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S. No. of Question Paper : 5775

Unique Paper Code : 2342011201

Name of the Paper : Object-Oriented Programming with C++
(DSC04)

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

Semester : II

Duration : 3 Hours

Maximum Marks : 90

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

Paper has two sections. All the questions in Section A are compulsory.

Answer any four questions from Section B.

Parts of question must be answered together.

Part A

1. (a) Draw flowchart for finding even number out of two numbers. 2
- (b) Identify the valid/invalid identifiers and write the reason for invalid identifiers : 3
 - (i) Num_total
 - (ii) 2ndValue
 - (iii) my@variable

P.T.O.

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11/6/09/11
(w) 570/9/11

(iv) firstName

(v) float

(vi) myValue123

(c) Identify and correct the errors in the following code segments : 10

```
(i) class Example {
    static int count;

public:
    Example()
    {
        count++;
    }

    void display()
    {
        cout << "Count: " << count << endl;
    }
};

int main()
{
    Example obj1, obj2;
    obj1.display();
    obj2.display();
    return 0;
}
```



```
(ii) class Person {
    private:
        string name;
    public:
        Person(string n)
        {
            name = n;
        }
        void display()
        {
            cout << "Name: " << name << endl;
        }
};

int main()
{
    Person p("John");
    cout << p.name << endl;
    p.display();
    return 0;
}
```

(iii) int main()

```
{  
    string str = "Hello";  
    str[5] = 'W';  
    cout << str << endl;  
    return 0;  
}
```

(iv) int main ()

```
{  
    int a = 10;  
    int b = 0;  
    try  
    {  
        if (b == 0)  
            throw "Division by zero error!";  
        cout << a / b << endl;  
    }  
    catch (int e)  
    {  
        cout << "Exception caught: " << e << endl;  
    }  
    return 0;  
}
```

```
(v) int main()
{
    int arr[5];
    for (int i = 0; i <= 5; i++)
    {
        arr[i] = i * 2;
    }
    for (int i = 0; i < 5; i++)
    {
        cout << arr[i] << " ";
    }
    return 0;
}
```

(d) Give the output for the following code segments :

10

(i) class Rectangle

```
{
    int length;
    int width;
public:
    Rectangle()
    {
        length = 0;
        width = 0;
    }
}
```

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```
Rectangle(int l, int w)
{
    length = l;
    width = w;
}

Rectangle(const Rectangle &r)
{
    length = r.length;
    width = r.width;
}

void display()
{
    cout<<"Length:"<<length<<"Width:"<<width<<endl;
}

};

int main()
{
    Rectangle rect1(10, 5);
    Rectangle rect2 = rect1;
    rect2.display();
    return 0;
}
```

(ii) #include <iostream>

using namespace std;

class Vehicle

{

public:

void start()

{

cout << "Vehicle started!" << endl;

}

};

class Car : public Vehicle

{

public:

void drive()

{

cout << "Car is driving!" << endl;

}

};

```
int main()
{
    Car myCar;
    myCar.start();
    myCar.drive();
    return 0;
}
```

```
(iii) #include <iostream>
using namespace std;
int main()
{
    int a = 5;
    int b = 2;
    float result1 = a / b;
    float result2 = (float)a / b;
    float result3 = a / (float)b;
    float result4 = (float)(a / b);
    cout << "result1: " << result1 << endl;
    cout << "result2: " << result2 << endl;
    cout << "result3: " << result3 << endl;
    cout << "result4: " << result4 << endl;
    return 0;
}
```


(iv) int main()

```
{  
    int matrix[2][3] = {{1, 2, 3}, {4, 5, 6}};  
    int sum = 0;  
    for (int i = 0; i < 2; i++)  
    {  
        for (int j = 0; j < 3; j++)  
        {  
            sum += matrix[i][j];  
        }  
    }  
    cout<<"Sum of all elements: "<<sum << endl;  
    cout<<"Element at [1] [2] : "<<matrix[1] [2]<< endl;  
    return 0;  
}
```

(v) int main()

