

`pow(2)`

`pow(4, 5)`

(200)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5980

K

Unique Paper Code : 2342011103

Name of the Paper : Mathematics for Computing

Name of the Course : B.Sc. (II) Computer Science

Semester : I

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question No. 1 (Section A) is compulsory.
3. Parts of a question must be answered together.
4. Attempt any 4 of Question Nos. 2 to 7.
5. Use of simple calculator is allowed.

SECTION A

- 1 (a) Find the Rank of the following matrix using row echelon form (5)

$$\begin{bmatrix} 2 & 1 & -1 \\ 4 & 2 & -2 \\ 1 & -1 & 3 \end{bmatrix}$$

- (b) Find the dot product, cross product, and angle between the vectors (5)

$$\vec{a} = 2i + 3j - 4k, \quad \vec{b} = -i + 5j + 2k$$

- (c) Determine following transformation T is linear or not? (5)

$$T: \mathbb{R}^2 \rightarrow \mathbb{R}^2, T([x, y]) = [3x - 4y, -x + 2y]$$

- (d) Define Basis. Show that the vectors $(2,1,4), (1,-1,2), (3,1,-2)$ form a basis for \mathbb{R}^3 (5)

- (e) Given following matrix (5)

$$A = \begin{pmatrix} 6 & 2 \\ 3 & 1 \end{pmatrix},$$

Use Cayley-Hamilton theorem to evaluate: $(A-I)(A-6I)$.

- (f) Define Subspace. Let Y be the set of vectors in R^4 of the form $[a,0,b,0]$. (5)
Prove that Y is a subspace of R^4 .

SECTION B

- 2 (a) What is Positive definite matrix? Is the following matrix positive definite? (7)

$$\begin{pmatrix} 6 & 2 & 1 \\ 2 & 5 & 3 \\ 1 & 3 & 4 \end{pmatrix}$$

- (b) Solve the following system of linear equations using Gauss Jordan Elimination. (8)

$$2x + y - z = 5$$

$$4x - y + 2z = 9$$

$$-2x + 2y + z = -1$$

- 3 (a) Calculate the curl and divergence for the following vector field at $(1,-1,1)$ (7)

$$\vec{f} = xy^2\hat{i} + 2x^2yz\hat{j} - 3yz^2\hat{k}$$

- (b) Diagonalize the following matrix (8)

$$\begin{bmatrix} 3 & 0 & 0 \\ 1 & 2 & 0 \\ 4 & 1 & 1 \end{bmatrix}$$

- 4 (a) For what value of λ and μ , do the following system of equations be consistent? (7)

$$x + y + z = 6$$

$$x + 2y + 3z = 10$$

$$x + 2y + \lambda z = \mu$$

- (b) Apply Gram Schmidt orthonormalization process to obtain an orthonormal basis for the subspace of \mathbb{R}^3 generated by the vectors (8)

$$\beta_1 = (1,0,1), \beta_2 = (1,0,-1), \beta_3 = (0,3,4)$$

- 5 (a) What is directional derivatives? Find the directional derivative of $f(x, y, z) = x^2z + xz^3 - xy$ at the point $P(1,1,-1)$ in the direction of $\vec{a} = \hat{i} - \hat{j} + 3\hat{k}$. (7)

- (b) Define inner product space. Consider a real vector space \mathbb{R}^2 , which is defined as: (8)

$$\langle (x_1, x_2), (y_1, y_2) \rangle = x_1y_1 + x_2y_2.$$

Show that it is an inner product space.

- 6 (a) Find inverse of the following matrix using Gauss Jordan Elimination (7)

$$\begin{bmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 1 & 0 & 0 \end{bmatrix}$$

- (b) The weather in a city change according to a Markov Chain with three states: Sunny (S), Cloudy (C), Rainy (R). (8)

The Transition Matrix is:

$$P = \begin{pmatrix} 0.6 & 0.3 & 0.1 \\ 0.2 & 0.5 & 0.3 \\ 0.3 & 0.4 & 0.3 \end{pmatrix}$$

- (i) If today is Sunny, find the probability that it will be Rainy after one day.

(ii) If today is Cloudy, find the probability that it will be Sunny after two days.

(iii) If the initial state vector is

$$v^{(0)} = (0.5, 0.3, 0.2),$$

Find the state distribution after one day and after two days.

7 (a) Find the bases of row space and null space of the following matrix (7)

$$\begin{bmatrix} 1 & -1 & 5 \\ -2 & 3 & -13 \\ 3 & -3 & -15 \end{bmatrix}$$

(b) The set \mathbb{R}^2 defined with addition operation and scalar multiplication on \mathbb{R}^2 (8)

$$[x, y] \oplus [u, v] = [x + u + 1, y + v - 4] \text{ and}$$

$$a \odot [x, y] = [ax + a - 1, ay - 4a + 4].$$

Show that \mathbb{R}^2 is a vector space over addition and scalar multiplication

[This question paper contains 12 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5726

K

Unique Paper Code : 2342012301

Name of the Paper : Data Structures

Name of the Course : B.Sc. (H) Computer Science

Semester : III

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **Section A** is Compulsory.
3. Attempt any **four** questions from **Section B**.
4. Parts of a question must be answered together.

Section A

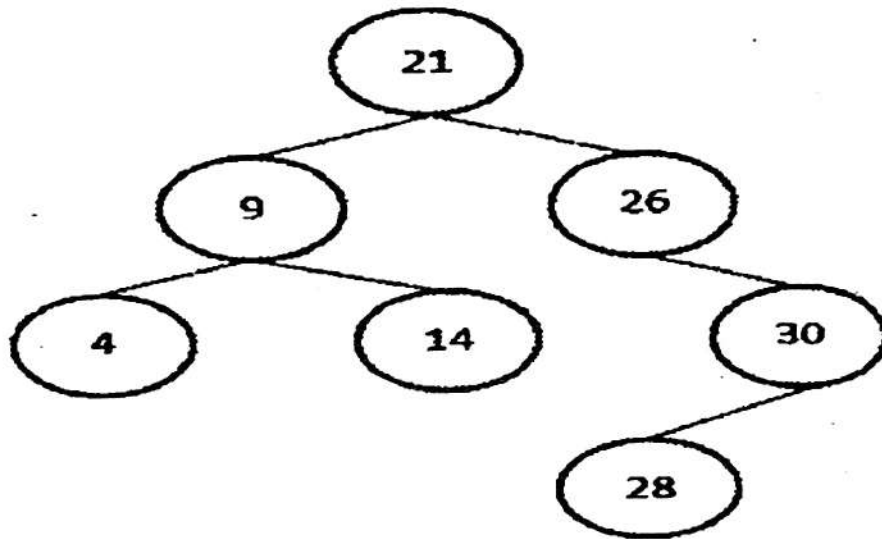
1. (a) If a binary tree has n nodes, what is the maximum and minimum possible height? (2)

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P.T.O.

(b) How is a deque (double-ended queue) different from its counterparts—stack and queue? (3)

(c) What is a balance factor in AVL tree. Is the given tree balanced? If not, balance the tree using required rotation. (4)



(d) Write a function to find the sum of all elements in an array using binary recursion. (4)

(e) Solve the following recurrence relation using the recursion tree method: (4)

$$T(n) = 2T\left(\frac{n}{2}\right) + n^2$$

- (f) Consider the following function that operates on a singly linked list : (4)

```
int sum (Node* head) {  
    if (head == NULL)  
        return 0;  
    return head->data + sum(head->next->next);  
}
```

Assume the linked list contains the elements:

1 → 3 → 5 → 7 → 9 → 11

and the function is called as:

cout << sum(head);

What will be the output of the program?

- (g) Given the function: (4)

$$F(n) = 8n^3 + 9n^2 + 6n + 5,$$

demonstrate that $F(n)$ belongs to the Big-Oh class $O(n^3)$. Also, provide the mathematical justification for your answer.

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- (h) Convert the following infix expression to postfix using a stack. Show the status of stack after each operation. (5)

$$((A + B * C) / D - (E + F) * G) ^ H$$

Section B

2. (a) Write a function `hasDuplicate()` to determine whether a singly linked list contains any duplicate values or not. (5)

- (b) Given the preorder traversal sequence of a binary search tree (BST) as:

30, 20, 10, 15, 25, 23, 39, 35, 42

- (i) Construct the BST.
- (ii) What is the postorder traversal sequence of the constructed BST? (5)

- (c) Construct a max-heap by inserting the following items successively. Show the status of tree after each insertion. (5)

1, 2, 3, 4, 5, 6, 7

Show the steps to delete the root from the above constructed tree.

3. (a) Given the postfix expression : (5)

$$BA * C/DEC^{^^} + C - A +$$

with variable values $B = 3$, $A = 4$, $C = 2$, $D = 0$, and $E = 8$, evaluate the expression step-by-step using a stack and find the result. Show the state of the stack after processing each symbol.

- (b) Solve the following recurrence relation using the Master Method: (5)

$$T(n) = 4T\left(\frac{n}{2}\right) + n^3$$

Clearly state which case of the method applies and provide the asymptotic bound for $T(n)$.

- (c) Create an AVL tree by inserting the following keys : (5)

9, 8, 7, 6, 1, 2, 3, 4, 5

Also, give the total number of rotations involved.

4. (a) Consider the following recursive function: (7)

```
void fun(n)
{
    cout<<n;
    if (n > 1)
    {
        fun(n-1);
        fun(n-2);
    }
}
```

- (i) What will be the output of the above code snippet for the function call fun(4)?

- (ii) How many total function calls are made when fun(4) is executed?
- (iii) Also create a recursion tree for the same.
- (b) A call center uses a circular queue with a maximum capacity of 3 to store incoming call requests. The sequence of operations is: (8)
- Enqueue(1), Enqueue(2), Enqueue(3), Dequeue(),
Enqueue(4), Enqueue(5), Enqueue(6), Dequeue(),
Dequeue(), Enqueue(7)

Simulate the above operations on the circular queue and determine :

- (i) Which call requests are successfully accepted (enqueued).
- (ii) Which call requests are rejected due to overflow.
- (iii) The final contents of the circular queue after all operations.

5. (a) Given the following sequence of operations performed on an empty stack (with maximum size 5) :

(7)
(push(54), push(52), pop(), push(55), push(62), peek(), pop(), S=pop())

and the following sequence of operations performed on an empty linear queue (of size 4):

{enqueue(1), enqueue(2), dequeue(), enqueue(3), enqueue(4), dequeue(), enqueue(5), q = dequeue()}

(i) Show the status of both stack and queue after each step.

(ii) What is the value of $s * q$ after executing all the above operations?

- (b) Consider the following keys in the given order:

(8)
100, 200, 300, 400, 500, 450, 350, 250, 150

(i) Create the BST,

- (ii) Show the steps to delete the key 100, and
(iii) Give the preorder traversal of the resulting tree.

6. (a) Write an algorithm using a Stack to determine whether a given expression containing parentheses is balanced or not. Illustrate its working for the following example: (7)

{(([]))}

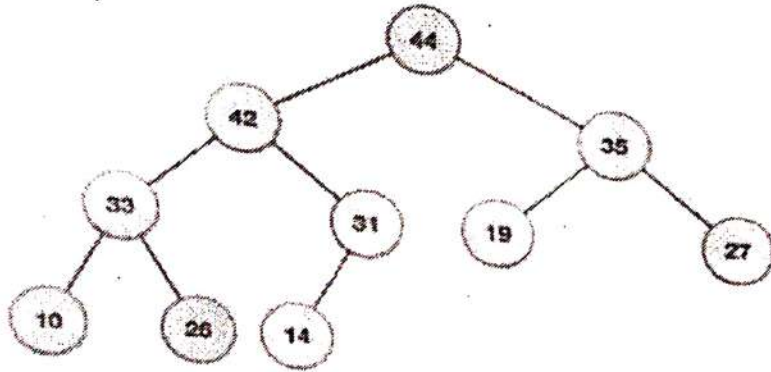
- (b) Given the array: (8)

9, 8, 6, 5, 2

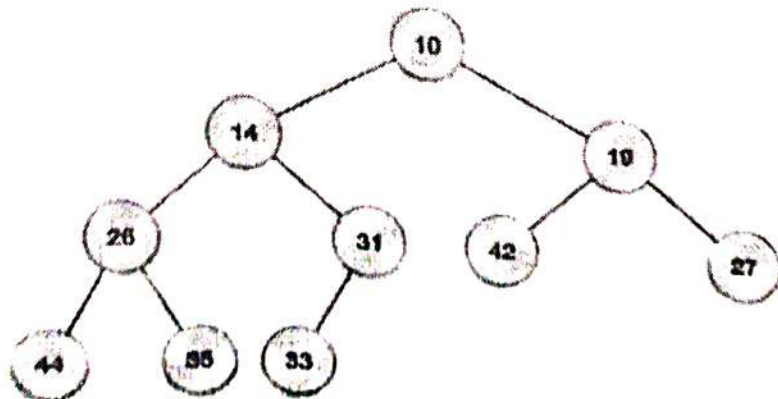
- (i) Sort the array using insertion sort and show the state of the array after each pass of the algorithm. Also, calculate the total number of comparisons made.
(ii) Specify whether this input represents the best case, worst case, or average case scenario for insertion sort, and briefly explain why?

7. (a) For each of the given binary trees, determine whether it satisfies the properties of a max-heap, a min-heap, or neither, and provide a brief justification for your answer. (3)

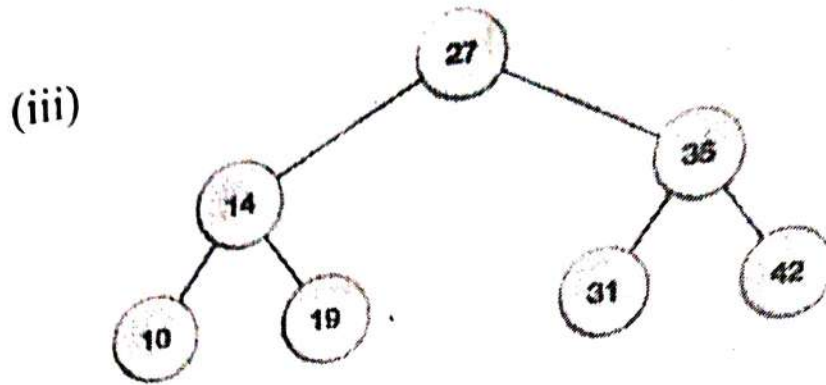
(i)



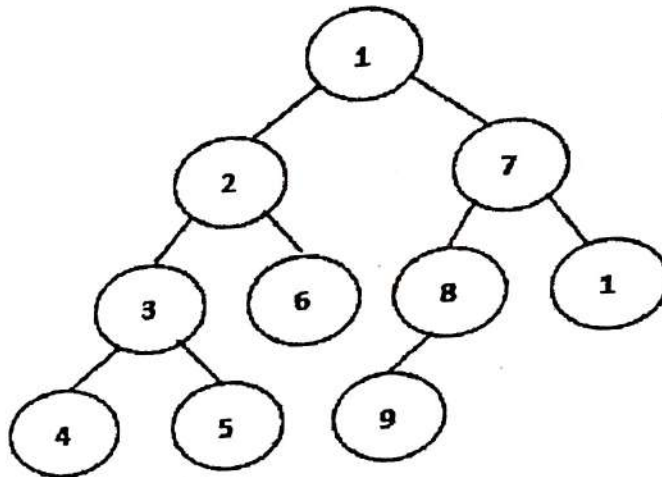
(ii)



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(b) Consider the following Tree and answer the questions given below : (5)



- (i) Breadth first traversal
- (ii) Depth of the tree
- (iii) Height of the tree
- (iv) Number of internal nodes
- (v) Number of leaf nodes

(c) Write the following functions to reverse a doubly linked list : (7)

(i) Reverse_with_Tail() {using Tail pointer}

(ii) Reverse_without_Tail() {without using Tail pointer}

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5960 **K**

Unique Paper Code : 2342012304

Name of the Paper : Computer Graphics

Name of the Course : B.Sc. (H) Computer Science
(Discipline Specific Core)

Semester : III

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. The paper has two sections. **Section A** is compulsory.
3. Attempt any **four** questions from **Section B**.
4. Parts of a question must be answered together.

SECTION A

1. (a) Consider a raster system with the resolution 640×640 . How many pixels can be accessed per second in the system by a display controller that refreshes the screen at a rate of 60 frames per second? What is the access time per pixel in this system. (3)
- (b) What is interlacing? What is its advantage? (3)
- (c) Differentiate between raster scan and random scan systems. (3)
- (d) Briefly explain how can we obtain various shades, tints and tones of a color. (3)
- (e) Write basic three steps to fill a polygon using scan line fill algorithm. (3)
- (f) Prove that two scaling transformations are commutative. (3)

- (g) List the steps involved in design of animation sequence. (3)
- (h) Draw a line between (4,1) and (8,5) using Bresenham's mid-point line algorithm. Find values of d, x and y. (3)
- (i) Illustrate the cases of trivial acceptance and trivial rejection in Cohen and Sutherland line clipping algorithm. (3)
- (j) Consider a triangle A(1,1), B(1,5) and C(6,1), rotate the triangle about the line $y = 0$ by an angle $\alpha = 45^\circ$ using homogeneous co-ordinates. Give the new co-ordinates of the rectangle after transformation. (3)

SECTION B

2. (a) Differentiate between Phong and Gouraud shading models. (5)

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- (b) Explain depth sort method for hidden surface elimination. What are the tests performed when there is depth overlap? (5)
- (c) Rasterize a circle using midpoint circle algorithm whose radius = 8 and Centre is (0,0). (5)
3. (a) Obtain the mirror reflection of triangle ABC with vertices A(0,1), B(1,2), C(2,0) about the line $y = -x$. (5)
- (b) Derive the Basis matrix for parametric cubic Bezier curve. Also, obtain its blending functions. (5)
- (c) Obtain a transformation matrix for shearing an object about a specified pivot point. (5)

4. (a) Prove that mid point of a line remains invariant before and after transformation. (5)
- (b) Derive a 3d homogeneous transformation matrix to rotate an object about a line parallel to y axis. (5)
- (c) Write the 3D projection matrices for each of the following : (5)
- (i) Orthographic projection on $x=0$ plane.
 - (ii) Single point projection with centre of projection on y-axis at $y_c=2$.
 - (iii) Trimetric Projection matrix.
5. (a) Transform a triangle $A(1,0)$, $B(0,1)$, $C(1,1)$ by each of the following transformations separately. (5)

- (i) Rotating 45° about the origin and then translating one unit in x and y direction.
- (ii) Translating one unit in x and y direction and then rotating 45° about the origin.
- (b) Show that a 2D reflection through the x-axis, followed by a 2D reflection through the line $y=x$, is equivalent to a pure rotation about the origin. (5)
- (c) Using Sutherland Hodgeman polygon clipping algorithm, clip the triangle ABC with the vertices as $A(4,5)$, $B(7,15)$, and $C(9,12)$, against a rectangular window $P(5,5)$, $Q(10,5)$, $R(10,10)$, and $S(5,10)$. Give the co-ordinates of the clipped polygons. (5)

6. (a) Clip the line $P_1(40,15)$ $P_2(75,45)$ against clip window $A(50,10)$, $B(80,10)$, $C(80,40)$, $D(50,40)$ using Cohen and Sutherland line clipping algorithm. (5)

(b) Specify the rules to equalize the set of edges in key frames 'k' and 'k+1' in an animation scene. Using these rules, transform a triangle into a Hexagon. (5)

(c) Briefly explain RGB color model. In a chromacity diagram of a RGB color model, define complementary colors and pure colors. (5)

7. (a) Briefly explain the two basic techniques for producing color displays in a CRT. (5)

(b) What is dithering? What are its advantages over half toning? Obtain higher order dither matrix D_4 from lower order dither matrix using recurrence relation. (5)

(c) List and explain the data structures used in Scan line polygon filling algorithm. (5)

[This question paper contains 4 printed pages.]

Your Roll No.....

K

Sr. No. of Question Paper : 5961

Unique Paper Code : 2342012305

Name of the Paper : Artificial Intelligence

Name of the Course : B.Sc. (H) Computer Science

Year of Admission : 2024 and Onwards (NEP-UGCF)

Semester : III

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Section A is compulsory.
3. Attempt any 4 questions from Section B.
4. Parts of the question must be answered together.

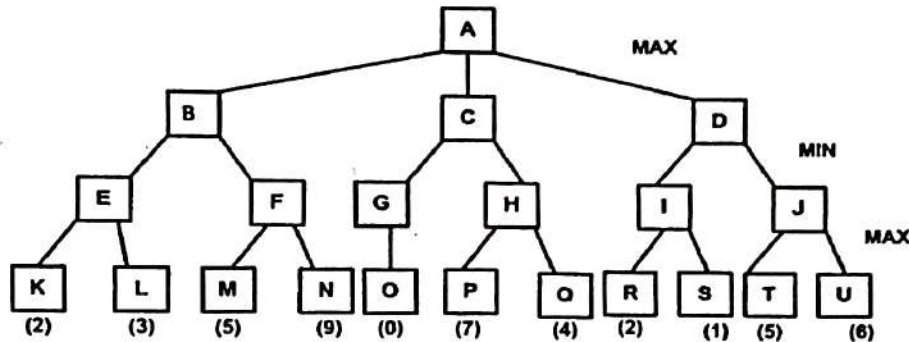
Section A

- Q1.a) Write any two limitations of Hill Climbing search method? 2
- b) What would be the output of the following statement in Prolog?
(?- A is 6*9, B = 54, A == B) 2
- c) Differentiate between Weak AI and Strong AI. 2
- d) Transform the logical statement $\forall x (P(x) \leftrightarrow Q(x))$ into clausal form. 2
- e) Define the terms: state space, initial state, and goal state. 3
- f) Write a program in Prolog to implement fact (N, F), where F is the factorial of a number N. 3
- g) Describe Recursive Transition Network (RTN). Give an example. 4

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- h) Compare and contrast between Best First Search and Depth First Search algorithms. 4
- i) Give PEAS for Auto Driver Agent. 4
- j) What are the universal and existential quantifiers? Translate the sentence "All employees of the AI-Software Company are programmers" into First Order Predicate Logic (FOPL). 4
- Q4.a) Transform the following into Conjunctive Normal Form (CNF): 4
- $P \vee (P \wedge Q)$
- $P \vee Q \vee (P \wedge Q \wedge S)$
- b) What is cut and fail in PROLOG? Give an example. Write a PROLOG program to generate the n^{th} term of the Fibonacci series. 5
- c) What is Chomsky Hierarchy of grammars? Give the properties of Type 0, Type 1, Type 2 and Type 3 grammar. 6
- Q5.a) Draw an associative network for the following sentences: 4
- i. "The bus is blue and has a powerful engine."
- ii. "The cake is delicious and has a creamy frosting."
- b) Given the following grammar: 5
- $S \rightarrow NP VP$
- $NP \rightarrow DET N$
- $VP \rightarrow V PP$
- $PP \rightarrow PREP NP$
- $N \rightarrow \text{cat} \mid \text{mat}$
- $V \rightarrow \text{sat}$
- $DET \rightarrow \text{The} \mid \text{the}$
- $PREP \rightarrow \text{on}$

Derive a parse tree for the sentence "The cat sat on the mat" using the above grammar.