```
{  
    int x = 10;  
    int* ptr = &x;  
    *ptr = *ptr + 5;  
    cout << "Value of x: " << x << endl;  
    cout << "Value at ptr: " << *ptr << endl;  
    return 0;  
}
```

- (e) Write a class Student with data members name, roll and marks. Include a constructor and a function display to display student details. 5

Part B

2. (a) Rewrite the following code for counting vowels and alphabets using a switch-case : 5

```
char *ch = "hello world";
int countv = 0, countalp = 0;
int i = 0;
while (ch[i])
{
    if (ch[i]=='a' || ch[i]=='e' || ch[i]=='i'
        || ch[i]=='o' || ch[i]=='u')
        countv++;
    else
        countalp++;
    i++;
}
cout << countv << endl;
cout << countalp;
```

- (b) Write a program to compute the series : 10

$$s = 1 + \frac{x}{2} + \frac{x^2}{3} + \frac{x^3}{4} + \dots \text{ upto } n \text{ terms}$$

using command line arguments.

3. (a) Write declarations/code for the following : 5

- (i) A function prototype for function fsum having int array, double and char as argument and return type as void.
- (ii) A function prototype for function f x with arguments pointer to double, and 2 dimensional array with size 8 × 10, returning integer value.
- (iii) Array of floats : {3.4, 5.6, 7.8, 9.1}
- (iv) Pointer variable for float x, y
- (v) Ternary operator for max of two values.

- (b) Write a program using a function findmaxmin with pointer arguments to find the maximum and minimum values from two integers entered by the user. Define the function : 10

void findMaxMin(int* a, int* b, int& max, int& min)

The function should :

- (i) Accept two integers via pointers.
- (ii) Store the maximum in the third argument.
- (iii) Store the minimum in the fourth argument.

And write main() to call this function for finding minimum and maximum out of two integers x and y.

Q4. (a) Explain the output of the following code segment :

```
class Shape
{
public:
    void draw()
    {
        cout << "Drawing Shape" << endl;
    }
};

class Circle: public Shape
{
public:
    void draw()
    {
        cout << "Drawing Circle" << endl;
    }
};

int main()
{
    Shape* s;
    Circle c;
    s = &c;
    s->draw();
    return 0;
}
```

- (b) Write a program that demonstrates single inheritance as per the description given :

10

Define a base class Person with the following :

- Data members : name (string), age (int)
- Member function : void getDetails() to input name and age
- Member function : void showDetails() to display name and age

Define a derived class Student that inherits from Person. It should have :

- Additional data members : rollNo (int), marks (float)
- Member function : void getStudentData() to input roll number and marks
- Member function: void showStudentData() to display roll number and marks along with inherited data

Create an object of class Student in main() and call appropriate functions to input and display all details.

5. (a) Identify and correct the errors in the following code segments :

5

```
class Base
{
    public:
        int Var1;
    protected:
        int Var2;
    private:
        int Var3;
    public:
        Base()
        {Var1=1;
        Var2=2;
        Var3=3; }
    void display()
    {
        cout<<"Display Base Variable1:"<<Var1<< endl;
        cout<<"Display Base Variable2:"<<Var2<< endl;
        cout<<"Display Base Variable3: "<<Var3<< endl;
    }
};
```

```
class Derived: public Base
{
public:
void display()
{
cout<<"Display Derived Variable1:"<<Var1<< endl;
cout<<"Display Derived Variable2:"<<Var2<< endl;
cout<<"Display Derived Variable3:"<<Var3<< endl;
}
};

int main()
{
Base baseObj;
Derived derivedObj;
cout<<"Accessing Base Class Object:"<<endl;
baseObj.display();
cout<<"Accessing Derived Class Object:"<<endl;
derivedObj.display();
return 0;
}
```


(b) Differentiate between the following using proper examples : 10

(i) Constructor and Destructor

(ii) While loop and do-while loop

(iii) Function Overloading and Function Overriding

(iv) Call by Value and Call by Reference

6. (a) Give output and explain the functioning of the following code segment : 5

```
void test(int x) {  
    if (x == 0)  
        throw 0;  
  
    else if (x < 0)  
        throw 'N';  
  
    else if (x > 100)  
        throw "Too large!";  
  
    else  
        cout << "Valid number: " << x << endl;  
}  
  
int main()
```



```
{  
    try {  
        test (25);  
        test(0);  
        test (150);  
        test (-5);  
    }  
    catch (...)  
    {  
        cout << "Some exception caught!" << endl;  
    }  
    return 0;  
}
```

- (b) Write a program that defines a function `isPalindrome (string str)` to check whether a given string is a palindrome or not. A string is a palindrome if it reads the same forwards and backwards. 5

The program should :

- Take a string input from the user.
- Pass it to the function.
- Print whether it is a palindrome or not.

- (c) What are streams ? What will be the content of the file data.txt and explain the reason after execution of this program ? 5

```
#include <fstream>
using namespace std;
int main()
{
    ofstream fout1("data.txt");
    fout << "Line 1\n";
    fout << "Line 2";
    fout.close( );
    ofstream fout2("data.txt");
    fout2 << "New Line";
    fout2.close();
    return 0;
}
```

7. (a) What is pure virtual function ? Give output of the following code segment : 5

```
#include <iostream>
using namespace std;
class Account
{
public:
    virtual void balance() = 0;
};
```

```
class SavingsAccount : public Account
{
public:
    void balance ()
    {
        cout<<'Savings Account Balance: $1000"<< endl;
    }
};

class CurrentAccount: public Account
{
public:
    void balance()
    {
        cout<<"Current Account Balance: $500" << endl;
    }
};

int main()
{
    Account* acc;
    SavingsAccount savings;
    CurrentAccount current;
    acc = &savings;
    acc->balance();
    acc = &current;
    acc->balance();
    return 0;
}
```

P.T.O.

- (b) Give output and explain the functioning of the following code segment : 5

```
template <typename T>
T add(T a, T b) {
    return a + b;
}

int main() {
    cout << add(5, 10) << endl;
    cout << add(3.5, 2.1) << endl;
    return 0;
}
```

- (c) Write a program to check whether the number is prime or not. 5

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S. No. of Question Paper : 5776

Unique Paper Code : 2342011204

Name of the Paper : Programming Using C++

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

Semester : II

Duration : 3 Hours

Maximum Marks : 90

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Paper has two sections. All the questions in Section A are compulsory.

Answer any four questions from Section B.

Parts of question must be answered together.

Section A

(Compulsory)

1. (a) Draw flowchart for finding sum of first n natural numbers. 2

(b) Which of the following are invalid identifiers in C++ ? 2

(i) A4#1

(ii) 1_Class

(iii) Class

(iv) Monthly_rate

P.T.O.

- (c) Write function `cube()` which computes the cube of an integer passed as a pointer in the following program and give the output of the following code segment. 3

```
void cube(int *numptr); //prototype
int main()
{
    int number=5;
    cout<<"The number is:"<<number<< endl;
    cube(&number);
    cout<<"The number after a call:"<< number<<endl;
    return 0;
}
```

- (d) Give the output that will be produced on execution of the following code segments :

(i) `void f(int x, int &y)` 3

```
{
    x+=10;
    y+=x;
}

int main()
{
    int num1=12, num2=5;
    cout<<"\nBefore:"<<"num1 = "<<num1<<" , num2="<<num2
    f(num1,num2);
    cout<<"\nAfter:"<<"num1="<<num1<<" , num2="<<num2;
    return 0;
}
```

(ii) class Test

3

```
{  
  
    private:  
  
        static int count;  
  
    public:  
  
        Test & fun( );  
  
};  
  
int Test::count = 0;  
Test & Test::fun()  
{  
  
    Test::count++;  
  
    cout << Test::count << " ";  
  
    return *this;  
}  
  
int main()  
{  
  
    Test t;  
  
    t.fun();  
  
    t.fun();  
  
    return 0;  
};
```

P.T.O.

(iii) void func(int a, int b)

3

```
{
    if (a == 0 || b == 0)
    {
        throw "The product is zero. Provide non-zero values.\n";
    }
    else
    {
        cout<<"Product of "<<a<<" and"<<b<<" is: "<<a*b<<endl;
    }
}

int main()
{
    try {
        func (5,0);
        func(2,5);
    }
    catch (const char* e)
    {
        cout<<e;
    }
    return 0;
}
```


- (e) Define a function omit (string W) which takes a string W as an argument and returns the word omitting all vowels from W. For example :
BEAUTIFUL returns BTFL. 4
- (f) Give the output of the following code segment : 5