- c) Differentiate between deterministic and non-deterministic parser with the help of suitable diagrams. 6
- Q6.a) Define Modus ponens and Chain rule. Give an example for each. 4
- b) i. Distinguish between uninformed search and informed search. 5
- ii. Let h' denote the estimate of h (the actual cost of getting from the current node to a final state node). Explain in what way the efficiency of A* algorithm and reaching of a goal state is affected if h' always overestimates h .
- c) Consider the following game tree in which the below given scores are all from the first player's point of view: 6



What move should be chosen by the first player and why? Which nodes will be pruned according to alpha-beta pruning procedure? Give justification.

- Q7.a) Write short notes on the following terms: 4
- i. Robot rights
- ii. Frames
- b) Write a script for going to a Museum. 5

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4

- c) Solve the following cryptarithmic problem using constraint satisfaction. 6

$$\begin{array}{r} \text{TWO} \\ + \text{TWO} \\ \hline \text{FOUR} \\ \hline \end{array}$$

[This question paper contains 4 printed pages.]

Your Roll No.....
K

Sr. No. of Question Paper : 5707
Unique Paper Code : 2342013501
Name of the Paper : Algorithms and Advanced Data Structures
Name of the Course : B.Sc. (H) Computer Science
Semester : V
Duration : 3 Hours

Maximum Marks : 90

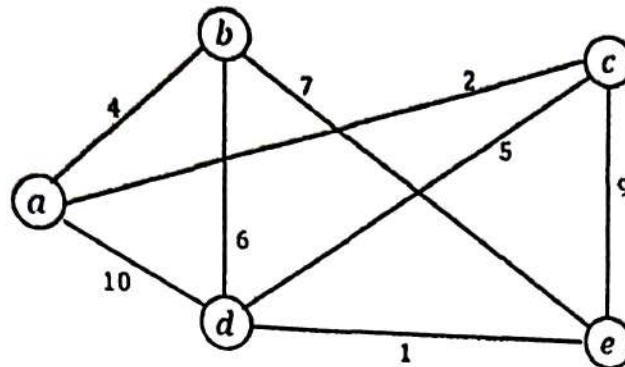
Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. This question paper has two sections A and B.
3. Section A carries 30 marks and each question in Section B carries 15 marks.
4. Section A is compulsory.
5. Attempt any 4 questions from Section B.
6. Parts of a question must be attempted together.

Section A

- Q.1 a) Differentiate between the crawling and indexing phases of a search engine's workflow. (3)
- b) In the VH-tree, what is the maximum number of horizontal pointers that can be traversed consecutively on a path from the root to a leaf? Justify your answer based on the tree's fundamental property. (3)
- c) Consider a binary counter of 4 bits that starts from 0 and supports only an INCREMENT operation. Using the accounting method of amortized analysis, determine the amortized cost per INCREMENT operation. Assign a credit to each bit flip and explain how these credits are used to pay for expensive operations. (4)
- d) The Subset-Sum problem is defined as: Given a set of integers and a target sum T , does there exist a subset whose elements add up to T ? Describe a brute-force algorithm for Subset-Sum and state its time complexity. Why does this algorithm fall in NP class? (5)
- e) Give an example of a dataset consisting of 7 elements that results in the worst case for Quick Sort. Using this dataset, Sort the array using Quick Sort (with the last element as the pivot). Sort the same array using Randomized Quick Sort (selecting a random pivot in each partition). Compare the impact of pivot selection on the performance in both cases. (5)
- f) What is meant by a residual graph G_f for a flow network G with a flow f and what is significance of a backward edge in this residual graph? Explain with the help of an example (5)

- g) Write Kruskal's algorithm for finding Minimum Spanning Tree. Apply the same on the following weighted undirected graph. Clearly show every step of addition of selected edge to generate MST.

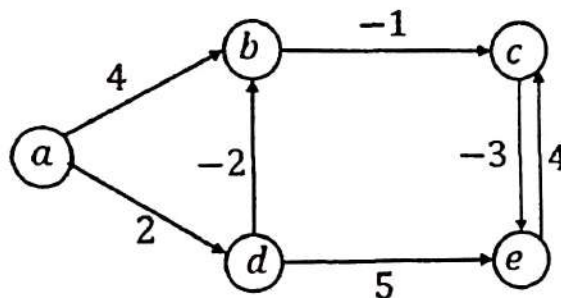


(5)

Section B

- Q.2 a) Explain Independent Set and Vertex-Cover problems. Prove that Independent Set \leq_p Vertex-Cover.
- b) Apply Bellman-Ford algorithm to find the shortest path from a to all other vertices on the following weighted directed graph G . Show the distance progressions of all vertices after each iteration. When does Bellman-Ford algorithm fail? Justify your answer with proper example.

(7)



(8)

- Q.3 a) How the suffix trie of a string S of length n can be used to check if a pattern P of length m is a substring of S in $O(m)$ time? Illustrate with the pattern "NAN" on the suffix trie for "BANANAS". Why is a suffix trie not the preferred data structure for large genomic sequences despite its powerful substring operations?
- b) Using Knuth-Morris-Pratt (KMP) algorithm, construct the failure function for $P = "ABAABAC"$ and find the first occurrence of the pattern P in the text string $T = "ABABACABABABAABACABAC"$ clearly illustrating all shifts and comparisons. Compare the Brute Force and KMP algorithms in terms of time complexity.

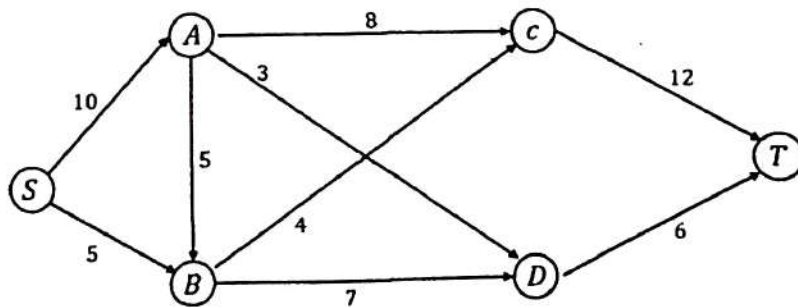
(7)

(8)

- Q.4 a) Considering the set of words: {programmer, programming, progress, project, python, slack, stack, stream, string, structure, algorithm, algebra, alpha} make a standard trie to store these words. By converting it into a compressed trie, show how much space is saved.

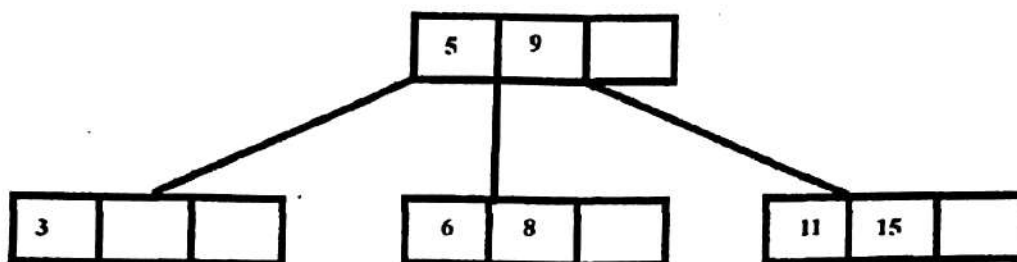
(7)

- b) What is the minimum number of keys allowed in the root node, non-root internal node, and leaf node in a B-Tree of order m ? Create a B-tree of order 3 with help of operations (insert 10), (insert 20), (insert 5), (delete 10), (insert 15), (insert 25), (delete 5), (insert 30). Show the state of tree after each operation. (8)
- Q. 5 a) What is meant by a partition being helpful in Randomized-Select and prove that probability of a partition being helpful is at least $1/2$. Considering an unsorted array of integers $A = \{34, 17, 28, 12, 45, 19, 7, 72, 67, 4, 93, 52, 10, 86\}$, find 6th smallest element using Randomized-Select algorithm. Element at $1/4$ th location of resultant array is selected as pivot every time. (7)
- b) Consider the Union-Find data structure where Union procedure performs union by rank and Find procedure performs path compression. Prove that irrespective of the sequence of operations, the rank of any node is strictly less than its parent. Prove that the maximum rank of any node in a connected component containing n nodes is at most $\lfloor \log_2 n \rfloor$. How does the performance change if Union procedure does not perform union by rank? (8)
- Q. 6 a) A queue is implemented using two stacks, Stack1 and Stack2. ENQUEUE pushes elements onto Stack1. DEQUEUE pops from Stack2 if it's not empty; if Stack2 is empty, all elements from Stack1 are popped and pushed onto Stack2 before the DEQUEUE. Using the accounting method, assign an amortized cost of 3 for ENQUEUE and 1 for DEQUEUE. Show that these credits suffice to pay for all operations. Explain why the amortized cost per operation is $O(1)$ even though some DEQUEUE operations may take $O(n)$ time. (7)
- b) Apply the Ford-Fulkerson algorithm to find maximum flow from S (Source) to T (Sink) in the following graph G . Show the residual graph after every augmentation step. How does the Ford-Fulkerson algorithm ensure that the flow is maximized. (8)



Level 3: $-\infty$ 75 ∞
 Level 2: $-\infty$ 15 75 ∞
 Level 1: $-\infty$ 15 25 75 ∞
 Level 0: $-\infty$ 15 25 42 75 90 ∞

- b) Explain the process of deletion of a key in a B-Tree. Consider a B-Tree of order 4 with following initial structure:



Delete 3 and 6 from the B-Tree and clearly show all the necessary steps involved in deleting these keys.

(8)

(1500)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5784

K

Unique Paper Code : 2342013502

Name of the Paper : Theory of Computation (DSC)

Name of the Course : B.Sc. (Hons) Computer Science

Semester : V

Duration : 3 Hours

Maximum Marks : 60

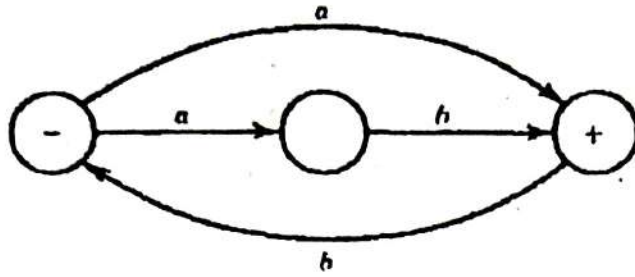
Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question No. 1 (Section A) is compulsory.
3. Attempt any 4 (four) questions from Section B.
4. Parts of a question should be attempted together.
5. Consider $\Sigma = \{a, b\}$ for all the questions unless specified otherwise.

Section A

1. (a) Describe (in English phrases) the language associated with the following regular expression : $(a + b)^* a (^ + bbbb)$.
- (b) Build a Deterministic Finite Automaton (FA) that accepts only those words that do not have the substring 'aa'. (3)
- (c) Prove that the regular languages are closed under complement. (3)
- (d) Show that if language L is recursive, then L is also recursively enumerable. (4)
- (e) Find the equivalent Deterministic Finite Automata for the following Non-Deterministic Finite Automata. (4)

P.T.O.



- (f) Consider the following Context-Free Grammar (CFG) : (4)

$$S \rightarrow XbaaX \mid aX$$

$$X \rightarrow Xa \mid Xb \mid \Lambda$$

What is the language this CFG generates? Find a derivation for *abaa*.

- (g) Convert the following grammar into Chomsky Normal Form (CNF) : (4)

$$S \rightarrow aSa$$

$$S \rightarrow bSb$$

$$S \rightarrow a$$

$$S \rightarrow b$$

- (h) Consider $L = \{a^p \text{ for } p = 2, 3, 5, 7, \dots \text{ i.e. } p \text{ is a prime number}\}$. Construct. Deterministic Finite Automata for L^* . (5)

Section B

2. (a) Consider the language S^* , where $S = \{a, b\}$. How many words does this language have of length 2? of length 3? of length n ? (4)
- (b) Write a regular expression for the language of all words that contain exactly two b 's or exactly three b 's, not more. (4)
- (c) Build a deterministic finite automaton that accepts the language of all strings of length 4 or more, such that the next-to-last letter is equal to the second letter of the input string. (7)

3. (a) Prove that the language $L = \{b^{2^n}a^n \text{ for } n = 1, 2, 3, \dots\}$ is not regular using the pumping lemma. (5)
- (b) Build a deterministic pushdown automaton for the language.

$$L = \{a^n b^m a^m b^n \text{ for } m, n = 1, 2, 3, \dots\}$$

(10)

Trace the word 'abbaab' on the PDA above.

4. (a) Design a deterministic pushdown automaton for the language (5)
- $$L = \{b^m a^n b^{m+n}, \text{ where } m, n \geq 1\}.$$

Consider the following context-free grammar (CFG): (10)

$$S \rightarrow AbB$$

$$A \rightarrow aA \mid \Lambda$$

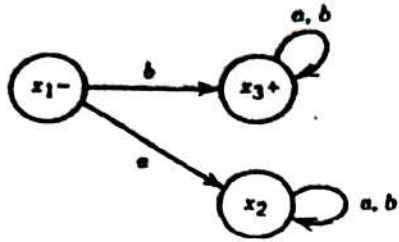
$$B \rightarrow aB \mid bB \mid \Lambda$$

- Construct a regular expression for this grammar.
- Create a parse tree for the word $aaba$.

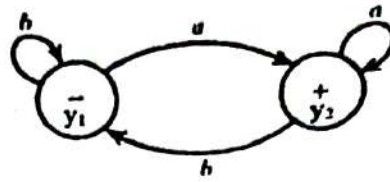
Is the above grammar ambiguous? Justify your answer.

5. (a) Let $S = \{ab, bb\}$ and let $T = \{ab, bb, bbbb\}$. Show that $S^* = T^*$. (3)
- (b) Find the intersection $(FA_1 \cap FA_2)$ of the following two deterministic finite automata: (6)

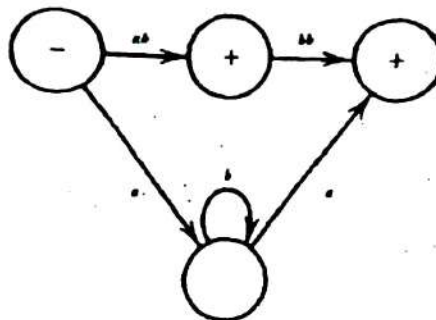
FA₁



FA₂



(c) Convert the following transition graph into its equivalent regular expression: (6)



- 6. (a) Describe the halting problem. (4)
- (b) Prove that if L is a recursive language, then its complement L' is also recursive. (5)
- (c) Build a Turing machine to copy the input string, i.e. it transforms the $\sqcup w \sqcup$ on the input tape into $\sqcup ww \sqcup$.

For example : $\sqcup aba \sqcup$ becomes $\sqcup abaaba \sqcup$ (6)

- 7 (a) Build a Turing machine (TM) for the language $L = \{a^n b^n c^{n+1} : n \geq 1\}$ over the alphabet $\Sigma = \{a, b, c\}$. (7)
- (k) Consider the following languages : (8)

L_1 = Language of all the words having 'ab' as a substring

L_2 = Language of all the words ending with 'b'

Build a finite automaton, FA_1 , with 3 states for L_1 , and FA_2 with 2 states for L_2 . Also, build a finite automaton (FA) for $FA_1 FA_2$ (concatenation).

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5842

K

Unique Paper Code : 2342013503

Name of the Paper : Software Engineering

Name of the Course : B.Sc. (H) Computer Science

Semester : V

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **Section A** is compulsory.
3. Attempt any **FOUR** questions from **Section B**.
4. Parts of a question should be attempted together.

SECTION A

1. (a) Select the most appropriate software development process model for each scenario described below and justify your choice with relevant reasoning:

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P.T.O.

- (i) A project that involves research, experimentation, and high uncertainty, where the final system requirements and solution are not clearly understood at the beginning.
- (ii) A software product being developed in a startup environment, where rapid releases, continuous customer feedback, and maximum flexibility are critical for business survival. (3)
- (b) Describe any three development activities used in Scrum. (3)
- (c) Differentiate between functional and non-functional requirements. (3)
- (d) What are the characteristics of risk? Explain the reactive and proactive risk strategies to deal with software development risks. (3)
- (e) Define the following two measures of Software Product Quality : (3)
- (i) Reliability
 - (ii) Maintainability

- (f) What is the purpose of Time Line Chart in project management? (3)
- (g) Assume that an organisation produces 450 LOC/PM with a burdened labour rate of \$5000/PM. Estimate the effort in Person-Month (PM) and cost in (\$) required to build the software having a total estimate of 70,000 LOC. (3)
- (h) A software increment is delivered to end-users by a software team. The users uncover 8 defects during the first month of use. Prior to delivery, the software team found 242 errors during formal technical reviews and all testing tasks. What is the overall DRE for the project? (3)
- (i) Illustrate any three process flows in software development with the help of diagram. (3)
- (j) Distinguish between Black-box and White-box testing techniques. (3)

SECTION B

2. (a) (i) What are Incremental Process Models? (7)
- (ii) Explain the Spiral Model with the help of suitable diagram.

(iii) Under which scenario is the spiral model more suitable for the development of software systems?

(b) Draw a labelled Context-Level and a Level-1 DFD for a store that sells paints and hardware products. The store receives supplies from multiple approved suppliers. Consider the following System Requirements :

(i) Customer Registration

- New customers provide their personal details to register with the store.
- The system stores the registration information in the Customer Database for future transactions.

(ii) Inventory Management

- The store maintains a Product Inventory Database containing details such as item name, item code, brand, price, quantity in stock, and supplier information.

(iii) Order Processing

- When a registered customer requests an item, the system checks inventory to confirm stock availability.

- If the item is available, the system records the order details (item code, quantity ordered, and unit price) in the Customer Database.

(iv) Billing

- Using the stored ordered-item details, the system generates and issues a Payment Receipt to the customer.

3. (a) Define Software Reliability? Discuss the three product quality factors introduced by McCall's Software Quality Model. (7)

(b) Explain the following elements of Software Quality Assurance. (8)

(i) Standards

(ii) Review and audit

(iii) Change Management

(iv) Vendor Management

4. (a) What is the significance of Boundary Value Analysis (BVA) in testing? Consider a program for computing the function $f(x, y)$ where the input variables x and y are in the range : (7)

$$5 \leq x \leq 50$$

$$10 \leq y \leq 100$$

Design the boundary value test cases for the program.

- (b) Compute the Function Point value for a project with the following information domain characteristics : (8)

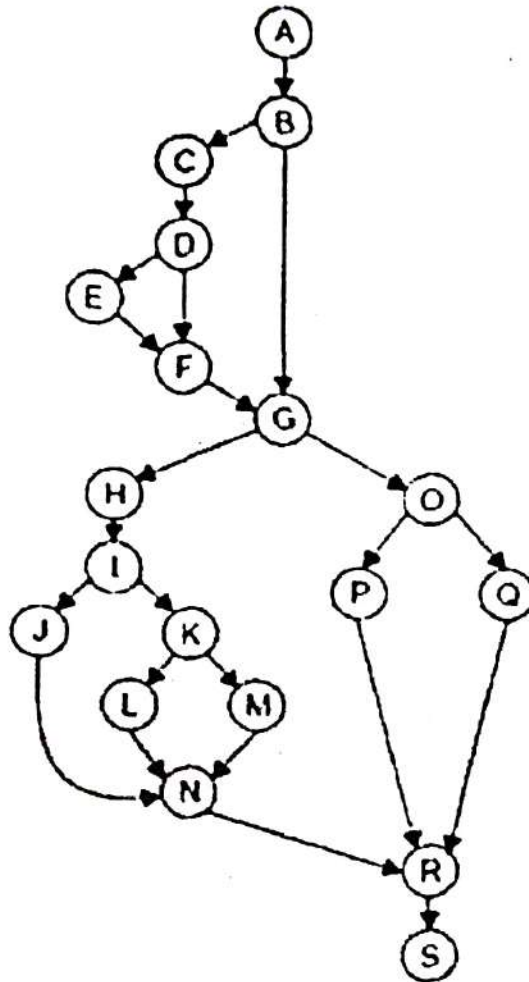
Measurement Parameters	Count	Weighing Factors		
		Low	Average	High
Number of user inputs	18	3	4	6
Number of user outputs	12	4	5	7
Number of user inquirers	6	3	4	6
Number of internal files	6	7	10	15
Number of external interfaces	3	5	7	10

Assume the Count of the Measurement Parameters are equally divided among low, average and high complexity. Further, assume that the complexity adjustment value is 1.75.

5. (a) What is Cohesion? Explain any five types of Cohesion with the help of suitable examples. (7)

(b) Consider the flow graph given below.

(8)



Answer the following:

- (i) Compute Cyclomatic Complexity using the three different methods.
- (ii) Write all the Independent paths.

6. (a) Answer the following related to Risk Management :

(7)

(i) Describe three categories of Project Risk.

(ii) Write the steps to be taken to mitigate risk for reducing 'Staff Turnover'.

(b) What is the importance of SRS (Software Requirements Specification) document in software development? Describe any five characteristics of an SRS. (8)

7. (a) What is Capability Maturity Model Integration (CMMI)? Explain the various maturity layers of CMMI in detail. (7)

(b) Write short notes on the following with suitable examples : (8)

(i) Equivalence class partitioning.

(ii) Umbrella Activities.

[This question paper contains 4 printed pages.]

Your Roll No.....

K

Sr. No. of Question Paper : 6602

Unique Paper Code : 2343010010

Name of the Paper : Data Privacy

Name of the Course : B.Sc. (II) Computer Science – DSE NEP-UGCF

Semester : V

Duration : 2 Hours

Maximum Marks : 60

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. The question paper has two sections.
3. Section A is compulsory.
4. Attempt any four questions from Section B.
5. All parts of a question must be attempted together.

Section – A

- Q1. (a) Explain the difference between Confidentiality and Integrity as components of the Confidentiality, Integrity and Availability (CIA) triad. Give one mechanism used to enforce each. 3
- (b) Define a Trojan horse attack. Is this classified as a threat, vulnerability, or a risk? Justify your answer. 3
- (c) Explain the concept of Collision Resistance in a cryptographic hash function. What is the minimum required output size (in bits) for a hash function to be practically collision-resistant? 1+2
- (d) Differentiate between Explicit Identifiers (EI) and Quasi-Identifiers (QI). Provide one example of each type of identifier from a typical customer database. 3
- (e) Briefly explain the Homogeneity Attack and which specific privacy model (K-anonymity, L-diversity, or t-closeness) was designed to counter it. 3
- (f) Discuss the Principle of Data Minimization under the General Data Protection Regulation (GDPR) or the Digital Personal Data Protection (DPDP) Act. Why this principle is considered foundational for privacy-by-design? 3

P.T.O.