```
class sample
```

```
{
```

```
protected:
```

```
    int count;
```

```
public:
```

```
    void initialize()
```

```
{
```

```
    count = 0;
```

```
    cout<< "sample with count: "<< count << endl;
```

```
}
```

```
    void setData(int k)
```

```
{
```

```
    count = k;
```

```
    cout<< "sample with count: "<< count << endl;
```

```
}
```

```
};
```

```
class newsample: protected sample
```

```
{
```

P.T.O.

```
private:
    int newcount;

public:
    void setValues(int k)
    {
        setData(k);
        newcount = count * 20;
        cout << "newsample with newcount: " << newcount << endl;
        cout << "newsample with count: " << count << endl;
    }
};

int main()
{
    sample S3;
    S3.initialize ();
    sample S1;
    S1. setData(5);
    newsample S2;
    S2. setValues(10);
    return 0;
}
```

- (g) Write a function template `minimum (T arr , int size)` where `T` is the generic type of array `arr` to find minimum from the array. Use this function for finding minimum from integer, character and floating-point number array. 5

Part B

(Attempt any four questions)

- 2 (a) Give the output of the following code segment : 3

```
void display(char c = '*', int count= 3)
{
    for(int i = 1; i <= count; ++i)
    {
        cout << c;
    }
    cout << endl;
}

int main()
{
    int count = 5;
    cout << "First Call:";
    display();
    cout << "Second Call: ";
    display('#');
    cout << "Third Call:";
    display('$', count);
    return 0;
}
```

(b) Write recursive function fact (int x) for finding the factorial of n.
 Use this function to find $C(n, r)$, where $C(n, r) = \frac{n!}{r! * (n-r)!}$. 6

(c) Given a following code segment. Write statements to call function display in Line 1-3 using object d of class Derived in main function to generate the following output : 6

Output:

Derived: display()

Intermediate: display()

Base: display()

Code segment:

```
class
{
public:
    void display()
    {
        cout << "Base: display()" << endl;
    }
};

class Intermediate : public Base
{
public:
    void display()
```

```
{  
    cout << "Intermediate: display()" << endl;  
}  
};  
  
class Derived : public Intermediate  
{  
public:  
    void display()  
    {  
        cout << "Derived: display()" << endl;  
    }  
};  
  
int main()  
{  
    Derived d;  
    -----//Line 1  
    -----//Line 2  
    -----//Line 3  
    return 0;  
}
```

3. (a) Give the output that will be produced on execution of the following code segment :

6

```
int main()
{
    int a[] = {2,9,7,21,46};
    int *pa = a;
    int *pr = pa+2;
    cout<< *pa << endl;
    cout<< *pr << endl;
    cout<< *pr-- << endl;
    pr+=2;
    cout<< *pr << endl;
    pr-=2;
    cout<< *pr << endl;
    cout<< *pr + *pa << endl;
    return 0;
}
```

- (b) Consider the following class :

9

```
class Ratio
{
    private:
        int numerator;
        int denominator;
```

```

public:
    Ratio(); //constructor
    Ratio(int n, int d); //constructor
    Ratio(Ratio& r); //copy constructor
    //Add two Ratios using this pointer
    Ratio& add(Ratio r1);
};

```

Define all functions and write main() to compute the equation

$$\text{Result} = \frac{2}{3} + \frac{4}{5}$$

by calling these functions using appropriate class Ratio objects.

4. (a) Give the output that will be produced on execution of the following code segment : 6

```

class Student
{
public:
    void displayInfo()
    {
        cout << "Student Information" << endl;
    }
    void calculateGrade()
    {
        cout << "Grade calculation" << endl;
    }
}

```

```
};  
  
class ScienceStudent: public Student  
{  
public:  
    void displayInfo()  
    {  
        cout << "Science Student Information" << endl;  
    }  
    void calculateGrade()  
    {  
        cout << "Grade: A" << endl;  
    }  
};  
  
int main()  
{  
    student students[3];  
    students[0] = ScienceStudent();  
    students[1] = ScienceStudent();  
    student* topper = &students[1];  
    for (int i = 0; i < 2; i++)  
    {  
        cout<<"Student " << i + 1 <<" Information: "endl;  
        students[i].displayInfo();  
        students[i].calculateGrade();  
        cout << endl;
```



```

}

cout<< "student Topper detail"<< endl;

topper-> displayInfo();

topper-> calculateGrade();

return 0;

}

```

(b) Write a program that multiplies two 2D matrices A and B entered by the user. The program should do the following : 9

- (i) Prompt the user to enter the dimensions (rows and columns) of both matrices.
- (ii) Check if matrix multiplication is possible (i.e., number of columns in Matrix A equals number of rows in Matrix B).
- (iii) If multiplication is possible:
 - Accept the elements of both matrices.
 - Multiply the matrices and store the result in a third matrix.
 - Display the result.
- (iv) If multiplication is not possible, display an appropriate error message.

5. (a) Give the output after execution of the following code segment. Explain which display () function is executed with a reason for each line 1-6 : 6

```

template <class T>

void display(T value)

```

```
{  
    cout<<" Display 1: "<<value<<endl;  
}  
  
template <class T, class T1>  
void display(T value1, T1 value2)  
{  
    cout<<"Display 2: "<<value1<<" & "<<value2<< endl;  
}  
  
void display(int value)  
{  
    cout << "Explicit Display: "<<value<<endl;  
}  
  
int main( )  
{  
    display(10);           //Line 1  
    display('A');          //Line 2  
    display(15.67);        //Line 3  
    display(110,12.78);    //Line 4  
    display(94,"Good");    //Line 5  
    display (12,34);       //Line 6  
    return 0;  
}
```

- (b) Write a program to demonstrate runtime polymorphism using an Employee base class and derived classes for different employee types having the following structures :

9

Base class : Employee

- Protected data member: name as string
- Parameterized constructor to initialize name
- Virtual function: calculateSalary () that displays a generic message with computed total salary and employee name.

Derived classes :

- FullTimeEmployee:

private data members: basicSalary, bonus

and total salary computed as (basicSalary + bonus)

- PartTimeEmployee:

private data members : hoursWorked, hourlyRate and total salary computed as (hoursWorked * hourlyRate)

Write calculateSalary () for both the derived classes and main () to show runtime polymorphism by calling calculateSalary () through the pointers to appropriate objects.

P.T.O.

6. (a) Given $x = 0$, $y = 0$, $z = 1$, what are the values of x , y and z after executing the following code segment : 2

```
switch(x)
```

```
{
```

```
    case 0 : x = 1;
```

```
            y = x+y;
```

```
            z = 8 ;
```

```
    case 1: x = 4 + z;
```

```
    default: y = 3;
```

```
            x = y;
```

```
            z = 1;
```

```
}
```

- (b) Find and explain the error(s) from the following code segment : 6

```
class Base
```

```
{
```

```
    private:
```

```
        int a;
```

```
    protected:
```

```
        int b;
```

```
    public:
```

```
        int c;
```

```
    Base( )
```

```
    { a=10;
```

```
      b=20;
```

```
      c=30;
```

```
    }
```

```
};
```

```
class Derived: protected Base
{
    private:
        int d;
    protected:
        int e;
    public:
        Derived( )
        { d=100;
          e=200; }
        void show( )
        {
            cout <<"b = " << b << endl; // Line 1
            cout << "c = " << c << endl; // Line 2
            cout << "d = " << d << endl; // Line 3
            cout << "e = " << e << endl; // Line 4
        }
};

class MoreDerived: public Derived
{
    private:
        int g;
    public:
        MoreDerived()
        {
            g = 109;
        }
}
```

P.T.O.