- (g) Define a Personal Data Breach as per the DPDP Act. Briefly explain the timeline for reporting such a breach. 3
- (h) Define a Data Processor as per the DPDP Act. Briefly explain how its responsibilities differ from those of a Data Fiduciary. 3
- (i) Explain how Public Key Infrastructure (PKI) is used to establish trust in the identity of a communicating party. 3
- (j) Give three examples of societal harms that can arise from the aggregation and analysis of anonymized datasets. 3

Section-B

- Q2. (a) Describe the function and primary goal of the Model Surveillance System in the context of data management and privacy engineering. Explain the various monitoring stages involved in this system with the help of a conceptual diagram. 2+5
- Q2. (b) Discuss the different lawful bases for processing personal data under General Data Protection Regulation (GDPR), focusing on Legitimate Interests and Contractual Necessity. Provide a relevant example for each. 4+4
- Q3. (a) Based on the case studies below, identify the relevant section(s) or key provision(s) of the DPDP Act that are violated or applicable. For each case, briefly describe the section(s) and explain why they apply. 4*2
- i. A health insurance company discovers that a third-party vendor it hired to process claims, experienced a significant security incident exposing the health records of thousands of policyholders. The insurance company refuses to take responsibility, claiming the vendor is solely liable for the breach.
 - ii. A local e-governance portal automatically sets the language preference of a new user based on their IP address and stores this preference without informing the user or providing an easy opt-out mechanism for language tracking.
 - iii. A social media platform continues to store and process the chat history and personal details of users after the users explicitly withdrew their consent for data processing and requested their data be erased.

- iv. A children's gaming app collects and tracks the precise location data of its young users, then uses this information to show them targeted ads for nearby stores.
- Q3. (b) How de-anonymization is prevented with respect to the following data types? 2+2+3
- I. Location/Spatial Data
 - II. Text/Free-form Data
 - III. Relational Data (Tables)
- Q4. (a) Compare and contrast Privacy-by-Design (PbD) and Security-by-Design (SbD). Highlight at least four key differences in their scope, objectives, and implementation approaches within an organization. Give an example of a practice that satisfies both PbD and SbD simultaneously 4+4
- Q4. (b) For any robust hash function, define Pre-image Resistance, Second Pre-image Resistance, and Collision Resistance. Also, explain why a weakness in **Collision Resistance** is particularly devastating for the integrity of a system that uses digital signatures. 3*2+1
- Q5. (a) Encrypt the plaintext message "PRIVATE DATA" using the followings: 3+4
- i. Caesar Cipher with a key shift of $k=7$
 - ii. Rail Fence Cipher with a key of 3 rails.
- Show the resulting cipher texts for both methods.
- Q5. (b) Define the concept of **k-Anonymity** in the context of data privacy. Specifically, explain how it relates to **Quasi-Identifiers (QIs)** in a dataset. Using the table provided below, demonstrate how a dataset is transformed to satisfy a k-anonymity requirement (e.g., $k=3$) through the two primary techniques: **Generalization** and **Suppression**. What is the specific privacy vulnerability (or type of attack) that **k-anonymity fails to fully address**, and which therefore necessitates the use of more advanced techniques like **L-Diversity**? 2+6

ID (Identifier)	Age (QI)	Gender (QI)	City (QI)
101	35	Male	London
102	34	Male	Paris
103	28	Female	London
104	29	Female	Paris
105	36	Male	London
106	51	Female	Paris
107	50	Female	London
108	52	Male	Paris
109	28	Female	London
110	53	Male	London

- Q6. (a) Classify the following attributes into Explicit Identifiers (EI), Quasi-Identifiers (QI), or Sensitive Data (SD), and justify your classification: 8
- i. Religious Affiliation
 - ii. First Name
 - iii. Age (in years)
 - iv. Vehicle Registration Number
- Additionally, explain the concept of discrimination harm arising from poor data privacy practices.
- Q6. (b) Differentiate between Symmetric-Key and Asymmetric-Key encryption based on key management and speed. 4+3
Explain why brute-force attacks against the key are generally more feasible for shorter symmetric keys compared to equivalent length asymmetric keys.
7. (a) What is the composition and appointment process of the members of the Data Protection Board of India? 7
7. (b) Explain four Ethical considerations in Data collection. Describe how these ethical considerations can be addressed in practice. 8

[This question paper contains 4 printed pages.]

Sr. No. of Question Paper : 516

Your Roll No.....

K

Unique Paper Code : 2343010010

Name of the Paper : Data Privacy

Name of the Course : B.Sc. (II) Computer Science – DSE NEP-UGCF

Semester : VII

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. The question paper has **two** sections.
3. **Section A** is compulsory.
4. Attempt any **four** questions from **Section B**.
5. **All** parts of a question must be attempted together.

Section – A

- Q1. (a) Define a denial-of-service attack. Is it an active or a passive attack? Justify your answer. 3
- (b) What sections of the Digital Personal Data Protection (DPDP) Act are violated if an organization collects data without explicit consent? Explain the sections briefly. 3
- (c) Differentiate between Impprecise and Insecure use of Data. 3
- (d) How are authenticity, integrity, and non-repudiation preserved with the use of Digital Signatures? 3

- (e) Why is it important for a cryptographic hash function to be collision-resistant? How does this property contribute to security? 2+1
- (f) List three economic harms caused by data leaks or incorrect data profiling. 3
- (g) Give the full form and briefly explain:
 i. HIPPA 3
 ii. COPPA
- (h) What is Personally Identifiable Information (PII)? For each of the following, state whether it qualifies as PII and justify your answer: 3
 i. Passport number
 ii. Browser cookies
- (i) Explain the concept of 'Transparency', 'Consent' and 'Fair Processing' with respect to the General Data Protection Regulation (GDPR). 3
- (j) Justify the statement "Privacy and Anonymity are the two sides of the same coin". 3

Section - B

- Q2. (a) Explain the CIA triad with respect to Information Security. Discuss how the concepts of authenticity and accountability complement these objectives. 7
- (b) Discuss the major principles of General Data Protection Regulation (GDPR). 8
- Q3. (a) Based on the case studies below, identify the relevant section(s) of the Digital Personal Data Protection (DPDP) Act that are violated or applicable. For each case, briefly describe the section(s) and explain why they apply. 3.5*2
- i. A fitness-tracking app collects users' heart-rate and exercise location data and stores it in plain text on a cloud database. A developer team member accidentally publishes a dataset snapshot to a public repository. The company delays informing affected users and the Data Protection Board for three months, citing reputation concerns.

- ii. A smart-toy manufacturer collects voice recordings of children to improve voice recognition. The toy's privacy policy does not disclose voice recording collection, and parental consent was not obtained before enabling the feature. The company uses those recordings to train a commercial speech model sold to advertisers.
- (b) How is the aspect of privacy preserved with respect to the following data types: 8
- i. Time Series Data
 - ii. Longitudinal Data
 - iii. Graph Data
- Q4. (a) Explain the different anonymization techniques: 2+2+3
- i. Generalization
 - ii. Suppression
 - iii. K-anonymity
- (b) Compare and contrast the followings: 8
- i. Symmetric and Asymmetric Encryption
 - ii. Privacy-by-Design and Privacy Engineering
- Q5. (a) Encrypt the plaintext = "Data Privacy" using the following methods: 3.5*2
- i. Caesar cipher with shift of 6
 - ii. Rail fence cipher with 4 rails
- (b) Explain cryptographic hash function. Also, discuss the purpose of using a cryptographic hash function in digital signatures and message integrity? 8
- Q6. (a) Describe the Model Surveillance system with the help of a diagram. 7
- (b) A bank maintains two separate tables: 4*2
1. Customer Table – *Name, Age, Phone Number, Address*
 2. Accounts Table – *Account Balance, Loan Status, ATM Usage*
- i. Classify the attributes in the Customer Table into EI and QI.
 - ii. Identify which attributes in the Accounts Table qualify as Sensitive Data (SD).
 - iii. Explain why combining quasi-identifiers (QI) with sensitive data (SD) is considered a serious privacy threat.
 - iv. Explain the difference between Explicit Identifiers (EI) and Quasi-Identifiers (QI).

P.T.O.

- Q7. (a) Identify three harms associated with improper data collection. Suggest measures to prevent these harms. 7
- (b) Explain four Ethical considerations in Data collection. Describe how these ethical considerations can be addressed in practice. 8

This question paper contains 5 printed pages]

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S. No. of Question Paper : 5765

Unique Paper Code : 2342014701

Name of the Paper : Compiler Design

Type of the Paper : NEP-UGCF-2022 (DSC)

Name of the Course : B.Sc. (Hons.) Computer Science

Semester : VII

Duration : 3 Hours

Maximum Marks : 90

(Write your Roll No. on the top immediately on receipt of this question paper.)

Section A is compulsory.

Attempt any four questions from Section B.

Parts of a question must be answered together.

Section-A

- (a) Why is lexical analysis separated from parsing ?
- (b) Differentiate between a compiler, interpreter and assembler.
- (c) Which phase of a compiler is optional and why ?
- (d) Differentiate LL (0) and LL (1) parser with example.

(2)

(e) Consider the grammar :

 $S \rightarrow c A d$ $A \rightarrow a b \mid a$ Construct a top-down parse tree for the input string $w = cad$.

(f) Determine whether the given grammar is ambiguous or not. Give reasons : 5

 $E \rightarrow E + E \mid E * E \mid id$

(g) Find FIRST and FOLLOW of each variable for : 5

 $S \rightarrow AB$ $A \rightarrow Aa \mid \epsilon$ $B \rightarrow Bb \mid \epsilon$

(h) Draw a block diagram to illustrate all the phases of a compiler. Explain each phase briefly. 5

Section-B

2. (a) Write short notes on : 8

(i) Symbol table

(ii) Peephole Optimization

(iii) Dynamic Storage Allocation.

- (b) For the given arithmetic expression :

7

$$b - b * (a + d) - (a + d) * c$$

(i) Give its three-address code

(ii) Draw its DAG.

3. (a) Construct SLR(1) parsing table for the following grammar :

8

$$S \rightarrow AaBb \mid BbBa$$

$$A \rightarrow \epsilon$$

$$B \rightarrow \epsilon$$

Discuss whether the above grammar has shift-reduce conflict or reduce-reduce conflict ? Give reasons to support your answer.

- (b) For the grammar given below, generate a predictive parsing table :

7

$$E \rightarrow T E'$$

$$E' \rightarrow + T E' \mid \epsilon$$

$$T \rightarrow F T'$$

$$T' \rightarrow * F T' \mid \epsilon$$

$$F \rightarrow (E) \mid id$$

4. (a) Consider the following regular expressions :

8

i. $0(1^*)1$

ii. $(ab)(a|b|c)^*$

iii. $(a|b)^*a(a|b)^*a(a|b)^*$

For each, describe precisely the language accepted by these regular expressions.

(b) Consider the context-free grammar :

$$S \rightarrow S + S \mid S * S \mid (S) \mid a$$

and the string $(a + a) * a$

- (a) Give a leftmost derivation for the string.
- (b) Give a parse tree for the string.
- (c) Is the grammar ambiguous or unambiguous ? Justify your answer.

5. (a) Show and explain the steps performed by a compiler while translating the given assignment statement :

$$a = 10 + b$$

(b) Consider the following three-address code :

- (1) $i = 10$
- (2) $j = 1$
- (3) $a = i * j$
- (4) $b = i + j$
- (5) if $a \leq b$ goto (3)
- (6) $a = a + 1$
- (7) $i = i - 1$
- (8) goto (3)
- (9) Exit

Draw the control-flow graph and find the number of basic blocks, number of nodes and number of edges in the graph.

6. (a) Give bottom-up parser for the following : 8
- (i) Grammar : $S \rightarrow 0 S 1 \mid 0 1$; input string : 000111
- (ii) Grammar : $S \rightarrow S S + \mid S S * \mid a$; input string : aaa *a + +
- (b) Consider the following example involving a recursive Fibonacci function : 7

```

int fibonacci(int n)
{
    int t, s;
    if (n < 2) return 1;
    s = f(n-1);
    t = f(n-2);
    return s+t;
}

int main()
{
    fibonacci(5);
}

```

Show the activation tree representing calls during an execution of above program.

7. (a) Give LR(0) automaton for the following grammar : 8

```

E -> E + T | T
T -> T * F | F
F -> ( E ) | id

```

- (b) Define semantic errors in a compiler. Discuss the challenges associated with detecting and handling semantic errors. Provide example to illustrate semantic issues. 7

This question paper contains 6 printed pages

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S. No. of Question Paper : 8675

Unique Paper Code : 2343010016

Name of the Paper : Computer Graphics

Name of the Course : B.Sc. (H) Computer Science NEP

Semester : VII

Duration : 3 Hours

Maximum Marks : 90

(Write your Roll No. on the top immediately on receipt of this question paper.)

The paper has two sections A and B. Section A is compulsory.

Attempt any *four* questions from Section B.

Each question is of 15 marks.

Answer all parts of a question together.

Section A

- (a) Calculate the memory (in Kilobytes) required to store an image of 640 × 480 resolution if each pixel required 3 bytes storage.

(b) Explain RGB colour model and its applications in digital and print media.

- (c) What are homogeneous coordinates ? Give *two* advantages of homogeneous coordinates. 3
- (d) Write the differences between perspective projection and orthographic projection. 3
- (e) Derive the Bezier blending function. 3
- (f) State the odd-parity rule. Explain how horizontal edges are handled in odd parity rule. 3
- (g) What is a polygon mesh ? Illustrate any *one* polygon mesh representation. 3
- (h) Define resolution, aspect ratio and persistence. 3
- (i) Rotate the point (5, 2) by 45° counterclockwise about the origin. 3
- (j) Prove that parallel lines remain parallel after transformation. 3

Section B

2. (a) Given the centre of projection (COP) as (0, 0, 0) and projection plane as $z = 1$. Perform the following transformations : 5
- (i) Project the point P(2, 1, 4) onto the $z = 1$ plane.
- (ii) A line segment has endpoints A(1, -1, 3) and (3, -1, 6). Project both points onto $z = 1$ plane and find the length of the projected line segment.

- (b) What do you mean by hidden surfaces ? List the tests performed to check the order of drawing overlapping polygons in Depth sort algorithm. 5
- (c) Given a triangle A(2, 3), B(4, 5), C(6, 1), find the final coordinates of the triangle after applying the following transformations : 5
- (i) Rotation of 45° about origin
- (ii) Scaling by a factor of 2 w.r.t. the pivot point A(2, 3).
3. (a) Consider the following two cubic Bézier segments C1 and C2 that join at P3(4, 0). 5
- C1 defined by P0(0, 0), P1(1, 2), P2(3, 2), P3(4, 0).
- C2 defined by P3(4, 0), Q1(x, y), Q2(7, -1), Q3(9, -1). Find the point Q1 that guarantees C1 continuity at the join point.
- (b) Using the Scanline polygon fill algorithm, determine the intersection points of the scanlines $y = 3$ and $y = 5$ with the edges of the triangle having vertices A(2, 2), B(6, 2) and C(4, 6). List all the intersection points that would be entered into the active edge table for these scanlines. 5

P.T.O.

(c) Construct a composite 4×4 3D transformation matrix with the following transformations : 5

(i) Rotation of 30° about the Z-axis.

(ii) Overall scaling by a factor of two.

(iii) Translation by 5 units in x-direction, -3 units in y-direction and 2 units in z-direction.

(iv) Parallel projection on $z = 0$ plane.

4. (a) Derive cubic Hermite basis matrix and its blending functions. Write any two characteristics of Hermite curves. 5

(b) Use Bresenham's midpoint ellipse algorithm to compute region-1 points for an ellipse with major axis as 6 and minor axis as 4, centred at origin. Write all steps. 5

(c) Derive mathematical formulation for Phong illumination model considering ambient, diffuse and specular reflection. 5

5. (a) Using the Bresenham's midpoint circle algorithm, find the points for the first octant of a circle with centre at (0, 0) and radius $r = 5$. 5

(b) For the line segment $P_1(-5, 4)$ to $P_2(12, 10)$ and clipping window $x_{\min} = 0$, $x_{\max} = 10$, $y_{\min} = 2$, $y_{\max} = 8$. 5

(i) Assign the region codes to both endpoints.

- (ii) Determine whether the line is trivially accepted, rejected or needs clipping.
- (iii) Calculate the coordinates of the clipped line segment.
- (c) Explain in detail the area subdivision Warnock's algorithm. 5
6. (a) Briefly explain how can we simulate zero acceleration, positive acceleration, decreasing acceleration between two key frames in an animation. 5
- (b) Find the two-point perspective projection of the line AB with endpoints A(0, 2, 2, 1) and B(4, 2, 6, 1), where the plane of projection is $z = 0$ and centre of projection are at $y = 2$ and $z = 1$ respectively. Also find the two vanishing points. 5
- (c) Given a triangle ABC, A(2, 0), B(4, 1), C(3, 3) : 5
- (i) Reflect the triangle with vertices about the line $y = (\frac{1}{2})x + 1$.
- (ii) Find the reflected vertices A'B'C'.
- (iii) Compute the area of triangle A'B'C'.
7. (a) Clip the polygon (2, 2), (8, 2), (8, 5), (2, 5) against the left clipping boundary $x = 5$ using Sutherland-Hodgman polygon clipping. Show a step-by-step list of entering and exiting points. 5

P.T.O.

- (b) A point $P(3, 4, 5)$ is first translated and then rotated : 5
- (i) Translate P by the vector $(2, -1, 4)$ using the homogeneous translation matrix.
 - (ii) Rotate the translated point by 90° about the Z -axis using the homogeneous rotation matrix.
 - (iii) Write the final coordinates after both transformations.
- (c) Rasterize a line from $(2, 3)$ to $(7, 6)$ using the DDA line drawing algorithm. Show all pixel values. 5

(11)
This question paper contains 4 printed pages]

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S. No. of Question Paper : 10574

Unique Paper Code : 2343010016

Name of the Paper : Computer Graphics

Name of the Course : B.Sc. (H) Computer Science NEP

Semester : VII

Duration : 3 Hours

Maximum Marks : 90

(Write your Roll No. on the top immediately on receipt of this question paper.)

The paper has two sections A and B. Section A is compulsory.

Attempt any four questions from Section B. Each question is of 15 marks.

Answer all parts of a question together.

Section-A

1. (a) State any two properties of Bezier curve. 2
- (b) What are trace points ? How are they different from principal vanishing points ? 2
- (c) Differentiate between the RGB and CMY colour models by listing any two properties of each. 2

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P.T.O.

- (d) Write steps to design animation sequence. 3
- (e) Define resolution, persistence and aspect ratio. 3
- (f) What is anti-aliasing ? State any *one* method to reduce or prevent aliasing in computer graphics. 3
- (g) What are homogenous coordinates ? What is their importance ? 3
- (h) Consider the rectangle with vertices (0, 0), (0, 2), (3, 0), (3, 2). Find new coordinates of the rectangle with a scaling of 2 along *x*-axis and 3 along *y*-axis. Give the transformation matrix and the final coordinates. 4
- (i) Differentiate between the following : 4
- (i) Orthographic and Oblique projection
- (ii) Cabinet and Cavalier parallel projection
- (j) List and explain the data structures used in scan line polygon filling algorithm. 4

Section-B

2. (a) Using homogeneous 4×4 transformation matrices, rotate the point (1, 2, 3, 1) by 90° about the *x*-axis, *y*-axis and *z*-axis, write the corresponding rotation matrices and compute the new coordinates after each rotation. 7

- (b) Explain the architecture of raster display system with integrated display processor. Write *four* differences between raster scan display and random scan display. 8
3. (a) Write a short note on hidden surface removal. Explain depth sort algorithm for visible surface determination. 7
- (b) Perform a three-point perspective projection onto $z = 0$ plane of unit cube, where centre of projection along x-axis is $X_c = 10$, along y-axis is $y_c = -10$ and along z-axis is $z_c = -10$. 8
4. (a) Find the equation of a Bezier curve with the following four control points : 7
 $B_0[1 \ 0], B_1[3 \ 3], B_2[6 \ 3], B_3[8 \ 1]$.
 Determine any *two* points lying on the curve.
- (b) Derive the basis matrix for Hermite curve. Find the Hermite curve passing through the starting point $P_0 = (2, 3)$ and end point $P_1 = (6, 5)$, with tangent vectors $R_0 = (1, 2)$ at P_0 and tangent $R_1 = (2, 1)$ at P_1 . 8
5. (a) Use Cohen Sutherland algorithm to clip a line $P(70, 20)$ and $Q(100, 10)$ to clip a line against a window with lower left-hand corner $(50, 10)$ and upper right-hand corner $(80, 40)$. 7
- (b) Explain homogenous coordinates. What is their importance ? Show that a 2D reflection about the x-axis followed by 2D reflection about the line $y = x$ is equivalent to a pure rotation about the origin. 8

P.T.O.

6. (a) Explain Z-buffer algorithm. Write *two* advantages and *two* disadvantages of Z-buffer algorithm. 7
- (b) State the rules used to match or equalize the number of edges in the shapes at key frames "k" and "k+1" in an animation sequence. Then, using these rules, show how a triangle can be converted into a pentagon. 8
7. (a) Given the centre coordinates (0, 0) and radius = 10. Generate the points of the first octant of the circle using mid-point circle drawing algorithm. 7
- (b) Explain the Sutherland-Hodgeman polygon clipping algorithm. Describe the steps involved in clipping a polygon against a rectangular clipping window. Using a suitable diagram, illustrate how the algorithm handles the four possible cases. 8

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 10578 **K**
Unique Paper Code : 2343010024
Name of the Paper : Cyber Forensics
Name of the Course : B.Sc. (Hons) Computer
Science – Discipline Specific
Elective
Semester : VII

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **Section A** is compulsory.
3. Attempt any 4 (**Four**) questions from **Section B**.
4. All parts of a question must be answered together.