```
void display( )
{
    cout << "a = " << a << endl; // Line 5
    cout << "b = " << b << endl; // Line 6
    cout << "c = " << c << endl; // Line 7
    cout << "d = " << d << endl; // Line 8
    cout << "e = " << e << endl; // Line 9
    cout << "g = " << g << endl; // Line 10
}

};

int main( )
{
    Derived d1;
    cout << d1.b << endl; // Line 11
    cout << d1.c << endl; // Line 12
    MoreDerived md;
    md.display();
    cout << md.e << endl; // Line 13
    cout << md.g << endl; // Line 14
    return 0;
}
```

(c) Write a program to calculate the square root of a number entered by the user. The program should follow these requirements : 7

(i) Prompt the user to enter a number.

- (ii) If the number is negative, the program should throw an exception indicating that square root of a negative number is not allowed.
 - (iii) Use a try-catch block to catch the exception and display an appropriate error message.
 - (iv) If the number is non-negative, calculate and display the square root of the number using the built-in `sqrt()` function.
7. (a) Write a program to copy a text file A.txt to another file B.txt having all words in reverse order. For example :

A. txt: This is the original file.

B. txt: sihT si eht lanigiro elif.

- (b) Find error(s) and give output that will be produced after correction in the following code segment:

```
class Sample
{
    int value;
    static int counter;
public:
    void setValue(int v)
    {
        value = v;
    }
    static void countCall()
    {
```

P.T.O.

```
        counter++;
        cout<<"Function called "<<counter<<"times . "<<endl;
        cout <<"Value is: "<<"value<<endl;
    }
};

int Sample::counter;

int main()
{
    Sample s1, s2;
    s1.setValue (5);
    s2.setValue(10);
    Sample::countCall();
    s1.countCall();
    return 0;
}
```


3

[This question paper contains 8 printed pages]

Your Roll No. :

Sl. No. of Q. Paper : **5796** **I**

Unique Paper Code : 2342011202

Name of the Paper : Discrete Mathematical Structures

Name of the Course : **B.Sc. (H) Computer Science (NEP – UGCF-2022)**

Semester : II

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) Question No. 1 is compulsory.
- (c) Attempt any 4 of Questions Nos. 2 to 7.
- (d) Parts of a question must be answered together.
- (e) Use of a simple calculator is allowed.

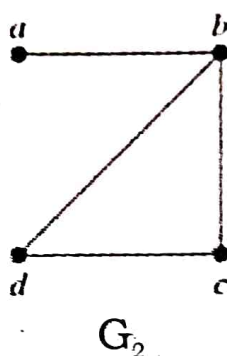
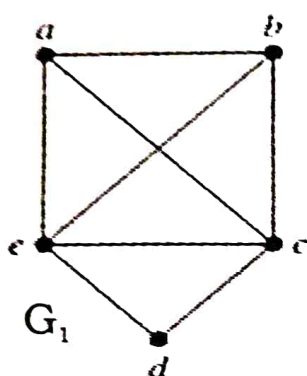
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Section - A

1. (a) Define a Hamilton path and Hamilton circuit. List a Hamilton path or Hamilton circuit in the graphs G_1 and G_2 given below if it exists.

5



- (b) (i) Find the contrapositive, the converse and the inverse of the statement :
"The home team wins whenever it is raining". 3
- (ii) Show that if n is an integer and $3n + 2$ is odd, then n is odd using a proof by contraposition. 2
- (c) Find the greatest common divisor of 414 and 662 using the Euclidean algorithm. 5
- (d) Let f be the function from the set $X = \{2, 3, 4, 5, 6, 7\}$ into the set $Y = \{0, 1, 2, 3, 4\}$ defined by $f(x) = 2x \pmod{5}$. Write f as a set of ordered pairs. Is f one - one or onto ? Justify. 5

- (e) (i) How many distinct 5 – letter passwords can be formed from English alphabets if repetition is allowed and at least one letter must be a vowel ? 3
- (ii) How many students must be in a class to guarantee that at least two students receive the same score on the final exam, if the exam is graded on a scale from 0 to 100 points ? 2
- (f) Let 'a' be a numeric function such that : 5

$$a_r = \begin{cases} 1 & 0 \leq r \leq 3 \\ 2^r + 3 & r \geq 4 \end{cases}$$

Find ∇a and $S^{-2} a$.

Section - B

2. (a) In how many ways can three examinations be scheduled in a seven-day week if more than one examination can be scheduled on the same day. 3
- (b) Let R be a relation on the set of real numbers such that 4

$$R = \{(a, b) \mid a^2 + b^2 = 1\}$$

State whether the relation R is reflexive, symmetric, antisymmetric and transitive. Briefly justify your answer in each case.

- (c) Use mathematical induction to prove that $n^3 + 2n$ is divisible by 3 for every integer $n \geq 1$. 8

3. (a) Let $N(x)$ be the statement "X has visited North Dakota", where the domain consists of the students in your school. Express each of these quantifications in English. 3

(i) $\exists x N(x)$

(ii) $\forall x N(x)$

- (b) Find the sum and the product of $(1001)_2$ and $(1101)_2$ without using decimal number system. 4

- (c) In a survey of 60 people, it was found that 25 people read Hindi newspaper, 26 read English newspaper, 26 read Urdu newspaper, 9 read both Hindi and Urdu newspaper, 11 read both Hindi and English newspaper, 8 read both English and Urdu newspaper, 3 read all three newspapers. Find : 8

- (i) The number of people who read at least one of the three newspapers.

- (ii) The number of people who read exactly one newspaper.

- (iii) The number of people who read both Hindi and Urdu newspaper, but not English ?

4. (a) (i) Define planar graph. Is K_5 a planar graph ? Justify your answer. 5
- (ii) Suppose that a connected planar graph has 30 edges. If a planar representation of this graph divides the plane into 20 regions, how many vertices does this graph have ? 2
- (b) Let 'a' and 'b' be two numeric functions defined as follows : 8

$$a_r = \begin{cases} 2 & 0 \leq r \leq 2 \\ 2^{-r} + 5 & r \geq 3 \end{cases}$$

$$b_r = \begin{cases} 3 - 2^{-r} & 0 \leq r \leq 1 \\ r + 2 & r \geq 2 \end{cases}$$

Determine the sum and product of numeric functions a and b.

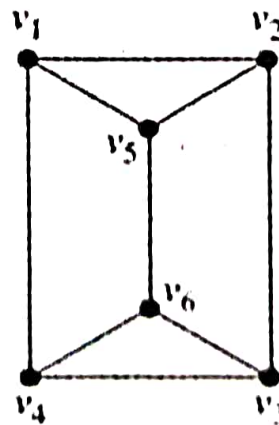
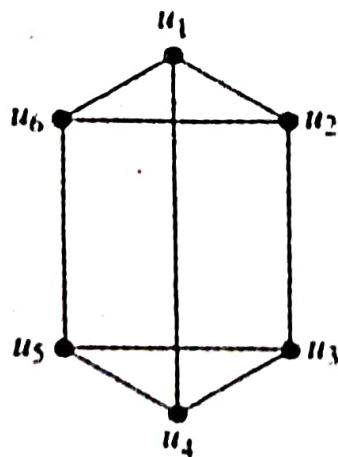
5. (a) In how many ways can a committee of 5 members be formed from 11 Senators so that : 7