Section A

1. (a) Briefly describe any three popular data recovery tools used by cyber forensic experts. (3)

- (b) Give any three precautionary measures that an Investigating Officer should take before acquiring digital evidence from a cyber-crime scene to ensure its integrity and prevent data loss. (3)
- (c) Differentiate between encryption and decryption. Name any two free open-source tools used to encrypt and decrypt files. (3)
- (d) What is digital signature? Explain its significance with respect to cyber security. (3)
- (e) How does Electronic Data Interchange (EDI) facilitate e-commerce transactions? (3)
- (f) What are write blockers? What is the difference between hardware and software write blockers? (3)
- (g) Differentiate between the following : (3×4=12)
- (i) FAT and NTFS
 - (ii) MBR and GPT partition schemes
 - (iii) Volatile and Non-Volatile Evidences
 - (iv) Swap files and Temporary files

Section B

(Attempt any four questions)

2. (a) Describe any three forensic tools that can be used to prevent, detect and analyse network attacks. (6)

- (b) What is Autopsy tool? Explain the operations that can be performed with this tool. (9)
3. (a) Name and explain the file system used by Linux/ Unix operating systems. Briefly describe any three versions of this file system. (7)
- (b) What are the various steps involved in the Forensic Investigation Process? (8)
4. (a) What are steps taken by the Investigating Officer during a cybercrime scene investigation? (5)
- (b) What is the purpose of Recuva tool? Explain briefly. (5)
- (c) What is Computer Fraud and Abuse Act (CFAA)? State any four misuses that are considered as criminal activities under Section 1030(a) of the CFAA. (5)
5. (a) Discuss any three operations that can be performed under email forensics. (6)
- (b) State and explain the following IPC Section under IT Act : (6)
- (i) 65
- (ii) 66B
- (iii) 72

- (c) Differentiate between BagMRU and RunMRU. (3)
6. (a) What is chain of custody? What data is included in chain of custody form? (5)
- (b) Enumerate any four tools used for drive imaging and validation. (4)
- (c) Explain briefly the following terms : (6)
- (i) E-Commerce
 - (ii) Dual key encryption
7. (a) Elaborate on Passware Kit Forensic tool for password recovery. (6)
- (b) What is windows registry? What is its purpose? (3)
- (c) Describe the output for following commands.
- (i) `grep "error" abc.txt`
 - (ii) `grep "404" abc.txt | wc -l`
 - (iii) `sed 's/unix/linux/' abc.txt`
 - (iv) `sed 's/unix/linux/g' abc.txt`
 - (v) `awk '{print $1, $4}' abc.txt`
 - (vi) `awk '/manager/ {print}' abc.txt` (6)

(13)
This question paper contains 6 printed pages|

Roll No.

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S. No. of Question Paper : 10581

Unique Paper Code : 2343010027

Name of the Paper : Digital Image Processing

Name of the Course : B.Sc. (H) Computer Science (NEP)

Semester : VII

Duration : 3 Hours

Maximum Marks : 90

(Write your Roll No. on the top immediately on receipt of this question paper.)

Question No. 1 is compulsory.

Attempt any 4 of Question Nos. 2 to 7.

Parts of a question must be answered together.

Use of simple non programmable calculator is allowed.

SECTION A

- 1 a) Define Isopreference curve with its application and suitable example. (2)
- b) Draw the bit planes for given 2-bit sub-image of size 2×2 . (2)

2	3
0	1

Sub-image

- c) Write any two sources of image noise. Write the mean and variance for uniform noise. (2)
- d) Calculate the number of bits required to store a 64×64 image with 128 gray levels. (2)

(2)

e) What is the significance of sampling? How is the resolution of an image affected by sampling? (2)

f) For the given 20-byte string, compute the encoded string by using run length encoding. Also, calculate the compression ratio. (4)

SSSSSSSSSTTTTTNGGMMM

g) Write 3×3 mask for the following low pass filters used for image smoothing: (4)

i. Gaussian filter

ii. Box filter

h) Write all the steps involved in frequency domain filtering? (4)

i) What is the significance of using a Laplacian filter on a digital image? (4)
Apply Laplacian filter on the given image (I) on the center pixel using kernel (K)

8	5	4
0	6	2
1	3	7

(I)

0	1	0
1	-4	1
0	1	0

(K)

j) Answer the following: (4)

i. Which morphological operation can be used to repair the broken characters in a digital image?

ii. Write the name of the morphological operation which can be used to find the instances of object A in a digital image.

iii. Write the name of the morphological operation used to detect the shape of an object in a digital image.

iv. Write the mathematical equation for the morphological operation used for boundary detection.

Section B

- 2 a) Consider the following sub-image: (7)

3	2	1	l(q)
0	2	0	2
1	2	1	1
l(p)	0	1	2

Let $V = \{0, 1\}$ be the set of intensity values used to define adjacency. Compute the length of shortest of 4-, 8-, and m-path between p and q. If a particular path does not exist between these two points, explain why?

- b) Define Discrete Fourier Transform (DFT) and Inverse-Discrete Fourier Transform (IDFT). Compute the DFT of the given time domain sequence: (8)

$$x(n) = \{1, 2, 4, 1\}$$

Values of exponentials are as follows:

$$e^{j0} = e^{-j0} = e^{-j2\pi} = 1, \quad e^{j\pi} = e^{-j\pi} = e^{-j3\pi} = -1,$$

$$e^{j\frac{\pi}{2}} = e^{-j\frac{3\pi}{2}} = j, \quad e^{j\frac{3\pi}{2}} = e^{-j\frac{9\pi}{2}} = e^{-j\frac{\pi}{2}} = -j$$

- 3 a) Apply the Basic Global Thresholding algorithm on the following 4×4 (7) gray-scale sub-image to determine the final threshold value T and obtain the segmented binary sub-image.

25	55	70	35
45	80	20	60
30	85	40	75
50	90	25	65

Sub-image

P.T.O.

Use the initial global threshold $T_0=65$. Stop the iteration when the threshold value is less than 1. Show all intermediate steps for each iteration.

- b) Consider the following 4-bit 5×5 sub-image: (8)

4	0	4	0	9
4	1	8	9	8
1	1	6	6	6
1	0	5	3	6
1	1	5	2	6

Perform the following operations for this sub-image:

- Negative of sub-image
- Log transformation with $c = 1$
- Power law transformation with $c = 1$ and $\gamma = 5$.

- 4 a) A source generates a sequence of symbols as follows: (7)

$F = [a a a b b a a a c c c b d d e e e c c d d f f e d d c d d d d]$

- Determine the frequency and probability of each symbol.
- Construct the Huffman code for the symbols based on their probabilities found in part (i).
- Average Code Length of the source

- b) Given below is a 3×3 3-bit sub-image: (8)

1	7	5
6	2	3
1	4	2

Sub-image

What would be the value of the center pixel when this image is passed through the following filters:

- Arithmetic mean filter
- Geometric mean filter
- Harmonic mean filter
- Min filter

- 5 a) Consider the following sub-image A and structuring element B (origin of the structuring element B is indicated with an encircled value). Perform the closing morphological operation on sub-image A by structuring element B.

0	0	0	0	0	0	0	0
0	1	1	0	0	0	1	1
0	1	1	1	0	0	1	1
0	0	0	1	1	0	0	0
0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0

Sub-image A

1	1	1
1	1	1
1	1	1

Structuring Element B

- b) Consider a 3-bit sub-image of size 5×5 . Perform the following (8) operations (in both x and y directions) at pixel position p on the given sub-image:
- i. 3×3 Prewitt gradient operator.
 - ii. 3×3 Sobel operator.
 - iii. 2×2 Roberts operator.

2	4	7	0	1
3	5	3	4	1
4	0	5	3	1
2	5	0	4	2
1	0	2	2	5

- 6 a) What is image restoration? Draw and explain the basic block diagram of (7) the restoration process.

- b) Calculate the first-order and second-order derivatives for the given 1-D (8) signal. How many zero crossings are present in the second-order derivative?

5	5	4	3	2	1	0	0	0	6	0	0	0	0	1	3	1	0	0	0	0	7	7	7
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- 7 a) Consider the following table showing gray levels of an image and the corresponding number of pixels for each level: (7)

Gray Level	0	1	2	3
Number of pixels	70	20	7	3

- Plot the histogram of the given gray-level data.
 - Perform the histogram equalization on the given data, showing all intermediate steps.
 - What is the effect of equalizing the histogram twice?
- b) What is intensity level slicing? Perform intensity level slicing in two (8) ways on a 3-bit image of size 5×5 given below:

2	1	2	2	1
2	3	4	5	2
6	2	7	6	0
2	6	6	5	1
0	3	2	2	1

Assume intensity range to be highlighted as (3-5). Write the modified 5×5 image obtained in each case.

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 6348

K

Unique Paper Code : 2342571102

Name of the Paper : Programming Using C++

Name of the Course : B.A. (P) CS M/N.M. & B.Sc. (PS/MS) with CS

Semester / Type : I / Discipline Specific Course A1 DSC

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Section A is compulsory.
3. Attempt any four questions from Section B.
4. Parts of a question must be answered together.
5. Use of scientific calculator is allowed.

Section A: 30 Marks

1. a) How built-in data types are different from derived data types. Give example. 5
b) Which of the following are valid identifiers and which of the following 5
invalid identifiers? Give reasons for each.
i) @count
ii) _count
iii) 3count
iv) #marks
v) Marks#
vi) english_marks
vii)countofstudents
viii) gmg4fuzj
ix) wluqfvy\$
x) gc7z4z
- c) Answer the following in one word: 5
i) An object-oriented programming language which does not allow multiple inheritance.

P.T.O.

- ii) The process of making an operator exhibit different behaviour in different instances is known as ?
 - iii) Header file that contains macros and helps in debugging.
 - iv) Header file that contains classes for identifying data types during execution.
 - v) Header file that contains classes for stream manipulation and formatting of data streams.
- d) Explain under what circumstances the following statements are used (any two) 2.5+2.5
- i) `throw;`
 - ii) `void fun1(float x) throw()`
 - iii) `catch (...)`
- e) i) Give four instances where inline function may not work. 2
- ii) Explain with example if a compiler ignore the inline function definition ? 1
- iii) Explain the tradeoff associated with the inline function ? 2
- f) How multi-level inheritance and multiple inheritance are different? Explain with example. 5

Section B: 60 Marks

2. a) Explain with example how pointer to functions is different from pointer to objects? 5
- b) Write a C++ program that uses a for loop to compute the sum of the first n natural numbers. The program asks the user to input a value for n and print out the sum. 6
- c) Explain the following statements with the help of an example: 2+2
- i) `break`
 - ii) `continue`
3. a) Find the error and correct the code 2*5
- i) `int m==40;`
 - ii) `if(x = 10) cout << "Yes";`
 - iii) `float arr[5] = {1, 2, 3, 4, 5, 6};`
 - iv) `int *p = &x; delete p;`
 - v) `for(int i=0; i<10; i--);`
- b) Why are access specifiers (private, public, protected) considered a tool of encapsulation? 5
4. a) Write a menu driven C++ program simulating a simple Shape hierarchy. Declare a base class called Shape with a virtual function `area()`. Derive two classes, Circle and Rectangle, each overriding the `area()` function to calculate the area of a circle and a rectangle respectively. The program will take all inputs necessary-for example, the radius for the circle and the length and width for the rectangle. The program should calculate the area and print the results. 8

- b) Explain call-by value and call-by reference with the help of example. Write a program to swap two numbers using these two concepts. 4+3
5. a) Explain how polymorphism can be achieved during run time using virtual functions. 5
- b) Write a program using c++ for the following numeric pyramid pattern: 5

```

1
1 2 1
1 2 3 2 1
1 2 3 4 3 2 1
1 2 3 4 5 4 3 2 1

```

- c) Given an array of n integers, write a user interactive program in C++ using recursive function to print all possible subsets of the array. The program should take array size and array values from the user. 5
6. a) Differentiate between object-based programming language and object-oriented language. 6
- b) Identify the error and rectify. Explain the reason also. 3*3

i) Code 1

```

#include <iostream>
using namespace std;
int main() {
    int *ptr;
    *ptr = 10;
    cout << "Value: " << *ptr << endl;
    delete ptr;
    return 0;
}

```

ii) Code 2

```

#include <iostream>
using namespace std;
class Test {
    int x;
public:
    Test(int val) { x = val; cout << "Constructor called\n"; }
    ~Test() { cout << "Destructor called for " << x << endl; }
};

```

```
int main() {
    Test t1(5);
    {
        Test t2(10);
    }
    t2.~Test(); // Explicit destructor call
    return 0;
}
iii) Code 3
#include <iostream>
using namespace std;
class Account {
private:
    double balance;
public:
    void setBalance(double b) { balance = b; }
};
int main() {
    Account obj;
    obj.balance = 1000.0;
    cout << "Balance set successfully!" << endl;
    return 0; }
```

7. Differentiate between the following terms (any five):
- i) Objects and classes
 - ii) Inheritance and polymorphism
 - iii) Early binding and Late Binding
 - iv) Data Abstraction and Data Encapsulation
 - v) Operator overloading and function overloading
 - vi) ifstream and ofstream

3*5

6516

[This question paper contains 7 printed pages]

Your Roll No.....

Sr. No. of Question Paper :
Unique Paper Code : 2342571103
Name of the paper : Object Oriented Programming using Python
Name of the Course : B.A. (Prog.)
Semester : I
Duration: 3 Hours

Maximum Marks: 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Section A is compulsory.
3. Attempt any four questions from Section B.
4. Answer all parts of a question together.

Section A

Q1. (a) What is Object Oriented Programming? State two advantages of object oriented programming languages over procedural programming languages. 3

(b) Find the errors in the following and correct them. 3

(i) `a = [1, 2, 3]`

`print(a[1:10:0])`

(ii) `text = "apple"`

`print(text.replace('p'))`

(iii) `d = {"a":1, "b":2}`

`d.add("c",3)`

- (c) Write a program to find the smallest of three numbers. 3
- (d) Write a function to compute a^b (a to the power b), where both a and b are provided as input by the user. 3
- (e) What will be the output of the following: 3
- ```
for i in range(3):
 for j in range(i):
 print(j, end=" ")
 print()
```
- (f) Differentiate between while loop and for loop. 3
- (g) What will be printed when the following code is executed? 3
- ```
Tuple = ("College")
```
- (i) `print(Tuple[2:])`
- (ii) `print(Tuple[2:4])`
- (iii) `print(Tuple[::-1])`
- (h) Identify valid/invalid identifiers from the following: 3
- (i) `sum1`
- (ii) `average%`
- (iii) `_temp`
- (iv) `For`

(v) data_value

(vi)@result

- (i) Differentiate between the append() and extend() functions of a list in Python, using a suitable example for each. 3
- (j) Write the syntax of three types of conditional statements used in Python. 3

Section B

- Q2. (a) Define a class *Student* to store and manage student details. 10

The class should have the following data members:

- rollNo – Roll number
- name – Student name
- marks – Marks obtained

The class should contain the following methods:

- A constructor `__init__()` to initialize all data members
- A method `addMarks()` to add bonus marks
- A method `__str__()` to display student details

Perform the following tasks:

- (i) Create an object S1 with roll number 101, name "Amit", and marks 78.
- (ii) Add 5 bonus marks.
- (iii) Display the student details.
- (b) Write a Python program to count duplicate elements in a given list and subsequently remove all duplicate elements to obtain a list of unique elements. 5

- Q3. (a) Write a program that accepts a string from the user and computes the frequency of each character, ignoring spaces and case differences. Use a variable of dictionary type to maintain the count. 5
- (b) What is a constructor? Explain the purpose of the `__init__()` method with a suitable example. 5
- (c) Find the errors in the following Python code: 5
- (i) `values = [1, 2, 3]`
`values.append(4, 5)`
 - (ii) `t = (10, 20, 30)`
`t[1] = 50`
 - (iii) `t = (5)`
`print(type(t))`
 - (iv) `name = "Ravi"`
`print(name + 10)`
 - (v) `d = {[1, 2]: "list"}`
- Q4. (a) What is exception handling? Explain try, except, else, and finally with suitable examples. 5
- (b) Write a Python program that stores student names and marks into a file. Then, read the file and display the names of students who scored above 75%. 5
- (c) Write a program to compute the factorial of a number n. 5
- Q5. (a) What do mean by the operator precedence and associativity of Python operators (arithmetic, comparison, logical)? 5
- What will be the output of the following statements:

- (i) `print(9 + 5 * 2**3 != 15 //6 - 2)`
- (ii) `print('apple' > 'banana' and 'orange' < 'grape')`
- (iii) `print(2** 3** 2)`

5

(b) Consider the following function:

```
def calculate():
    num = int(input("Enter a number: "))
    result = 100 / num
    total = result + value
    print(total)

calculate()
```

Identify any three exceptions that may be raised while executing the above function. Describe any two identified exceptions.

(c) Write a Python function that accepts a string as input, replaces all the vowels in the string with the symbol '*', and returns the modified string. 5

For example,

input = "Computer Science"

Output= C*mp*t*r Sc**nc*

Q6. (a) Consider a dictionary named countries that stores country codes as keys and country names as values: 5

```
countries = {"IN": "India", "US": "United States", "UK": "United Kingdom",
            "AU": "Australia"}
```

Write python statements for the following:

- (i) Display all country codes present in the dictionary.

- (ii) Remove the country with code "UK".
- (iii) Display the country name corresponding to code "IN".
- (iv) Check whether the country code "CA" exists in the dictionary.
- (v) Delete all elements from the dictionary.

(b) Write a program to print the following pattern:

5

```
*
**
***
****
*****
```

(c) Determine the number of times the string "Hello" is printed by the given program. Rewrite the program using a for loop to obtain the same output.

5

```
i = 0
while True:
    if i == 3:
        break
    print("Hello")
    i += 1
```

Q7. (a) Write a program to compute the Fibonacci series up to n terms.

5

(b) Consider the following string:

5

```
s = "programmingpython"
```

Write the output of the following Python statements:

(i) `print(s.isalpha())`

(ii) `print(s.find("gram"))`

(iii) `print(s.count("py"))`

(iv) `print(s.replace("py", "Py"))`

(v) `print(s.split("m"))`

(c) What are the different modes of file handling?

5

What will be the output when the following Python code is executed (Assume the text file named file.txt contains the string "abc")?

try:

```
f = open("file.txt")
```

```
print(int(f.readline()))
```

except ValueError:

```
print("Invalid")
```

SL No of QP : 7164
Unique Paper Code : 2342571101
Name of the Course : B. A. (Prog) & BSc (Non-Major)
Name of the Paper : Programming Fundamentals Using C++
Semester : I
Time : 3 hours

Maximum Marks : 90

Instructions for Candidates:

- a) Write your Roll No. on the top immediately on receipt of this question paper.
- b) Attempt all questions from Section-A.
- c) Attempt any four questions from Section-B.
- d) Attempt all parts of a question together.

Section A

- Q1. a) i. Name any three in-built data types used in C++. 3
ii. `int a = 21;`
`a << 1;`
`cout << a;`
State the output.
- b) What are the different object-oriented programming paradigms? How is it different from structured programming approach? 3
- c) Why are logical operators used? Also explain why function prototyping is used? 3
- d) How do the properties of the following three derived classes differ? 3
i. `class A1: private B`
ii. `class A2: public B`
iii. `class A3: protected B`
- e) Identify the type of constructors in the given code snippet: 3
`class Test{`
`int m, n;`
`public:`
`Test() {m=0; n=0;} // constructor1`
`Test(int a, int b) {m=a; n=b;} // constructor2`
`Test(Test & i) {m=i.m; n=i.n;} // constructor3`
`};`
- f) Identify the errors in following C++ statement: 3
i. `int b(5);`
ii. `int static count;`
iii. `cout << "x=" x;`
- g) Write a program to print the following output using for loop: 3
1
22
333
4444
55555
- h) Explain the concept of Pure Virtual Function with the help of suitable example. 3
- i) Give the output of following code: 6
i. `int total = 0;`
`int n=8;`
`for(int i=0; i<n; i++)`
`total+=1;`
`cout << total;`
ii. `void f(int &a) {`
`a = a + 10;`

```

}
int main() {
int y = 5;
f(y);
cout << y;
return 0;
}

```

Section B

- Q2. a) Why call by pointer parameter passing technique in C++ is in itself a call by reference? Justify your answer and explain with the help of suitable example. 5
- b) What is function overloading? Write a menu-driven program in C++ 10 program that uses function overloading to calculate the area of a rectangle, square, circle, and triangle. The program should accept appropriate input parameters from the user for each shape.
- Q3. a) What is "final" keyword in C++? Under what circumstances is it used? 5 Explain with the help of suitable example
- b) Write a C++ program for a bank account system with the following 10 specifications:

- i. Class: Account_holder
- ii. Private Data Members: Name of the depositor, Age
- iii. Public Data Members: Account number, Type of account, Balance amount
- iv. Member Functions (Inside the Class): A function to assign initial values, A function to deposit an amount
- v. Member Functions (Outside the Class): A function to withdraw an amount after verifying sufficient balance, A function to display the depositor's name and current balance

Explain how the members of the class can be accessed using both inside-the-class and outside-the-class member functions.

- Q4. a) Consider the code below and answer the following questions: 5

```

#include <iostream>
using namespace std;
class Base1 {
public:
Base1() { cout << "Base1 constructor" << endl; }
~Base1() { cout << "Base1 destructor" << endl; }
};
class Base2 {
public:
Base2() { cout << "Base2 constructor" << endl; }
~Base2() { cout << "Base2 destructor" << endl; }
};
class Derived : public Base1, public Base2 {
public:
Derived() { cout << "Derived constructor" << endl; }
~Derived() { cout << "Derived destructor" << endl; }
};
int main() {

```

```

    Derived d;
    return 0;
}

```

- i. Write the output of the program.
- ii. Explain the order of execution of constructors and destructors.

b) Determine value of each of the following expression if a=5, b=10 and c= -6: 5

- i. a>b && a<c;
- ii. a==c || b>a;
- iii. (a>b)?a:b;
- iv. a<b && a>c;
- v. b>15 && c<0 || a>0;

c) Write a C++ program to read thirty integers into an array. Count and print the number of positive and negative numbers present in the array. 5

Q5. a) Consider the following class: 5

```

class Student
{
    int roll_no;
    float marks;
};

```

Add the following member functions to the class with their definitions:

- i. Add default constructor
- ii. Add parameterized constructor to initialize private data members of the class.
- iii. Add a function to enter the student details.
- iv. Add a function to display the student details.
- v. Create an object and call the above defined functions in the main() function.

b) What are the different ways of declaring a string in C++? List any three in-built string functions available in C++ and the input and output parameters of each function. 5

c) Write the output of the following code: 5

```

#include <iostream>
using namespace std;
double division(int a, int b)
{
    if (b == 0)
    {
        throw "Division by zero exception!";
    }
    return (a / b);
}
int main()
{
    int x;
    try
    {
        x = division(50, 5);
        cout << x << endl;
        x = division(50, 0);
    }
    catch (const char* msg)
    {
        cout << msg << endl;
    }
}

```

```
}  
return 0;
```

- Q6. a) What is polymorphism? Distinguish between early binding and late binding in context of polymorphism. 5

- b) What is the output of the following code: 5

```
i.  
#include <iostream>  
using namespace std;  
int a = 10;  
int main()  
{  
    int a = 20;  
    int b = 5, c = 0;  
    c = a++ + 5 * (::a)*20 / 30 - b;  
    cout << c;  
    return 0;  
}
```

- ii. Assume address of x is 0x7D0.

```
#include <iostream>  
using namespace std;  
int main()  
{  
    int x = 10;  
    int* myptr;  
    myptr = &x;  
    cout << x << endl;  
    cout << myptr << endl;  
    cout << *myptr << endl;  
    return 0;  
}
```

- c) Create a class Box with static data member, count. Display the number of objects created and destroyed. 5

- Q7. a) Identify and explain the errors in the given code. Rewrite the corrected code. What will be the output of the corrected code? 5

```
#include <iostream>  
using namespace std;  
class Employee {  
    int id;  
    string name;  
public:  
    setId(int i)  
    {  
        id = i;  
    }  
    void setName(string n)  
    {  
        name = n;  
    }  
  
    void display()  
    {  
        cout << "ID: " << id << ", Name: " << name  
        << endl;  
    }  
}
```

```
};
int main() {
    Employee emp;
    emp.id = 101;
    emp.name = "Alice";
    emp.setId(101);
    emp.setName("Alice");
    emp.display();
    return 0;
}
```

b) Rewrite the following C++ code using switch statement:

5

```
#include <iostream>
using namespace std;
int main()
{
    char grade;
    cout << "Enter your grade (A, B, C, D, F):";
    cin >> grade;
    if (grade == 'A') {
        cout << "Excellent!" << endl;
    }
    else if (grade == 'B') {
        cout << "Well done!" << endl;
    }
    else if (grade == 'C') {
        cout << "Good job!" << endl;
    }
    else if (grade == 'D') {
        cout << "You passed!" << endl;
    }
    else if (grade == 'F') {
        cout << "Better luck next time!" << endl;
    }
    else {
        cout << "Invalid grade." << endl;
    }
    return 0;
}
```

c) State whether true or false:

5

- i. A C++ program can have multiple main () functions.
- ii. Constructor can be declared in private section of the class.
- iii. A reference variable must always be initialized when it is declared.
- iv. A friend function can be a friend to more than one class.
- v. There can be multiple catch blocks in a single program.

[This question paper contains 12 printed pages.]

Your Roll No.....

K

Sr. No. of Question Paper : 521

Unique Paper Code : 2343010021

Name of the Paper : Data Mining

Name of the Course : **Discipline Specific Elective
(DSE) – NEP-UGCF-2022**

Semester : III

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **Section A** is compulsory.
3. Attempt any **Four** Questions from **Section B**.
4. Parts of a question must be answered together.
5. Use of scientific calculator is allowed.

P.T.O.

Section A

1. (a) What is overfitting? How can it be avoided? (2)
- (b) Why is data cleaning important in pre-processing? (3)
- (c) State any two methods for dealing with missing values. Explain each approach. (3)
- (d) State the key differences between lazy learners and eager learners. Give an example of each type of learner. (4)
- (e) Consider the following values for two attributes corresponding to four data points :
 $P_1(1, 3)$, $P_2(3, 1)$, $P_3(4, 2)$, and $P_4(6, 3)$. Compute the proximity matrix using Euclidean Distance. (4)

- (f) Why is sampling needed in data mining? Explain any two sampling methods. (4)
- (g) What are outliers in a dataset? Why is it important to detect and analyze them in data mining? Are all noise points considered outliers? (5)
- (h) Identify whether the following represent classification or regression process: (5)
- (i) Predicting the price of a stock based on historical data.
 - (ii) Predicting whether a credit card transaction is fraudulent or legitimate.
 - (iii) Predicting the sales of a product for the next month or quarter.
 - (iv) Predicting whether a customer will purchase an item or not.

P.T.O.

- (v) Predicting the price of a house based on features such as size, location, number of rooms, etc.

Section B

2. (a) Evaluate the performance of the classifier in terms accuracy, precision, recall, and f1-score using the following confusion matrix : (8)

	Predicted Positive	Predicted Negative
Actual Positive	40	10
Actual Negative	5	45

- (b) Given the following dataset, construct a decision tree. (7)

Outlook	Temperature	Humidity	Wind	Play Tennis
Sunny	Hot	High	Weak	No
Sunny	Hot	High	Strong	No
Overcast	Hot	High	Weak	Yes
Rain	Mild	High	Weak	Yes
Rain	Cool	Normal	Weak	Yes
Rain	Cool	Normal	Strong	No
Overcast	Cool	Normal	Strong	Yes
Sunny	Mild	High	Weak	No
Sunny	Cool	Normal	Weak	Yes
Rain	Mild	Normal	Weak	Yes
Sunny	Mild	Normal	Strong	Yes
Overcast	Mild	High	Strong	Yes
Overcast	Hot	Normal	Weak	Yes
Rain	Mild	High	Strong	No

- (i) Calculate the entropy of the dataset.
- (ii) Calculate Information Gain for each attribute.
- (iii) Build the decision tree step-by-step.

P.T.O.

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3. (a) What is 'curse of dimensionality'? What is the difference between feature subset selection and dimensionality reduction techniques. (5)
- (b) How does the presence of missing values affect the performance of the Naive Bayes classifier? (5)
- (c) Consider the following dataset containing two numerical attributes, Age and Salary: (5)

ID	Age (in years)	Salary (in rupees)
1	44	72000
2	27	48000
3	30	54000
4	38	61000
5	50	83000
6	37	67000

Explain the potential issues if the above dataset is directly used for k-means clustering without preprocessing. Suggest and apply an appropriate preprocessing step to handle this issue.

4. (a) For the dataset given below: (7)

- (i) Apply the Apriori algorithm with support $1/3$. Show the frequent itemsets for each database scan.
- (ii) Indicate the association rules that are generated; sort them by confidence.

TID	Items
T1	Pen, Pencil, Paper
T2	Pencil, Eraser
T3	Pen, Sharpener
T4	Pen, Eraser
T5	Pen, Pencil, Sharpener
T6	Pencil, Eraser
T7	Pen, Eraser
T8	Pen, Pencil, Eraser, Paper
T9	Pen, Pencil, Eraser

- (b) Suppose we have a dataset of 10 patients, where each patient is classified as either 'having a heart disease' or 'not having a heart disease'. The dataset contains three categorical features: the

P.T.O.

patient's age group (x_1), blood pressure level (x_2), and cholesterol level (x_3). A Naive Bayes classifier is to be used to predict whether a new patient is likely to have a heart disease based on the age group, blood pressure level, and cholesterol level. The dataset and their class labels are given below:

Age Group (x_1)	Blood Pressure (x_2)	Cholesterol Level (x_3)	Heart Disease (y)
< 40	Normal	High	No
< 40	High	Normal	No
< 40	High	Normal	Yes
40-49	High	High	Yes
40-49	Normal	High	Yes
50-59	Normal	High	Yes
50-59	Normal	High	No
50-59	Normal	Normal	Yes
60+	High	High	Yes
60+	High	High	Yes

- (a) Estimate the conditional probabilities for $P(\text{Age Group}=60+|\text{Yes})$, $P(\text{Blood Pressure}=\text{High}|\text{Yes})$, $P(\text{Cholesterol Level}=\text{Normal}|\text{Yes})$, $P(\text{Age Group}=40-49|\text{No})$, $P(\text{Blood Pressure}=\text{High}|\text{No})$, and $P(\text{Cholesterol Level}=\text{High}|\text{No})$.

- (b) Use the estimate of conditional probabilities to predict the class label (Heart Disease) for a test sample (Age Group = 50-59, Blood Pressure = High, Cholesterol Level = Normal) using the Naive Bayes approach.
5. (a) Consider the following dataset, which consists of 10 tuples with the two features, X_1 and X_2 , and a binary class label Y .

Tuple	X1	X2	Y
T1	0.5	500	A
T2	1.0	750	A
T3	1.5	250	A
T4	2.0	1000	B
T5	2.5	600	B
T6	3.0	200	B
T7	3.5	800	B
T8	4.0	300	A
T9	4.5	900	A
T10	5.0	700	B

P.T.O.

Scale the features X_1 and X_2 to range $[0 - 1]$ using min-max normalization. (8)

(b) Use the k-Nearest Neighbor (k-NN) classifier with $k = 5$ and proximity measure as 7 Euclidean distance to classify the tuple $T_{11}(3, 600)$. Which class would the k-NN classifier assign to the tuple T_{11} ? Justify. (7)

6. (a) Describe well-separated clusters and density-based clusters, providing examples of each type. (5)

(b) Consider a dataset for K-means clustering. Perform two iterations of the K-means clustering algorithm and show the clusters, their new centroids, and compute SSE after each iteration. Use Euclidean distance as proximity measure and the following three as Initial centroids : (10)

Initial Centroids:

- Centroid 1: Observation 1 \rightarrow (4, 1, 1)
- Centroid 2: Observation 2 \rightarrow (2, 3, 1)
- Centroid 3: Observation 3 \rightarrow (1, 2, 4)

Observation ID	X	Y	Z
1	4	1	1
2	2	3	1
3	1	2	4
4	5	2	1
5	2	2	2
6	3	3	3
7	1	3	5

7. (a) (i) In the following dataset, identify the types of attributes, as nominal, ordinal, interval or ratio. (4)
- (ii) Standardize the numerical features and convert the nominal features to asymmetric binary attributes. (4)

ID	Age	Gender	Income	Education Level	Purchase History	Temperature (°C)	Customer Rating
1	25	Male	55000	Bachelor's	Laptop	22.5	4
2	34	Female	75000	Master's	Tablet	18.0	5
3	22	Male	62000	Bachelor's	Camera	15.5	3
4	40	Female	85000	PhD	TV	19.5	5
5	60	Male	42000	High School	Washing Machine	25.0	2

(b) Consider the following sample dataset. Using the K-Nearest Neighbors (KNN) algorithm, classify an Iris flower with attributes, Sepal Length = 5.4 cm and Petal Length = 3.7 cm. Use Manhattan distance metric.

(i) consider $k = 3$ for classification

(ii) consider $k = 6$ for classification (7)

Sepal Length (cm)	Petal Length (cm)	Species (Target)
5.1	1.4	Setosa
4.9	1.4	Setosa
4.7	1.3	Setosa
7.0	4.7	Versicolor
6.4	4.5	Versicolor
6.9	4.9	Versicolor
6.5	5.2	Virginica
5.8	5.1	Virginica
7.3	5.9	Virginica

[This question paper contains 8 printed pages.]

Your Roll No.....

K

Sr. No. of Question Paper : 6300

Unique Paper Code : 2342572301

Name of the Paper : Computer System Architecture

Name of the Course : B.A. (Prog.) / B.Sc. (P) /
B.Sc. (Maths Sc.)

Semester : III

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. This question paper has two Sections A and B.
3. Section A carries 30 marks and each question in Section B carries 15 marks.
4. Section A is compulsory.
5. Attempt any 4 questions from Section B.
6. Parts of a question must be attempted together.

6300

Section A

1. (a) Represent $(-17)_{10}$ in 8-bit register by the following representations : (3)
 - (i) Signed magnitude representation
 - (ii) Signed 1's complement representation
 - (iii) Signed 2's complement representation.
- (b) Define canonical and standard forms in Boolean algebra with an example of each. (3)
- (c) Write the microoperations for push operation of Register Stack. (3)
- (d) Define pipelining and give one advantage and one limitation. (3)
- (e) What is Cache Memory? How is it different from auxiliary memory? (3)
- (f) Differentiate between GPU and CPU. (3)

- (g) What is a BCD code? Convert $(10100101)_2$ to BCD. (3)
- (h) What is the advantage of JK flip flop over SR flip flop? Write the characteristic tables of both flip flops. (3)
- (i) What is indirect addressing mode? Explain with the help of example. (3)
- (j) What are the essential categories for instruction set completeness? (3)

Section B

2. (a) Perform the following arithmetic operations in binary using 2's complement representation:
- (i) $(+37) + (-13)$
- (ii) $(+37) - (-13)$ (5)
- (b) Differentiate between combinational circuits and sequential circuits. Explain them using block diagrams. (5)

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- (c) List five characteristics of RISC and CISC architectures. (5)
3. (a) State De-Morgan's law and prove it using truth table. (5)
- (b) What is a multiplexer? Draw the logic diagram of 4×1 multiplexer and explain its functioning. (5)
- (c) What is a microprogrammed control unit? Write the microoperations that will be executed when the following 14-bit control word are applied:

(i) 010 001 011 00101

(ii) 011010 10101010

Given the binary code for ADD is 00101 and SUB is 01010 and three-bit binary code for selecting the register corresponds to the register number. (5)

4. (a) A non-pipeline system takes 50 ns to process a task. The same task can be processed in a six-segment pipeline with a clock cycle of 10 ns. Determine the speed-up ratio of the pipeline for 100 tasks. What is the maximum achievable speed-up? (5)
- (b) Give the block diagram of DMA and discuss its functioning. (5)
- (c) Draw the diagram of a 4-bit binary adder-subtractor. Explain its working with the help of an example. (5)
5. (a) Explain, with the help of a neat block diagram, how a 3×8 decoder can be constructed using two 2×4 decoders. (5)
- (b) Find the complement of the following function and draw the logic diagram of the complemented function :

$$F = x'y + xyz'$$

Provide the truth table having F and F'. (5)

- (c) Give the micro-operations of BSA instruction for the basic computer. Explain its working with the help of an example. How does it retrieve the return address? (5)

6. (a) Simplify the following Boolean function F together with don't care conditions:

$$F(A, B, C, D) = \Sigma(0, 1, 2, 3, 7, 8, 10)$$

$$d(A, B, C, D) = \Sigma(5, 6, 11, 15)$$

Draw the logic diagram of simplified function.

(5)

- (b) Consider the basic computer organization having the content of AC and E as :

$$AC = 5D2A, E = 0$$

Show the contents of AC & E after the execution of :

(i) CMA

(ii) CME

(iii) CIR

(iv) CIL

(5)

(v) INC

(5)

(c) Write short note on :

(i) Programmed I/O

(ii) Interrupt initiated I/O

7. (a) Draw a flowchart to depict instruction cycle of basic computer. (5)

(b) An instruction is stored at location 300 with its address field at location 301. The address field has the value 400. A processor register R1 contains the number 200. Evaluate the effective address if the addressing mode of the instruction is

(i) Direct;

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- (ii) Register Indirect with R1 having address 400;
 - (iii) Immediate;
 - (iv) Relative;
 - (v) Index with R1 as the index register. (5)
- (c) Design a full adder. Derive the Boolean expressions using the truth table and draw the logic diagram. (5)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 6467 **K**
Unique Paper Code : 2342572302
Name of the Paper : Design and Analysis of
Algorithm
Name of the Course : NEP-UGCF-2022 DSC B.A.
(Prog. / B.Sc. (Prog.)
Semester : III

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

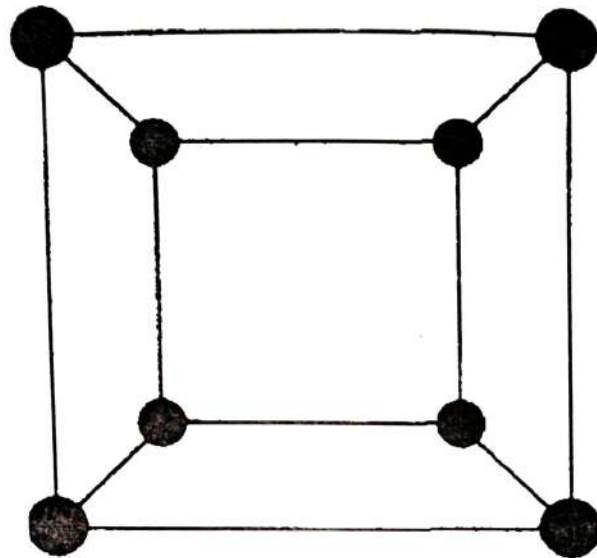
1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **Section A** is compulsory contain 30 marks
3. Attempt any **four** questions from **Section B**.
4. Parts of a question must be answered together.

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Section A

1. (a) What are the two key factors that decide whether dynamic programming is applicable for an optimization problem or not? (3)
- (b) Consider the undirected graph $G(V, E)$: (3)



Check If the Graph is bipartite and give the two vertex sets.

- (c) Briefly Explain the Divide and Conquer technique with an example of algorithm that uses this approach. (3)
- (d) Show that at most $3 * \lceil n/2 \rceil$ comparisons are sufficient to find both the minimum and maximum number in a given array of size n . (3)

- (e) Define the following terms in the context of graphs giving suitable examples of each:
- (i) Acyclic graph
 - (ii) Weighted graph (3)
- (f) Prove: If a graph is bipartite then it cannot contain an odd cycle. (3)
- (g) Explain the concept of Primary Clustering and Secondary Clustering in hashing. (3)
- (h) What is the recurrence relation for the following algorithms :
- (i) Insertion sort
 - (ii) Merge Sort
 - (iii) Counting sort (3)
- (i) Explain Randomized Quick Sort algorithm for sorting a list of numbers. How does the use of random pivot selection affect the time complexity compared to normal Quick Sort? (3)
- (j) What is collision in hashing? Name any two collision resolution techniques. (3)

Section B

Attempt any 4 parts out of 6 questions :

2. (a) Use Strassen's Algorithm to multiply the following two matrices : (7)

$$A = \begin{bmatrix} 2 & 4 \\ 3 & 5 \end{bmatrix}, \quad B = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$

- (b) Consider the undirected graph $G(V, E)$ with vertices (8)

$V = \{A, B, C, D, E, F\}$ and edges

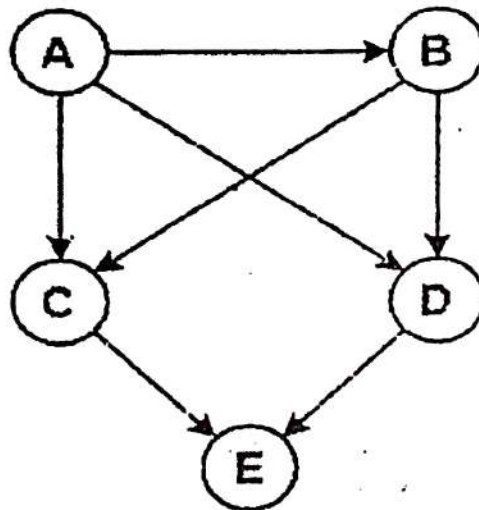
$E = \{(A, B), (A, C), (B, C), (C, D), (D, E), (E, F)\}$

- (i) Draw the graph G .
- (ii) Determine whether the graph is connected or disconnected.
- (iii) If it is disconnected, find all its connected components.
- (iv) Generate Depth first traversal (DFS) for the graph taking A as source vertex.
3. (a) Analyse heap sort algorithm giving run time complexity of Max_heapify, build_Max_heap and heap Sort Procedure. (7)

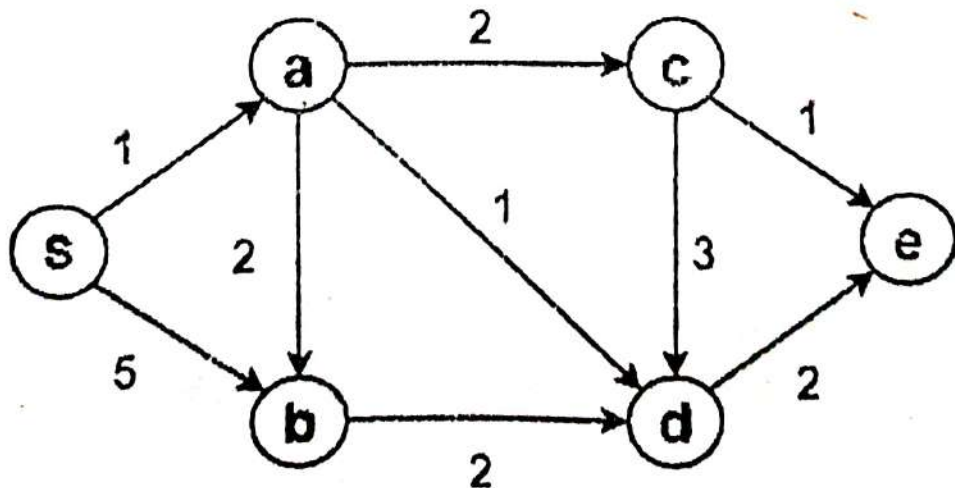
(b) (i) Define the following terms : (8)

- Directed acyclic graph
- Topological ordering
- In degree of a vertex
- Out degree of a vertex

(ii) List all possible topological orderings for the given graphs :



4. (a) Using Dijkstra's Algorithm, find the shortest distance from source vertex 'S' to remaining vertices in the following graph : (7)

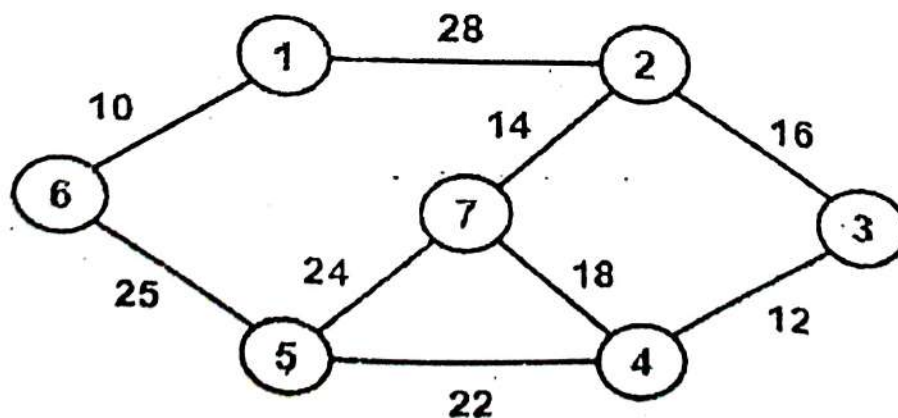


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- (b) A thief enters a house carrying a bag of maximum capacity of 60 Kg. There are 5 8 items in the house with the following weights and values. What items should he take in order to maximize the value (fractional weights are also allowed).

Item	Weight	Value
1	5	30
2	10	40
3	15	45
4	22	77
5	25	90

5. (a) Show the step by step execution of Prim's algorithm to find minimum spanning tree (MST) of the given graph :



What is the cost of MST generated?

(7)

(b) Consider Interval Scheduling problem where we are given a resource and a set of requests each having a start time and finish time.

The goal is to maximize the number of requests scheduled.

Determine whether the following greedy strategy gives an optimal solution for the above problem or not:

“Select the requests with fewest number of incompatible requests.” (8)

6. (a) Sort the following list using Merge Sort and show all division and merging steps with diagrams:

[45, 23, 53, 12, 64, 2, 87, 31]

Give the best case and worst-case time complexity. (7)

(b) A hash table has Size = 11 Use the division method $h(k) = k \text{ mod } 11$

Insert keys in this order: 27, 18, 29, 28, 39, 13, 16

Resolve collision by Linear probing :

Show the final position of keys in hash table with index. (8)

7. (a) Explain the Radix Sort algorithm in detail and apply it to sort the given list :

[319, 212, 405, 123, 394, 209]

Show each pass and the final sorted output.

(7)

- (b) Solve the subset sum problem using dynamic programming for the set $A = [2, 3, 7, 8, 10]$ and intended sum = 11.

(8)

No of page 7

6716

Unique paper Code

2342202302

Name of Paper

Data Mining I

Name of Course

B.A. (P) DSC-A3 & B3(A or B)

Semester

III

Duration: 3 Hours

Maximum Marks: 90

Instructions for candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **Question No. 1 (Section A)** is compulsory.
3. Attempt any 4 (**four**) questions from **Section B**.
4. Parts of a question should be attempted together.
5. The use of simple calculator is allowed.

Section A

- Q1 a) In the given dataset, identify the type of attributes as nominal, ordinal, (5)
interval or ratio.

Emp_ID	Department	Position Level	Years_of_Experience	Salary(\$)
E11	HR	Senior	8	52000
E12	IT	Junior	2	30000
E13	Sales	Mid	4	42000
E14	Finance	Senior	10	60000

- b) In the given dataset, standardize both age and salary. Also explain the (5)
significance of standardization.

Sample	Age	Salary
S1	20	25,000
S2	30	40,000

S3	25	35,000
S4	35	45,000

- c) State Bayes' theorem. What assumption is used by the Naïve Bayes classifier? (4)
- d) Identify whether the following represent classification or regression (4) problem.
- A hospital wants to determine whether a patient has diabetes (yes/no) based on their health data.
 - A bank wants to assign customers into "low-risk," "medium-risk," or "high-risk" categories based on their financial history.
 - A weather app predicts the temperature (in °C) for the next day using historical data.
 - An app identifies handwritten digits from 0–9.
- e) State the purpose of employing sampling techniques in data mining, (4) mentioning any two reasons.
- f) Define class imbalance and explain how it impacts model accuracy and other (4) evaluation metrics.
- g) Data mining tasks are generally grouped into which two main categories? (4) Give suitable examples of each.

Section B

- Q2 a) Given a sample dataset derived from the Iris dataset, use the K-Nearest (10) Neighbors (KNN) algorithm to classify a new flower with Sepal Length = 5.8 cm and Sepal Width = 3.2 cm. Consider $k = 4$ and compute distances using the Manhattan distance metric to determine its species.

Sample	Sepal Length (cm)	Sepal Width (cm)	Species
S1	5.1	3.5	Setosa
S2	4.9	3.0	Setosa
S3	6.2	3.4	Versicolor
S4	5.9	3.0	Versicolor
S5	5.4	3.9	Setosa
S6	6.0	3.2	Versicolor
S7	5.5	3.5	Setosa
S8	6.3	3.3	Versicolor

- b) A sensor has recorded the following temperature readings ($^{\circ}\text{C}$) over a week: (5)
[22, 23, 21, 22, 120, 23, 22]

Identify any outlier present in the dataset. Explain the significance of detecting and analyzing outliers in data.

- Q3 A classifier is evaluated on 12 students to predict whether each student (15)
passes (1) or fails (0) an exam. The true and predicted labels are as follows:

Sample	True Label	Predicted Label
1	1	1
2	0	0
3	1	1
4	1	0
5	0	0
6	0	1
7	1	1
8	0	0
9	1	1
10	0	0

11	1	1
12	0	0

- i. Construct the confusion matrix for this classifier.
- ii. Calculate the Accuracy, Precision, Recall, and F1-Score.
- iii. Perform 4-fold cross-validation on this dataset and determine the overall accuracy.

Q4 a) A company wants to predict whether a customer will buy a product (Yes/No) (10) based on their Age and Income in the dataset shown below:

Customer	Age	Income	Buy
C1	Young	High	No
C2	Young	High	No
C3	Middle	High	Yes
C4	Senior	Medium	Yes
C5	Senior	Low	Yes
C6	Senior	Low	No
C7	Middle	Low	Yes
C8	Young	Medium	No
C9	Young	Low	Yes
C10	Senior	Medium	Yes

Using the Gini index, determine the best attribute to split the dataset at the root node. Draw the first level of the decision tree after the root split. Show

all Gini index calculations step by step.

- b) Explain the concept of K-Fold Cross Validation. Discuss its role in measuring and validating a model's predictive accuracy. (5)

Q5

Consider a transaction dataset as given in following table: (15)

Transaction ID	Items Bought
T1	{a, d, e}
T2	{a, b, c, e}
T3	{a, b, d, e}
T4	{a, c, d, e}
T5	{b, c, e}
T6	{b, d, e}
T7	{c, d}
T8	{a, b, c}
T9	{a, d, e}
T10	{a, b, e}

- If the minimum support is 40%, apply the Apriori algorithm to generate frequent itemset.
- From the frequent itemset {b, d, e}, generate all possible association rules and compute the confidence for each rule.

- Q6 a) Consider the following dataset of students and their university admission status: (10)

Student	GPA	Work Experience	Admission
S1	High	Yes	Yes
S2	High	No	Yes
S3	Medium	Yes	Yes
S4	Low	Yes	No
S5	Low	No	No
S6	Medium	No	No
S7	High	Yes	Yes
S8	Medium	Yes	Yes
S9	Low	Yes	No
S10	Medium	No	No

- i. A new student has GPA = Medium and Work Experience = Yes. Using the Naive Bayes Classifier, compute the posterior probabilities for:
1. Admission = Yes
 2. Admission = No
- ii. Based on the calculated probabilities, predict whether the student is likely to be admitted or not admitted.
- b) Define the DBSCAN clustering algorithm and discuss its key components, (5) including core points, border points, and noise points.

Q7

List the differences between any five of the following pairs:

(15)

- i. KNN and K-Means Clustering
- ii. Hierarchical Clustering and Agglomerative Clustering
- iii. Stratified Sampling and Random sampling

- iv. Exclusive Clustering and Fuzzy Clustering
- v. Dimensionality Reduction and Feature Engineering
- vi. Normalization and Standardization
- vii. DBSCAN and K-Means Clustering
- viii. Hold-Out Validation and K-Fold Cross-Validation

[This question paper contains 4 printed pages.]

Your Roll No.....
K

Sr. No. of Question Paper : 7009

Unique Paper Code : 2342572301

Name of the Paper : Computer System Architecture

Name of the Course : B.A. (Prog.) / B.Sc. (P) / B.Sc. (Maths Sc.)

Semester : III

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. This question paper has two Sections A and B.
3. Section A carries 30 marks and each question in Section B carries 15 marks.
4. Section A is compulsory.
5. Attempt any 4 questions from Section B.
6. Parts of a question must be attempted together.

Section A

- Q. 1 a) Using only NOR gates implement the functioning of AND gate. (3)
- b) Represent the decimal number $(-38)_{10}$ in the following representations:
- i) Signed magnitude
 - ii) 1's complement
 - iii) 2's complement (3)
- c) What is a flip-flop? Compare the block diagram and characteristic table of the D flip flop and the T flip flop. (3)
- d) What do you mean by Multiplexer? Explain with the help of a function table and block diagram. (3)
- e) Describe I/O interface. List any two advantages of it. (3)
- f) Explain the Complex Instruction Set Computer (CISC) and write its two characteristics. (3)

P.T.O.

7009

- g) List any four characteristics of GPU. (4)
- h) Write micro-operations for the execution phase of the following memory reference instructions: (4)
- (i) STA
- (ii) ISZ
- i) Describe hardware interrupt and write micro-operations for interrupt cycle. (4)

Section B

- Q.2 a) Discuss the Fetch, Decode and Execute phase of Instruction Cycle. Write the micro-operations for fetch phase. (5)
- b) Explain decoder. Draw the block diagram of a 4x16 decoder using two 3x8 decoders. (5)
- c) Write the names and purpose of the following registers: (5)
- i. PC
 - ii. AR
 - iii. INPR
 - iv. I
 - v. AC
- Q.3 a) Explain half adder with the help of a truth table. Derive the expression using K-map and draw the logical diagram. (5)
- b) Simplify the Boolean function F together with the don't care conditions d in Sum-of-products form using K-Map.
- $$F(w, x, y, z) = \Sigma(4, 5, 7, 12, 13, 14)$$
- $$D(w, x, y, z) = \Sigma(1, 9, 11, 15)$$
- Draw the logic diagram of the simplified function. (5)
- c) The memory unit of a computer has 256 K words of 32 bits each. The computer has an instruction format with four fields: an operation code field, a mode field to specify one of the addressing modes, a register address field to specify one of the 64 processor registers and a memory address field. Specify the instruction format and the number of bits in each field if the instructions are in one memory word. (5)
- Q.4 a) A two-word load instruction is stored at location 221 with its address field at location 222. The address field has the value 600. A processor register R₁ contains the number 200. Evaluate the effective address if the addressing mode of the instruction is:

- i) Immediate
- ii) Direct
- iii) Relative
- iv) Indexed with R1 as index register
- v) Register-indirect

(5)

- b) Assume that there are 7 general purpose registers in the CPU and the operation code is of 5 bits. Design a control word for this configuration with the help of a diagram. Write the control word that must be applied to the processor to implement the following microoperations:

i) $R_2 \leftarrow R_4 + R_3$

ii) $R_5 \leftarrow \text{Shl } R_3$

iii) $R_7 \leftarrow \text{input}$

where, the 5-bit OPR codes for the ALU operations are given as:

OPR	Operation
00000	Transfer A
11000	Shift left A
00010	Increment A
00011	Add A + B

(5)

- c) Differentiate between Main Memory and Cache Memory. How many $4K \times 4$ memory chips are needed to provide a memory capacity of $32K \times 8$? (5)

- Q. 5 a) Explain the usage of FGI and FGO flip-flops. How do they work in conjunction with an IEN flip-flop? Write the control condition to set the R-flag to one. (5)

- b) Draw a space-time diagram for a five-segment pipeline showing the time it takes to process seven tasks. Also, derive the formula for the speed-up ratio. (5)

- c) For the Boolean function

$$F = xyz + xy'z + xy'z$$

- i) Obtain the truth table of F.

- ii) Draw the logic diagram of the above Boolean expression.

- iii) Use De-Morgan's law to obtain the complement of F

(5)

- Q. 6 a) Convert the following numbers to the indicated base:

i) $(1100\ 101.110)_2$ to $(\dots)_{10}$

ii) $(98)_{10}$ to $(\dots)_6$

iii) $(1010001010001001)_2$ to $(\dots)_{16}$

(5)

P.T.O.

- b) Explain programmed I/O with the help of a flowchart. (5)
- c) Perform the following operation using 2's complement representation:
- i) $(+128)_{10} - (+233)_{10}$
- ii) $(-128)_{10} - (-233)_{10}$ (5)

Q. 7 a) Draw the logic diagram of 4-bit adder-subtractor. Explain with the help of an example. (5)

b) What is an isolated I/O? Write its two advantages and two disadvantages. (5)

c) An instruction at memory address $(01F)_{16}$ has a mode bit $I=0$, an operation code of store instruction, an address part $(083)_{16}$. The memory word at location $(083)_{16}$ contains $(00F2)_{16}$ and the content of AC is $(A937)_{16}$. Create a table as shown below and fill in the content of the table for each timing sequence. Write the register-transfer instruction for the instruction cycles in column 2. (5)

Timing Sequence No	Register Transfer Instruction	PC	AR	IR	DR	AC	I
T ₀							
T ₁							
T ₂							
T ₃							
T ₄							
T ₅							

Determine the contents of PC, AR, DR, AC, IR, and I after the instruction at $(01F)_{16}$ is fetched and executed.

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7010

K

Unique Paper Code : 2342572302

Name of the Paper : Design and Analysis of Algorithms (Adm. 2024)

Name of the Course : DSC B.Sc. (Prog) / B.A. (Prog.) (NEP-UGCF -2022)

Semester : III

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Section A is compulsory.
3. Attempt any 4 questions from Section B.
4. Parts of a question must be answered together.

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Section A

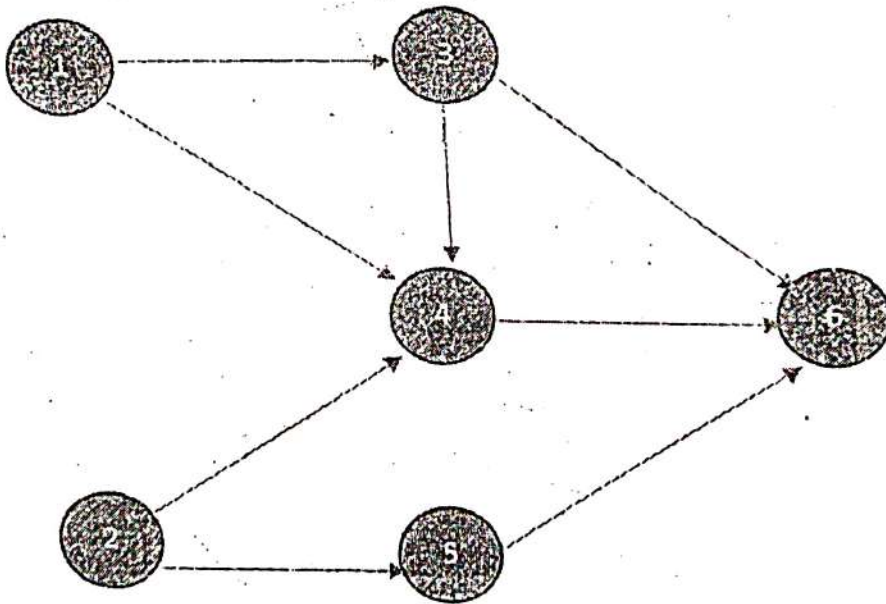
1. (a) Which of the following are 'Inplace' Sorting Algorithms?
Count Sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort (3)
- (b) What is 'Multiplication' method of designing a Hash function? Support your answer with an example. (3)
- (c) Let T be a Minimum Spanning Tree with cost C . If $c(e)$ denotes non negative edge, then indicate if T and C will change if edge costs are replaced with $c(e)^2$. (3)
- (d) Which Algorithm design approach is Binary Search based on -Divide and Conquer approach or Greedy approach? Justify your answer. (3)

Section B

2. (a) Formulate Recurrence Relation for Strassen's Algorithm for Matrix Multiplication.

Solve it using Master's Theorem to find its time complexity. (8)

- (b) Give any three examples of Topological Ordering from the digraph given below: (3+4)



Also, justify why the sequence 142356 is not a topological order for the above.

P.T.O.

3. (a) Consider inserting the keys 3, 2, 9, 6, 11, 13, 7, 12 into a hash table.

For each of the given keys, insert k_i at first free location from $(u + i) \% m$ where $i=0$ to $m-i$. The hash function is $h(k) = (2k+3) \bmod 10$. Show the result using Linear Probing (in case of collisions).

(8)

- (b) Illustrate with an example how Greedy strategy doesn't work for the 0-1 knapsack problem but can yield an optimal solution for fractional knapsack problem.

(7)

4. (a) Sort the following elements using Heap Sort:

(Show 'max-heap' after each call of MAX-HEAPIFY:

$$Z = \{4, 1, 3, 2, 16, 9, 10, 14, 8, 7\} \quad (8)$$

- (b) (i) Prove that if a graph P is bipartite, then it cannot contain an odd cycle.

(ii) What is a stable algorithm? Give 2 examples of stable algorithms. (4+3)

(a) With the help of an example, briefly explain Dijkstra's Algorithm for finding single source shortest path on a weighted directed graph. (8)

(b) Prove that: in every DAG G , there is a node 'v' with no incoming edges. (7)

6. (a) Using dynamic programming, write the recurrence equation for solving 0-1 knapsack problem. Also explain how memorization technique is used in solving the problem. (8)

(b) Can DFS be used to find a shortest path from a source node to a destination node in an unweighted graph? Justify your answer with a suitable example. (7)

7. (a) Prove that Prim's Algorithm produces a minimum spanning tree. (8)

(b) Consider the Interval Scheduling problem where we are given a resource and a set of requests each having a start time and a finish time. Will the following strategy work?

'While requests remain; choose and add a request to solution that has the largest starting time and delete all non-compatible requests.'

Justify your answer.

This question paper contains 7 pages.

Your Roll No.....

Unique Paper Code: 2342573501

Name of the Paper: Database Management Systems

Name of the Course: B.A. (Prog.)/B.Sc. (PS)/B.Sc.(MS) (NEP-UGCF)

Semester: V

Duration : Three Hours

Maximum Marks: 90 Marks

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All parts of Question 1 (Section A) are compulsory.
3. Attempt any four questions from Section B.
4. All questions in Section B carry equal marks.
5. Parts of a question must be answered together.

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Section A

- Q1 (a) What are the different types of database users? 3
- (b) Draw the symbols that are used in ER diagram for representing the following: 3
- i) Composite Attribute
 - ii) Multivalued Attribute
 - iii) Derived Attribute
- (c) Consider the following relational schema and identify the foreign keys: 3
- CUSTOMER**(Cust#, Cname, Phone, City)
ORDER(Order#, Odate, Cust#, OrderAmount)
ORDER_ITEM(Order#, Item#, Qty)
ITEM(Item#, ItemName, UnitPrice)

- (d) Consider the following table: 3

SID	SName	CourseID	CourseName	Instructor
S1	Raman	C101	DBMS	Dr. Jain
S2	Neha	C102	OS	Dr. Sharma
S3	Raman	C101	DBMS	Dr. Jain
S4	Amit	C103	Networks	Dr. Rajat
S5	Neha	C102	OS	Dr. Sharma
S6	Raman	C101	DBMS	Dr. Puri

For the given relational state, check if the following functional dependencies exist or not:

- i) $SID \rightarrow SName$
 - ii) $CourseID \rightarrow CourseName$
 - iii) $CourseID \rightarrow Instructor$
- (e) Consider entity types DOCTOR and PATIENT. A doctor has DoctorID, DoctorName and Specialization. A patient has PatientID, PatientName and Disease as attributes. A doctor can treat at most one patient at a time while a patient can consult at most three doctors for a disease. How will you draw these entities in an ER diagram using (min, max) notation. 3
- (f) Consider the relation: 3
- COMPANY**(EmpID, EmpName, Dept, MonthlySalary).
 Write a command to create a view showing all employees of 'IT' department and their MonthlySalary > 30000.
- (g) Consider a Relation R(A, B, C, D, E) with following Functional Dependencies: 3

FD1: A → BC

FD2: B → D

FD3: CD → E

Find closure of A (A^+) and decide whether {A} is a candidate key or not.
Give reason for your answer.

- (h) Show the resulting relation after performing the **FULL OUTER JOIN** on the following relations **STUDENT** and **MARKS**: 3

STUDENT	
StudentID	Name
101	Anuj
102	Meera
103	Kavita

MARKS	
StudentID	Marks
102	90
103	75
104	68

- (i) What is the significance of role names in the relationship? In what situations role names are essential? 3
- (j) Define **ACID** properties in the context of a database transaction. 3

Section B

- Q2 (a) Discuss five main advantages of using Database Management System. 5
- (b) Consider the following instance of a relation **PRODUCT_SUPPLIER**: 5

<u>ProductID</u>	ProductName	SupplierID	SupplierName	SupplierCity
PD1	Pen	SP1	Dell Stationers	Pune
PD2	Pencil	SP2	Om Stationers	Delhi
PD3	Eraser	SP2	Om Stationers	Delhi
PD4	Folder	SP3	HP Stationers	Mumbai
PD5	Sheets	SP2	Om Stationers	Delhi

Explain the kind of anomalies (if any) that may occur if we apply the following operations on the above table:

- Insert a new supplier (SP4, Golden Stationary, Delhi) who has not supplied any product yet.
- Delete the product PD3 as it is no longer needed.
- Supplier SP2 has moved from Delhi to Noida.
- Delete the product PD1.
- Insert a new product (PD5, Marker) whose supplier is not yet known.

(c) In DBMSs where a clear distinction is maintained between the three levels, which of the DBMS LANGUAGES will be used to specify each of the following:

- i) To insert, delete and modify data
- ii) To retrieve data
- iii) To create user views
- iv) To specify conceptual schema
- v) To add a new constraint to a table

15 (a) Explain three-schema architecture and draw a diagram. Why do we need mappings between schema levels? 5

(b) Draw an Entity Relationship diagram for the **Recording Studio** having the following requirements: 10

- Studio keeps records of each musician who come for recording. Musician has an ID number, name, an address (street, city) and more than one phone number.
- Studio has many instruments used for recording the songs. Each instrument has a unique name. Type of instrument is also stored.
- Each album recorded at the studio has a unique label, an album identifier and copyright date.
- Each song in the album has unique title and the name of the writer.
- A musician may play several instruments, and a given instrument may be played by many musicians.
- Every album has several songs on it, but a song may belong to only one album.
- A song may be performed by one or more musician. A musician may record several songs in the studio.
- An album is produced by a musician. A musician is allowed to produce only one album.

Please NOTE, the diagram should include entities, their attributes, keys, relationship between the entities, cardinality ratio and participation constraints.

Q4 (a) Consider the following relations:

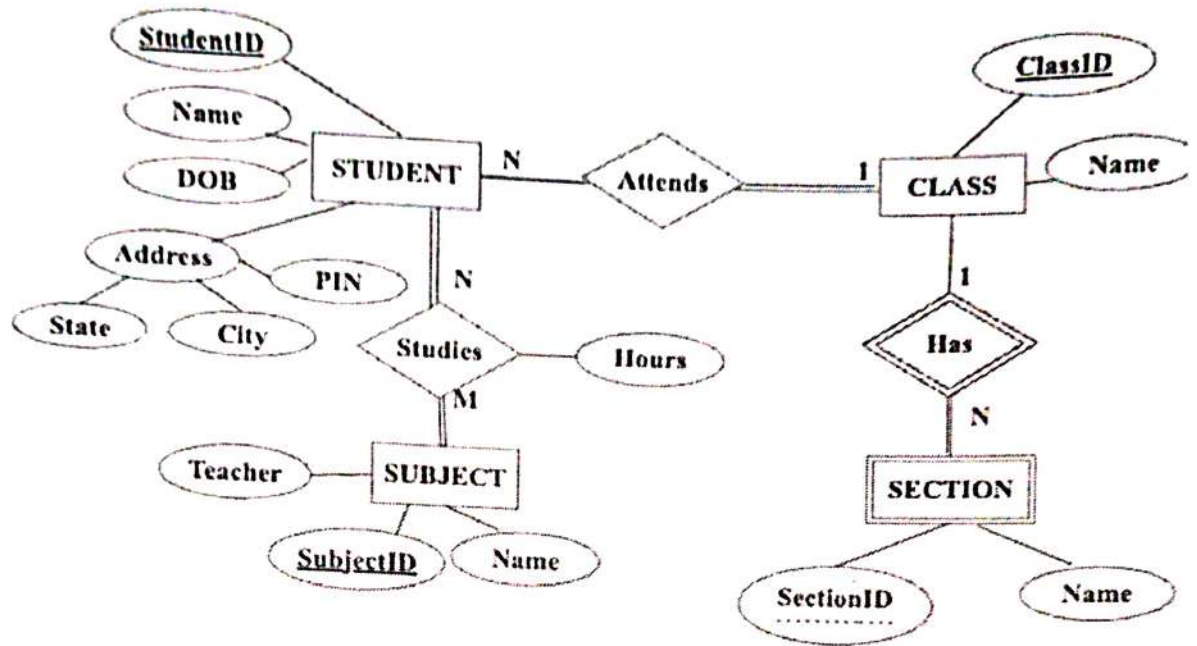
EMPLOYEE(EmpID, Name, DeptID, Salary)

DEPARTMENT(DeptID, DeptName, Location)

Write the following queries in **relational algebra**:

- i) List the details of all employees who earn more than 25000.
- ii) List the name of all departments located in 'Delhi'.
- iii) Give the average salary of all employees.
- iv) List the name of employees who work in department number 101.
- v) Show EmpID, Name, DeptName and Location.

- (b) Consider the following ER diagram UNIVERSITY. Map the ER diagram into a relational schema. Identify relational tables, primary key and foreign key of each table. 10



- Q5 (a) Find the left outer join and right outer join of the following tables: 5

EmpID	EName
E101	Manoj
E102	Meera
E103	Kavita
E104	Sagar
E105	Sujata

EmpID	Dname
E101	Finance
E102	Admin
E103	Accounts
E106	Research
E107	Library

- (b) Consider the relation **SHIPPING** (Ship#, Capacity, Date, Cargo, Value) and the following set of functional dependencies: 10

FD1: Ship# → Capacity

FD2: Ship#, Date → Cargo

FD3: Cargo → Value

- i) Find the Primary key of the relation **SHIPPING**.
- ii) State whether the relation is in 2NF or not. Give reason for your answer.
- iii) Normalize the relation up to 3NF.

- Q6 (a) Consider a disk with block size B=512 bytes. File has 20,000 records of employees. Each record has SSN (9 bytes), Name (30 bytes), Dnumber (9 bytes), and Sex (1 byte). An additional byte is used as a deletion marker. The block pointer P is 6 bytes long. Calculate the following: 5

- i) the record size in bytes,
- ii) the blocking factor

iii) the number of file blocks, assuming an unspanned organization.
 Consider the following tables **CUSTOMER** and **ORDER**:

CUSTOMER

<u>CustID</u>	Name	Mobile
C001	Anita	9910236788
C002	Mehak	9989237446
C003	Rohan	9987190346
C004	Sagar	9927143000
C005	Sujata	9951830058

ORDER

<u>OrderID</u>	<u>CustID</u>	Amount	Status
121	C001	3000	Pending
122	C002	6000	Delivered
123	C003	2300	Pending

Suppose the following operations are performed on the above tables. State whether it results in any constraint violation. If yes, state the violated constraint with reason:

- i) Insert < 'C004', 'Aman', '9938712009' > into **CUSTOMER**
- ii) Insert < 124, 'C006', 1000, 'Pending' > into **ORDER**
- iii) Delete tuple from **CUSTOMER** with Name 'Sujata'
- iv) Insert < NULL, C001, 1500, 'Pending' > into **ORDER**
- v) Update the amount of **ORDER** tuple with OrderID=121 to 6000

Q7 (a) Consider the following schedule of transactions of T1 and T2 executing concurrently. Consider Balance = 1000 and Amount = 300.

T1	T2
read item(Balance)	
	read item(Balance)
	Balance = Balance + Amount
	write item(Balance)
Balance = Balance - 500	
write item(Balance)	

- i) What will be the value of Balance after the completion of T1 and T2.
- ii) Is it the correct value of Balance? If not then, what type of concurrency problem may occur?
- iii) What should be the actual value of Balance?

(b) Consider the following tables:

WORKS(Pname, Cname, Salary)

LIVES(Pname, Street, City)

LOCATED_IN(Cname, City)

MANAGER(Pname, MgrName)

Where Pname = Person Name, Cname = Company Name, and MgrName = Manager Name

Write following queries in **SQL**:

- i) Give details of the persons who do not work for Big4 Companies (Deloitte, PwC, EY and KPMG).
- ii) Find the company wise average salary.
- iii) Write name of the persons who work in the company 'Amazon' along with the city they live in.
- iv) Find the total number of persons working in each city.
- v) Write names of the persons who live and work in the same city.

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 6425
Unique Paper Code : 2342573501
Name of the Paper : Database Management Systems
Name of the Course : B.A. (Prog.)/B.Sc. (PS)/B.Sc. (MS) (NEP-UGCF)
Semester : V
Duration : 3 Hours

K

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All parts of Question 1 (Section A) are compulsory.
3. Attempt any four questions from Section B.
4. All questions in Section B carry equal marks.
5. Parts of a question must be answered together.

Section A

- Q1 (a) State any three responsibilities of the Database Administrator (DBA). 3
- (b) Identify the multivalued and composite attributes from the following complex attribute: 3
Student_Enrollment (Name(FirstName, LastName), ContactDetails (PhoneNo, Email), {Course})
- (c) Classify the following commands as Data Definition Language (DDL) or Data Manipulation Language (DML): 3
- i. CREATE TABLE
 - ii. CRETAE VIEW
 - iii. UPDATE TABLE
- (d) Consider the following relation: 3

P	Q	R
2	20	C
1	10	B
3	30	D
1	10	B
2	20	A
4	20	C

For the given relational state, do the following functional dependencies hold?

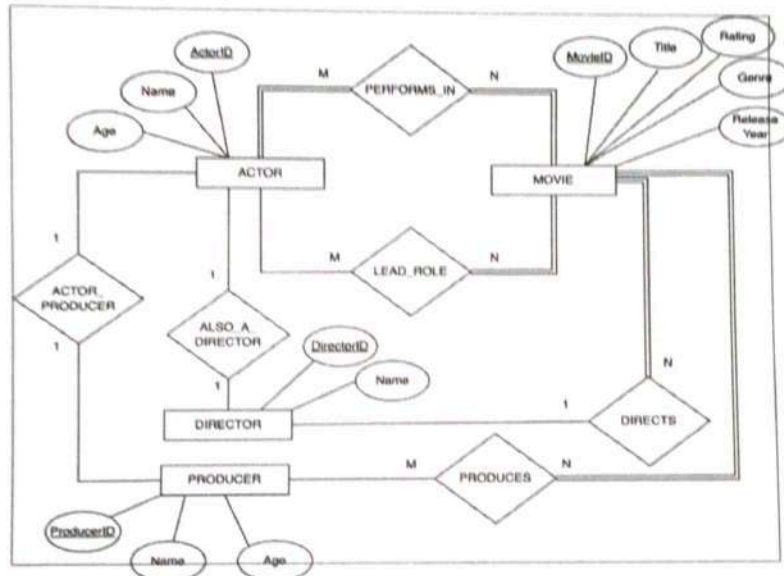
- i. $P \rightarrow Q$
 - ii. $PQ \rightarrow R$
 - iii. $R \rightarrow P$
- (e) Explain three reasons that lead to NULL values in a relation with example. 3
- (f) Mention the cardinality ratio of the following, State assumptions that you make (if any): 3
- i. Teachers teach Courses
 - ii. An Actor performs in Movies
 - iii. Food Items in a Menu
- (g) Identify the rules for each of the following Armstrong's axioms: 3
- i. $\{P \rightarrow Q\} \models PR \rightarrow QR$
 - ii. $\{P \rightarrow Q, Q \rightarrow R\} \models P \rightarrow R$

P.T.O.

- (h) Consider the table **PRODUCT** (PID, PName, Price, StockQty). Create a view named Premium_Products that only shows the StockQty of products having price greater than Rs. 5000. The view should include PID, Price, and StockQty columns from the original **PRODUCT** table. 3
- (i) Consider the relational schema **R(A,B,C,D,E,F)** and a set of FDs = {A→B, BC→DE, AE→F}. Determine the closure of AC (AC)⁺, and decide whether {AC} is a candidate key or not. Give reason for your answer. 3
- (j) Give one-word answer for the following: 3
 - i. A row in a relational table is called.
 - ii. SQL clause that is used to display the output of the query in ascending order.
 - iii. Data about data.

Section B

- Q2 (a) Discuss the main characteristics of the database approach and how it differs from traditional file system. 5
- (b) Design a relational database schema for the given ER diagram. Identify relations, primary key and foreign key of each relation. 10



- Q3 (a) Differentiate between logical data independence and physical data independence? Which one is harder to achieve? Why? 5
- (b) Consider the tables **PRODUCT** and **INVOICE**: 10

PRODUCT

<u>ProductID</u>	ProductName	QtyInStock	UnitPrice
P01	Computer Table	20	2000
P02	Computer Chair	30	2500
P03	Study Table	40	3000

INVOICE

<u>InvoiceID</u>	<u>ProductID</u>	Qty
I01	P01	1
I02	P02	2

For each of the following operations, indicate whether it results in any constraint violation and if so, state the violated constraint with reason.

- Insert (P04, 'Computer Chair', 40, 3000) in PRODUCT table
- Delete (P02, 'Computer Chair', 30, 2500) from PRODUCT table
- Update ProductID P02 to P05 in PRODUCT table
- Update InvoiceID I02 to I04 in the INVOICE table
- Insert (I03, P04, 3) in INVOICE table

Q4 (a) With the help of suitable examples show how the binary, ternary, and recursive relationships are represented in an ER diagram. 5

(b) Consider the following database relations (primary keys are underlined): 10

TEACHER (TID, Name, Address, Gender, Specialization)
COURSE (CNO, CName)
TEACHES (TID, CNO)

Give an expression in the relational algebra for the following queries:

- List the course number that are taught by any teacher.
- Show the teacher id and name of teacher who have specialization in "Algorithms" and "Data Analysis".
- Show the teacher's name who is teaching course number "CS01".
- List the name of teachers who are teaching any course.
- Show the total numbers of female teachers.

Q5 (a) A company stores its employee records in an ordered sequential file containing 64000 records. The disk block size is $B = 8,192$ bytes. Each record has a fixed length of $R = 64$ bytes, and records are unspanned. Calculate the blocking factor (bfr) for the file. Also determine the total number of blocks required to store the file. 5

(b) Consider a relation $R(A,B,C,D,E)$ and the following set of functional dependencies: 10
 FD: $\{A \rightarrow B, AC \rightarrow D, D \rightarrow E\}$

- Find the primary key of the above relation.
- Normalize the relation into 3NF stating the reasons behind each decomposition.

Q6 (a) Consider the following tables Hindi and Sanskrit: 5

Hindi

StudentName	RollNum
Ram	01
Mohan	02
Vivek	03
Rohan	04

Sanskrit

StudentName	RollNum
Pooja	13
Anil	14
Vivek	03
Rohan	04

Show the result for each of the following:

- $\pi_{(StudentName)} Hindi \cup \pi_{(StudentName)} Sanskrit$
- $\pi_{(StudentName)} Hindi \cap \pi_{(StudentName)} Sanskrit$
- $\pi_{(StudentName)} Hindi - \pi_{(StudentName)} Sanskrit$
- $\sigma_{(RollNum=01)} Hindi$
- $\pi_{(StudentName)} (\sigma_{(RollNum=03)} Sanskrit)$

P.T.O.

- (b) Draw an ER (Entity-Relationship) diagram for a university research system to manage information about academic departments, research projects, faculty supervisors, and student researchers within a university. The diagram must clearly specify the entities, their attributes, the cardinality ratio and the participation constraints. State clearly any assumptions you make. 10

- Each research supervisor is identified by sup_id, name, age, position and specialization.
- Each research student is identified by stud_id, name, age, course (Msc/Phd).
- Each project has a project number, start date, end date, funding agency, budget and at least one supervisor.
- A supervisor can supervise multiple projects
- Every student is associated with only one project
- Each department has a department number, name, location
- Projects are controlled by a department

- Q7 (a) Consider the following schedule of transactions of T1 and T2 executing concurrently. Consider A = 100 and R = 30. 5

T1	T2
read_item(A)	
A = A + 10	
	read_item(A)
	A = A + R
write_item(A)	
read_item(R)	
	write_item(A)

After the completion of the transaction T1 and T2 what will be the value of A? Is this the correct value of A? If not, then state the concurrency problem which may occur.

- (b) Consider the following relations (Key of each relation is underlined) 10
- SALESPERSON** (SNO, SName, Commission)
- PRODUCT**(PID, Pname)
- CUSTOMER**(CNO, CName, CAddress)
- SALE**(CNO, SNO, PID, Date, Quantity)

Write SQL statements for the following queries:

- i. Write a command to create the table **SALE**. Use appropriate datatype, primary key and foreign key.
- ii. Get the names of the salespersons who sold the product with PID=60.
- iii. Get the names of the customers who bought the product "Juicer".
- iv. Get the total number of products sold on "25-11-2025".
- v. Get the total number of products purchased by each customer.

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7004

K

Unique Paper Code : 2342573501

Name of the Paper : Database Management Systems

Name of the Course : B.A. (Prog.)/B.Sc.(P)/B.Sc. Maths. Sc. (NEP-UGCF)

Semester : V

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All parts of Question 1 (Section A) are compulsory.
3. Attempt any four questions from Section B.
4. All questions in Section B carry equal marks.
5. Attempt all parts of a question together.

SECTION A

- 1 (a) In the context of database systems, define the following terms and give one example of each of the following: (3)
- (i) Naïve or parametric users
 - (ii) Standalone users
 - (iii) Sophisticated users
- (b) Give the Entity Relationship diagram (ERD) representation of the following entity: (3)
- An entity STUDENT consists of Rollno, Name, Address, date of birth, age and Phone number attributes. Address attribute is split into House no, Street no, City and zipcode. An entity can have multiple phone numbers and age is derived from date of birth attribute.

P.T.O.

7004

- (c) Consider a relational schema $R(A, B, C, D, E)$ and the following set of functional dependencies defined on it: $F = \{A \rightarrow BCD, BC \rightarrow DE, B \rightarrow D, D \rightarrow A\}$. Determine any three candidate keys of R . (3)

- (d) Consider the following tables R and S : (3)

X	Y	Z
10	a	7
25	b	8
30	a	9

A	B	C
25	c	7
30	d	8
25	c	7
10	a	7

The attributes $X, Y,$ and Z of relation R are domain-compatible with the attributes $A, B,$ and C of relation S , respectively. What will be the output produced on executing the following relational algebraic expressions?

- (i) $R \bowtie_{RZ=S.C} S$
 (ii) $R \times S$
 (iii) $R - S$
- (e) Consider the following relation (3)

P	Q	R	S	T
P1	Q1	50	S1	20
P2	Q2	60	S2	20
P3	Q1	70	S3	40

Which of the following functional dependencies are violated based on the above relation state? Justify your answer.

- (i) $Q \rightarrow R$
 (ii) $S \rightarrow T$
 (iii) $T \rightarrow P$
- (f) Explain the following set-at-a-time operations applied to a file in database systems: (3)
- (i) FindOrdered
 (ii) Reorganize
- (g) Suppose we have an ordered file with $r=300,000$ records stored on a disk with block size $B=4,096$ bytes. The file records are fixed size and unspanned, with record length $R=100$ bytes. Compute the blocking factor and the number of blocks needed for the file. (3)

(h) Consider the following relations:

(3)

SUPPLIER		
Sid	Sname	Pnumber
1	X	11
2	Y	12
3	Z	11

PART	
Pno	Pname
11	A
12	B
14	C

Sid is the primary key of SUPPLIER and Pno is the primary key of PART. Pnumber is a foreign key in SUPPLIER relation. For each of the following operations, which database constraints may be violated? Justify your answer.

- (i) Insert $\langle 2, 'W', 14 \rangle$ in SUPPLIER relation.
- (ii) Delete the tuple $\langle 12, 'B' \rangle$ from PART relation.
- (iii) Update the value of Pname from A to 10 in PART relation.

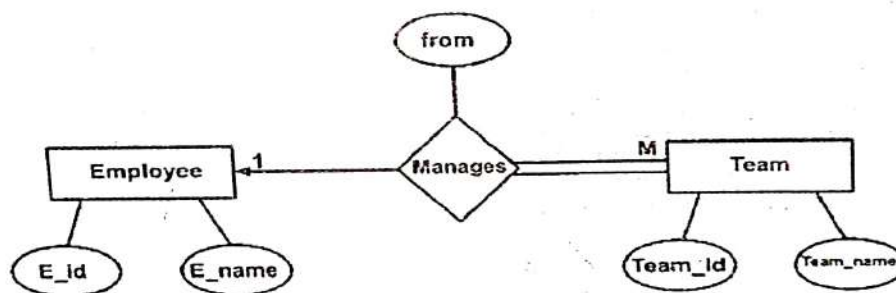
(i) Write SQL query to create a table EMPLOYEE based on the following information:

(3)

- Table EMPLOYEE has the attributes Ecode, Name and age.
- Ecode is the primary key.
- Name should not be NULL.
- Age should take the values between 18 and 60 (both inclusive)

(i) Map the following Entity Relationship diagram to relational tables. Also, identify the primary keys and foreign key for each table.

(3)



SECTION B

2 (a) Differentiate between database schema and database state. Also give an example of each.

(5)

P.T.O.

(b) Consider a CONFERENCE_REVIEW database in which researchers submit their research papers for consideration. Reviews by reviewers are recorded for the paper selection process. The data requirements are summarized as follows: (10)

- Authors of papers are uniquely identified by e-mail id. First and last names are also recorded.
- Each paper is assigned a unique identifier by the system and is described by a title, and abstract
- A paper may have multiple authors, but one of the authors is designated as the contact author.
- Reviewers of papers are uniquely identified by e-mail address. Each reviewer's first name, last name, phone number, affiliation, and topics of interest are also recorded.
- Each paper is assigned between two and four reviewers. A reviewer rates each paper assigned to him or her on a scale of 1 to 10. Finally, each reviewer provides an overall recommendation regarding each paper.

Design an Entity Relationship diagram for CONFERENCE_REVIEW database, stating any assumptions you make. Clearly specify cardinality ratios and participation constraints.

3 (a) Consider the AIRLINE relational database schema which describes a database for airline flight information: (5)

AIRPORT(Acode, Aname, City, State)

FLIGHT(Flightno, Airline, Fare)

TRAVELINFO(Flightno, Date, Depar_acode, Arrival_acode, Depart_time, Arrival_time)

Primary Key in each relation is underlined.

- (i) Specify the foreign keys for this schema.
- (ii) Populate the relations with few sample tuples and write an SQL statement that violates the referential integrity constraint while inserting a tuple in TRAVELINFO relation.

- (b) Consider the AIRLINE relational database schema which describes a database for airline flight information: (10)

AIRPORT (Acode, Aname, City, State)

FLIGHT (Flightno, Airline, Fare)

TRAVELINFO (Flightno, Date, Deapar_acode, Arrival_acode,
Departure_time, Arrival_time)

Primary Key in each relation is underlined.

Write relational algebraic expressions to perform the following:

- (i) Retrieve the code and name of all airports located in Chennai city.
- (ii) Display the flight numbers of TATA Airlines that have the minimum and maximum fares.
- (iii) Find the Flight numbers that are not flying on 2nd March 2025.
- (iv) Find the number of flights boarded from Chennai city.
- (v) Display airport code, airport name, airline, flight number arriving on 4th March 2025 at 10 am.

- 4 (a) Consider the BANK database, where the primary keys are underlined. Each bank can have multiple branches, and each branch can have multiple accounts and loans. Borrower relation corresponds to customers' loan details. Account relation stores customers' account details. (10)

BRANCH (branchID, branchName, branchCity)

CUSTOMER (custID, custName, custCity)

BORROWER (custID, loanNumber, branchID, amount)

ACCOUNT (accountNumber, branchID, custID, balance)

Give the following SQL queries to perform the following operations:

- (i) Find the names of customers who have an account but not a loan.
- (ii) Find branch names from which more than 10 customers have taken loan.
- (iii) Create a view to keep track of the names of customers, their account numbers and branch names.
- (iv) Find the names of all customers who live in the same city as the customer whose name is "Vijay".
- (v) List the names of all customers (in alphabetical order) having a loan in the "Kamla Nagar" branch.

P.T.O.

7004

- (b) Consider the following relation:
 EMPLOYEE (Ecode, Ename, Dept_no, Salary)
 Here Ecode is the primary key.

Which of the following SQL queries is correct for the following statement?
 Justify the answer for both the queries.
 For each department that has more than five employees, retrieve the department number and the number of its employees whose salary is more than Rs. 40,000.

- (i) SELECT Dept_no, COUNT (*)
 FROM EMPLOYEE
 WHERE Salary > 40000
 GROUP BY Dept_no
 HAVING COUNT (*) > 5;
- (ii) SELECT Dept_no, COUNT (*) FROM EMPLOYEE
 WHERE Salary > 40000 AND Dept_no IN
 (SELECT Dept_no
 FROM EMPLOYEE
 GROUP BY Dept_no
 HAVING COUNT (*) > 5)
 GROUP BY Dept_no;

- 5 (a) Consider the following relation: (4)
 STUDENT(Rollno, Name, {Phone}, {Degree})
 State First Normal Form. Is the relation in First Normal Form? If not, then normalise it into First Normal Form.

- (b) Consider the following tables EMPLOYEE and PROJECT: (4)

EMPLOYEE

Ecode	EName	Plocation
1	A	a
2	B	b
3	C	a
4	B	b

PROJECT

Ecode	Pno	Plocation
1	10	a
2	10	b
2	20	b

What will be the output when both the tables are equi-joined on Plocation attribute? Will the output produce spurious tuples? Justify your answer.

- (c) Consider the following relation for published books: (7)
 BOOK(Book_title, Author_name, Book_type, List_price,
 Author_affil, Publisher)
 Author_affil refers to the author's affiliation. Suppose the following dependencies exist:

Book_title -> {Publisher, Book_type}
 Book_type -> List_price
 Author_name -> Author_affil

- (i) What is the candidate key for BOOK relation?
 (ii) What normal form is the relation in? Apply normalization until the relations are in 3NF.

- 6 (a) Consider the following interleaved transactions T1 and T2, executed concurrently. Assume that the initial value of X is 10. (6)

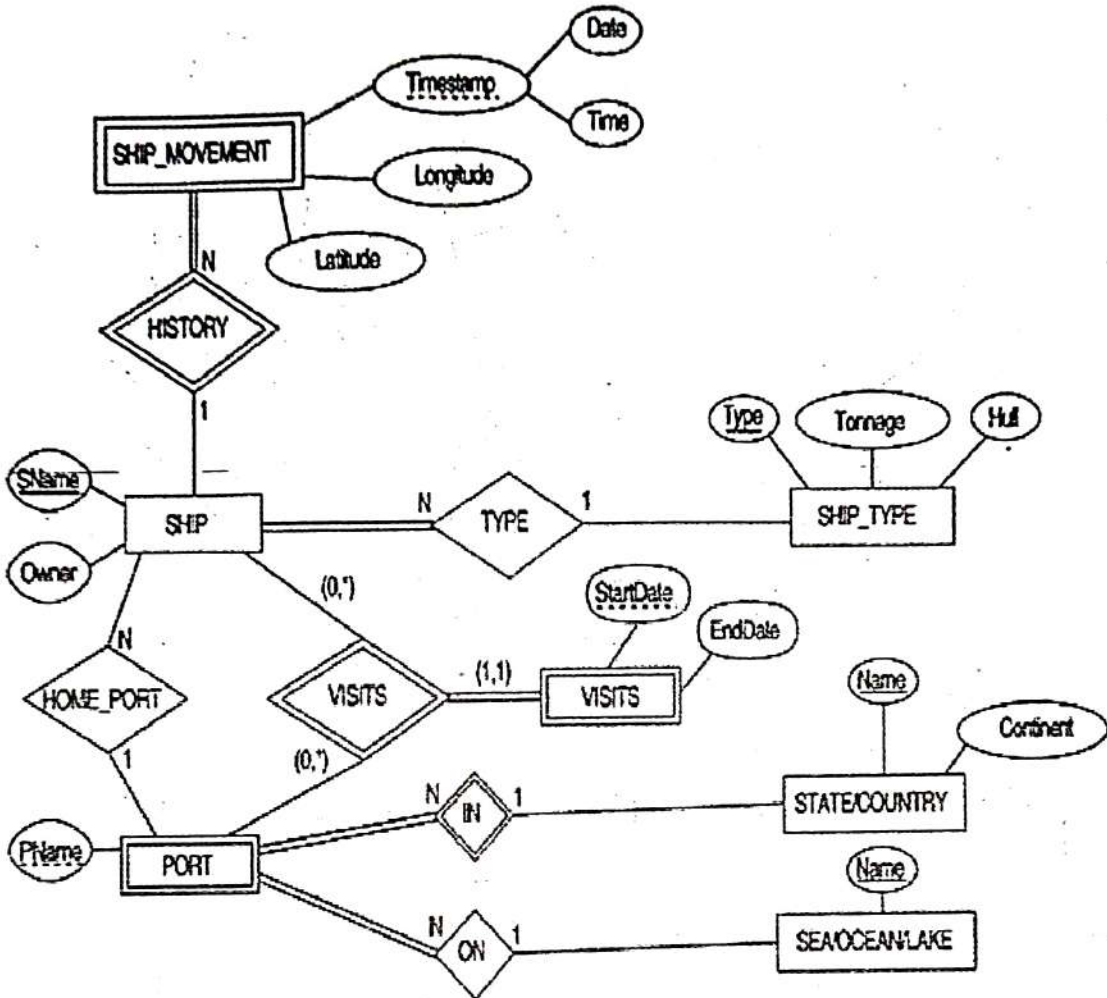
T1	T2
read (X); X = X-3;	
	read(X); X = X-4;
write(X);	write(X);

Compute the value of X after the given schedule is executed. Is the value of X correct? If we remove the interleaving between the transactions T1 and T2, what will be the value of X?

- (b) Why does a binary search on the index file require fewer block accesses than a binary search on the data file? Also explain with suitable example. (4)
- (c) Define Transaction and ACID properties of transaction with respect to database. (5)
- 7 (a) Consider the following six relations for an order-processing database application in a company: (5)
- CUSTOMER (Cust#, Cname, City)
 ORDER (Order#, Odate, Cust#, Ord_amt)
 ORDER_ITEM (Order#, Item#, Qty)
 ITEM (Item#, Unit_price)
 SHIPMENT (Order#, Warehouse#, Ship_date)
 WAREHOUSE (Warehouse#, City)
- Here, Ord_amt refers to the total amount of order (in rupees), Odate is the date of order placed, and Ship_date is the date an order (or part of an order) is shipped from the warehouse. Assume that an order can be shipped from several warehouses.
- (i) What type of constraints would you expect to check?
 (ii) Depict the referential integrity constraints diagrammatically using a schema diagram.

P.T.O.

(b) Map the following Entity Relationship (ER) diagram to its corresponding relational schema. Specify all primary and foreign keys clearly. (10)



(2000)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 8677

K

Unique Paper Code : 2343010020

Name of the Paper : Research Methodology
(Computer Science)

Name of the Course : **Discipline Specific Elective**

Semester : VII (Students admitted 2022
onwards)

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All parts of Question No. 1 (Section A) are compulsory.
3. Attempt any **four** questions from **Section B**.
4. Parts of a question must be answered together.
5. Use of scientific calculator is allowed.

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P.T.O.

Section A

1. (a) How are descriptive statistics different from inferential statistics? Explain with the help of a suitable example. (3)
- (b) Explain briefly about any three techniques of organising data to make them easier to think about and interpret. (3)
- (c) Elaborate the term OWL in reference to writing assistance. Mention at least two activities that are supported by it. (3)
- (d) List six general tools of research. (3)
- (e) Differentiate between Type I and Type II errors. (3)
- (f) Mention any three types of quality measures provided by Scopus for a given title. (3)

(g) Joe is in high school. In February, he attempted

20 tests and got the following grades : (3)

92, 69, 91, 70, 90, 89, 72, 87, 73, 86, 85, 75, 84,

76, 83, 83, 77, 81, 78, 79.

Calculate the interquartile range for his grades

(h) Define plagiarism. Mention different levels of

plagiarism. (3)

(i) Why are process and impact indicators both

important for monitoring and assessing a research

project's performance? (3)

(j) Suppose an outside agency funds a research

project. What steps should the researcher take to

handle this situation ethically? (3)

P.T.O.

Section B

2. (a) Explain the differences between experimental and non-experimental research designs with suitable examples. (7.5)
- (b) Mention any 7 Important points that must be considered carefully before finalising a research project. (7.5)
3. (a) (i) Define the term correlation coefficient.
What can you infer from the statement " $r = -0.08$ ".
- (ii) How coefficient of determination explained?
In what way is it related to the coefficient of correlation? (7.5)
- (b) A researcher has published 10 papers, and the citation counts for each paper are : (7.5)

21, 18, 15, 14, 12, 9, 7, 4, 2, 1.

Calculate the h-index, i10-index, and g-index for this researcher.

4. (a) Justify the following statements : (7.5)

(i) Language can be used as a research tool.

(ii) Human Mind can be used as a research tool.

(b) Given the following research scenarios, identify whether they are prospective or retrospective studies, with suitable reasons for your choice.

(7.5)

(i) Studying a group of people who already have lung cancer and asking them about their past smoking habits to find a correlation.

(ii) Observing a group of people from a young age to see how their diet and exercise habits affect their risk of developing chronic diseases later in life.

5. (a) What do you mean by academic integrity? Explain any five important do's or don'ts taken care of while writing a research report. (7.5)

(b) What is a Geographical Indication (GI), and how does it differ from other forms of intellectual property like trademarks and patents? (7.5)

6. (a) What do you understand by the term Fraud and Misconduct in Scientific Research.

Explain the term, giving examples of four different domains. (7.5)

(b) Expand the Following terms :

(i) URL

(ii) DOI

While referring to an article, which of the two (URL, DOI) is a better option and why? What do you mean by the term peer review? Elaborate.

7. (a) A sample of 20 students has a mean score of 72 with a standard deviation of 10. The population mean is assumed to be 65. Does the sample belong to the population? (7.5)

(i) Frame null hypothesis.

(ii) Frame alternate hypothesis.

On evaluation of statistics, the t-test gives $p = 0.012$. What can you conclude at $\alpha = 0.05$?

(b) Write short notes on following :

(7.5)

- (i) Parametric Statistics.
- (ii) Trade-Related Aspects of Intellectual Property Rights.
- (iii) Meta Analysis.

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 8679

K

Unique Paper Code : 2343010024

Name of the Paper : Cyber Forensics

Name of the Course : **Discipline Specific Elective**

Semester : VII

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. The paper has **two** sections. **Section A** is compulsory.
3. Attempt any **four** questions from **Section B**.
4. Parts of a question must be answered together.

Section A

1. (a) Name the various file systems available on the Windows platform. (2)
- (b) Write the name of any two tools used for network traffic analysis. (2)
- (c) Describe e-mail spoofing with an example. (2)
- (d) What is meant by the term search and seizure in digital forensics? (2)

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- (e) Name any two tools used for recovering deleted files. (2)
- (f) Differentiate between hacking and cracking with an example. (2)
- (g) Describe the significance of a digital forensic report in a court proceeding. List any two essential components included in a standard forensic report. (3)
- (h) How can you analyze an email header to trace an email's path and identify its origin? (3)
- (i) What is the role of these files in windows operating system. (3)
- (i) Swap Files
 - (ii) Temporary Files
 - (iii) Cache Files
- (j) What information can be obtained from the following hive files? (3)
- (i) NTUser.dat
 - (ii) SAM
 - (iii) AmCache.hve
- (k) Define cyber defamation and list the key elements that must be proven in a court of law to establish a case, providing an example. (3)
- (l) How do encryption and decryption methods help in the process of investigation? (3)

Section B

2. (a) Define cyber forensics with an example and also explain the legal considerations that a cyber forensics expert must keep in mind during an investigation. (5)
- (b) Describe the process of conducting a keyword search using the grep command during a forensic investigation. Discuss its significance in locating potential digital evidence. (5)
- (c) What is a hash value? How does it ensure the integrity of digital evidence? Give one example using MD5 or SHA-1. (5)
3. (a) Define Digital Forensics and explain the step-by-step forensic process with an example of a real-world investigation. (5)
- (b) Discuss the four key characteristics of digital evidence and why it is considered fragile. (5)
- (c) Compare the FAT32, NTFS, and exFAT file systems based on their key technical characteristics. Briefly explain one primary advantage of using NTFS over FAT32 for a modern Windows system drive. (5)
4. (a) What is the Information Technology Act, 2000? Explain the primary objectives that led to the enactment of the Information Technology Act, 2000. (7)

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- (b) What is Data recovery and integrity? What precautions should an investigator follow during file recovery to maintain data integrity? (8)
5. (a) Explain the roles of the First Responder and CERT team during a cyber investigation. (7)
- (b) What is a digital signature? Explain with suitable diagram. How it is efficient than electronic signature. (8)
6. (a) What is Intellectual Property (IP) in the context of cybercrime? Explain how digital forensics helps detect and prove IP violations such as software piracy or data theft. Give suitable examples. (5)
- (b) Explain with suitable examples (10)
- (i) Copyright (ii) Patent
- (iii) TradeMark (iv) Trade Secret
7. (a) Write short notes on any five of the following in the context of cyber forensics. (15)
- (i) Spoofing
- (ii) Software Piracy
- (iii) Peer Review
- (iv) Viruses
- (v) International Law
- (vi) Cyber Crimes and Internet
- (vii) Forensic Tool Kit

This question paper contains 4 printed pages|

Roll No.

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S. No. of Question Paper : 10576

Unique Paper Code : 2343010020

Name of the Paper : Research Methodology (Computer Science)

Name of the Course : Discipline Specific Elective

Semester : VII (2022 onwards)

Duration : 3 Hours

Maximum Marks : 90

(Write your Roll No. on the top immediately on receipt of this question paper.)

All parts of Question No. 1 (Section A) are compulsory.

Attempt any four questions from Section B.

Parts of a question must be answered together.

Use of scientific calculator is allowed.

Section-A

1. (a) What is the role of literature review in research ? 3
- (b) A student has a z-score of 3.5 : 3
- (i) Calculate its IQ score.
- (ii) Calculate its stanine score.

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- (c) Describe the essential elements of a research paper. 3
- (d) What are the differences between retrospective and prospective type of research ? 3
- (e) Explain Nominal and Ordinal data with examples. 3
- (f) What is h-index ? Calculate the h-index for the author who has published 6 papers having the following citations :

15, 10, 12, 3, 2, 1. 3

- (g) The following data gives the number of points scored in a class test on scale of (1-10) : 3

6, 8, 5, 7, 9

Compute standard deviation of points scored.

- (h) Explain peer reviewed process and its significance. 3
- (i) State any *two* ethical issues in research. 3
- (j) What are intellectual property rights (IPR) ? Name any *four* types of IPR. 3

Section-B

2. (a) Discuss the various steps involved in the research process. 7.5
- (b) Explain inductive and deductive research methods with the help of example. How do they differ ? 7.5

3. (a) (i) Differentiate between Type I and Type II errors in hypothesis testing. 4
- (ii) The correlation score between student's study hours and their exam scores is found to be +0.85. Interpret this correlation score in terms of direction and strength of relationship between study hours and exam score. 3.5
- (b) What is self-plagiarism and accidental plagiarism ? What is the role of plagiarism checker ? 7.5
4. (a) What is meant by a research problem ? Describe the methods of identifying and defining a research problem. 7.5
- (b) What are the possible recommendations a reviewer can provide regarding paper submitted to a journal ? What are the possible reasons of rejection of a paper ? 7.5
5. (a) A teacher records the following marks of 5 students : 7.5

12, 15, 11, 14, 18

Calculate the mean, average deviation about the mean. Also calculate the minimum marks to obtain percentile rank 80.

- (b) Write *two* differences between cite score and impact factor. Explain their significance. A journal published 120 papers in 2022 and 160 papers in 2023. In 2024, the total number of citations received by these papers is 480. Calculate the Impact Factor (IF) of the journal for the year 2024. 7.5
6. (a) Write short notes on the following : 7.5
- (i) Fraud and misconduct in science
- (ii) Copyright and patents
- (iii) Normal Distribution
- (b) (i) Differentiate between endnotes and footnotes. 4
- (ii) Expand the term OWL. How can it be used as writing assistance tool ? 3.5
7. (a) How to identify the possible weakness of the current study or research gap ? 7.5
- (b) Explain issues related to fabrication, falsification and duplicate publication with suitable examples. 7.5

Sr. No. of QP : 10580
Unique Paper Code: 2343010026
Name of the Paper: Machine Learning
Name of the Course: DSE
Semester: VII
Duration: 3 Hours
Maximum Marks: 90 Marks

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. **Section A** is compulsory.
3. Attempt any **four** questions from **Section B**.
4. Parts of a question must be answered together.
5. Use of a **scientific calculator** is allowed.

Section A

- Q1. a) Explain the difference between the predictor and response variable. Additionally, provide a real-world example for each. Consider the case study of finding out the number of ice-creams sold in a particular mother dairy shop based on the temperature of the day. Specify the predictor and response variables in this case study. 3
- b) Given a Neural network (NN) with two hidden layers where each hidden layer has 4 hidden units. The number of features in the training data set is 4 and the target variable can take three distinct values. Calculate the total number of parameters used in the said NN. 3
- c) A medical test was conducted on 500 individuals, out of which 400 were healthy, and 100 were truly sick. Among the sick individuals, only 70 tested positive, while the rest received a negative result. For the healthy individuals, 25 tested positive, and 375 received a negative result. Draw the confusion matrix for the test results and calculate the Accuracy. 3
- d) Identify whether the following problems should be handled as supervised learning or unsupervised learning problems. Justify your answer. 3
- (i) Identify whether the mail in the given Inbox is spam or non-spam.
- (ii) Group the similar customers according to the items purchased in the supermarket.
- (iii) Identify the characters in the handwritten paper.
- e) Name a classification algorithm which is a 'lazy learner'. Justify the reason why it is called a lazy learner. 3
- f) State Naïve Bayes theorem. Enumerate the key assumption underlying the Naive Bayes classifier. 3
- g) Given the number of features (p) as 15, find the number of models to be fitted by the best subset selection method and the forward subset selection. 3
- h) Construct a decision tree to represent the Boolean function $F(A,B,C)=A\wedge B\wedge C$. 3
- i) The precision and recall values for two models M1 and M2 is 0.88 and 0.33 respectively, and 0.61 and 0.56 respectively. Which one of the two models has a better performance? 3
- j) Why R^2 statistic is a better performance metric to assess a regression model, as compared to Residual Standard Error? 3

Section B

- Q2. a) Using customer transaction data given in part (b) of this question, find the entropy of attributes 'Price' and 'Quantity'. Which of the attribute has more randomness? 5
- b) Consider the following customer transaction data, with the "Purchase" attribute representing the class label: 10

Product	Price	Quantity	Day	Purchase
Laptop	high	1	Weekday	Yes
Headphones	low	2	Weekend	No
Mouse	low	3	Weekday	Yes
Keyboard	low	1	Weekend	Yes
Monitor	high	1	Weekday	No
Laptop	high	1	Weekend	Yes
Headphones	low	1	Weekday	No
Mouse	low	2	Weekend	Yes
Keyboard	low	1	Weekday	No
Monitor	high	1	Weekend	Yes

Using this dataset, train a Naive Bayes classifier and predict the class label "Purchase" for a new instance with the following attribute values: Product = Laptop, Price = low, Quantity = 1, Day = Weekday.

- Q3. a) When do we use logistic regression classifier over linear regression model? Explain with one example. In a binary classification scenario using logistic regression, the model outputs a probability score of 0.4 for the positive class. If the decision threshold is set at 0.5, what will be the predicted class label? 5
- b) Given the following data with one input attribute 'x' and one output variable 'y', fit a linear regression model using the least squares method. Determine the residual error for the best-fit line. Calculate the R^2 for the linear regression model for this data and predict the value of y for $x=20$. 10

Input (x)	Output (y)
10	45
14	55
19	66
21	79
24	95
26	102

- Q4. a) Apply the k-means clustering to cluster the following data into two clusters: 5
 3, 5, 8, 10, 13, 16, 21, 25
 Initially, let 8 and 16 be the two initial cluster centroids. Use Euclidean distance to compute the distance between any two points. Compute the data membership and the centroid of each cluster after first iteration.

- b) Consider the following dataset representing customer behaviour metrics X and Y 10
 for an online retail platform:

Points	X	Y
P1	2	8
P2	3	5
P3	8	4
P4	4	8
P5	7	5
P6	6	4

Generate the distance matrix using Euclidean distance. Using the Complete Linkage method, generate a dendrogram for the given data. From the dendrogram, identify the clustering scheme with two clusters.

- Q5. a) For a maximal margin classifier, which points of the training set are called as support vectors? Discuss the capability of this classifier for data which is not linearly separable. 5
- b) Describe the structure of a multilayer neural network with a suitable example. Discuss any two strategies employed to prevent a neural network from overfitting? 5
- c) The provided regression coefficients show a multiple logistic regression model used to predict the risk of sudden death. Using these coefficients calculate the predicted probability of death for a man with blood pressure of 110 mmHg, Cholesterol level of 280 mg/100mL, and Glucose level of 120 mg/100mL. 5

Risk Factor	Regression Coefficient
Constant term (β_0)	-17.2
Blood Pressure (mm Hg) (β_1)	0.112
Cholesterol (mg/100 mL) (β_2)	0.0071
Glucose (mg/100 mL) (β_3)	0.0075

- Q6. a) How does the hold-out method differ from k-fold cross-validation in context to the performance evaluation of a classifier? Compare the two approaches on the basis of bias-variance trade-off. 5

- b) Consider the following customer purchase dataset for an e-commerce platform: 10

Customer ID	Purchase	Age Group	Income Level	Purchase
1	Yes	Kid	High	Yes
2	No	Adult	Low	No
3	Yes	Adult	High	Yes
4	No	Kid	Low	No
5	Yes	Adult	High	No
6	No	Adult	Low	Yes
7	Yes	Kid	High	Yes
8	No	Adult	Low	No

Using the Entropy criterion, construct a decision tree.

- Q7. a) What is the maximum number of principal components that can be extracted for the dataset with n observations and p features? Write the formal equation for computing the first principal component. What are the distinguishing characteristics of the first principal component compared to the second principal component? 5
- b) Consider the 2 classes of points in a 2-dimensional graph: 5
class +1 : (3,3), (6,3), (6,6)
class -1 : (3,6), (6,9), (3,9).
(i) Plot the above points on 2-dimensional axes.
(ii) Draw the line that separates the two classes and then draw the maximal margin between the classes.
(iii) Identify the support vectors.
- c) Discuss the role of activation functions in a neural network. Name the two commonly used activation functions. Show the graphical representation of each, along with their mathematical formula. 5

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 10803 K

Unique Paper Code : 2353010015

Name of the Paper : Research Methodology

Name of the Course : Bachelor of Arts / Bachelor
of Science (Programme)

Semester : VII (DSE)

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All six questions are compulsory, attempt any two parts from each question.
3. All questions carry equal marks.

1. (a) Explain the concept of literature survey in mathematical research.

- (b) Write the importance of writing keywords and MSC-full form classification in mathematical research.
- (c) What should we take care of while submitting a research paper to some journal?
2. (a) What key points should one remember while presenting work to the audience?
- (b) What is the difference between Theorem, Lemma and Corollary? Explain with examples.
- (c) Is it important to give assignments and home works in Mathematical research? Explain your answer.
3. (a) Write the LaTeX code required to create a simple table containing three rows and four columns. The table must have vertical lines separating all columns and horizontal lines separating all rows.
- (b) Identify and explain two common compilation errors that beginners encounter in LaTeX. Provide a corrected code snippet for one of the identified errors.

- (c) What is the preamble of a LaTeX document? List three essential types of information or commands (excluding the document class) that must typically be included in the preamble for a standard scientific paper.
4. (a) Explain the purpose and usage of the following LaTeX commands, which are often used together in document preparation: `\pageref{}` and `\label{}`. Explain the use of the commands `\pageref`, `\ref` and `\eqref` with examples.
- (b) Explain the purpose of the LaTeX command `\mbox` (Make Box). Describe a situation in a research document where using `\mbox{}` is required to prevent an unwanted line break or poor formatting.
- (c) What is meant by a fragile command in LaTeX? Provide an example. Which command can be used to prevent errors caused by fragile commands? Illustrate with an example.
5. (a) Discuss about the various databases used for exploring mathematical articles.

- (b) What are the key differences between zbMath and MathSciNet?
- (c) Explain how SIAM and AMS help in mathematical research.
6. (a) What do you mean by copyright infringement? How can we get permission to use someone else's song, images or footage?
- (b) Write short note on MCQ, SNIP and SJR.
- (c) Mention the ethics for researchers. Explain why is it important.