- (i) Senator A is always included
- (ii) Senator A is always excluded
- (iii) At least one of senator A and senator B will be included

- (b) Consider the following premises : 8

"It is not sunny this afternoon and it is colder than yesterday", "We will go swimming only if it is sunny", "If we do not go swimming, then we will take a canoe trip", and "If we take a canoe trip, then we will be home by sunset".

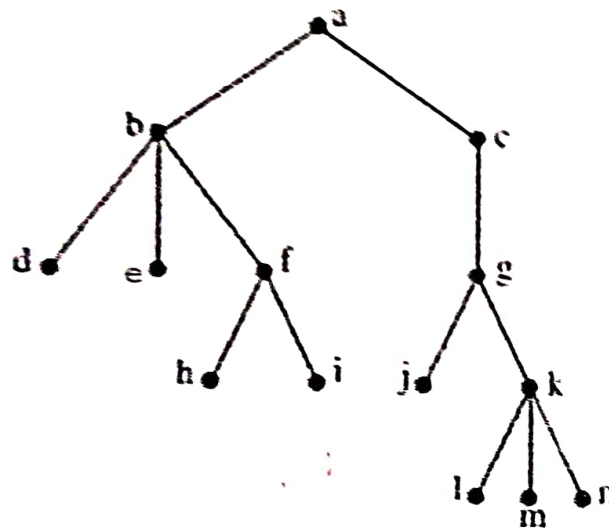
Determine whether the conclusion *"We will be home by sunset."* follows logically from the above set of premises.

6. (a) What do you mean by graph invariant ? Is the following pair of graphs isomorphic ? Justify. 7



- (b) Evaluate $3^{644} \bmod 645$ using Fast Modular Exponentiation algorithm. 8

7. (a) How many leaves does a full 4-ary tree with 101 vertices have ? Given the rooted m-ary tree below, answer the following questions : 7



- (i) Draw the subtree that is rooted at g ?
 - (ii) Which vertices are ancestors of k ?
 - (iii) What is the value of m for the given rooted m -ary tree ?
 - (iv) Is the tree a balanced tree ? Give reason for your answer.
- (b) Given a relation R on set $A = \{3, 5, 9, 15, 24, 45\}$ such that : 8
- $$R = \{(a, b) : a \text{ is divisor of } b \text{ and } a, b \in A\}$$
- (i) Show that R is a POSET.

5796

- (ii) Draw Hasse Diagram.
- (iii) Find the maximal and minimal elements in A.

This question paper contains 7 printed pages]

Roll No.

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S. No. of Question Paper : 5816

Unique Paper Code : 2342011203

Name of the Paper : Probability for Computing

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

Semester : II / DSC

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.

Use of scientific calculator is allowed.

Use of z table is allowed.

Section A

1. (a) What will be the sample space for the following cases : 3
 - (i) If the experiment consists of measuring the lifetime of a car.
 - (ii) If the experiment consists of rolling the two dice and records the sum of the numbers shown.

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- (iii) If the experiment consists of recording the attendance of a class having 50 students.
- (b) Suppose that the chance of rain tomorrow depends on previous weather conditions only through whether or not it is raining today and not on past weather conditions. Suppose also that if it rains today, then it will rain tomorrow with probability α ; and if it does not rain today, then it will rain tomorrow with probability β . Provide the transition matrix for the same. 3
- (c) Prove that any events say E and E' are always mutually exclusive. Use a suitable example. 3
- (d) Suppose X has a probability mass function given by . 3

$$p(1) = \frac{1}{2}, \quad p(2) = \frac{1}{3}, \quad p(3) = \frac{1}{6}$$

Write down the cumulative distribution function F of X.

- (e) What are the mathematical conditions to say that a state is : 3
- (i) A recurrent state
- (ii) A transient state.
- (f) Suppose that the number of phone calls received by a call center in a 1-minute interval follows a Poisson distribution with parameter $\lambda = 2$. What is the probability that no calls are received in a given 1-minute interval ? 3

- (g) Suppose that $p(x, y)$ the joint probability mass function of X and Y is given by

$$p(1, 1) = 0.5, p(1, 2) = 0.1, p(2, 1) = 0.1, p(2, 2) = 0.3.$$

Calculate the conditional probability mass function of X given that $Y = 1$. 3

- (h) A coin, having probability p of coming up heads, is to be successively flipped until the first head appears. What is the expected number of flips required ? 3

- (i) Explain how are pseudo random numbers generated using a seed value. 3

- (j) List *three* properties of covariance. 3

Section B

2. (a) A family has two children. What is the conditional probability that both are boys given that at least one of them is a boy ? For instance (b, g) means that the older child is a boy and the younger child a girl. 5
- (b) Calculate the cumulative distribution function of a random variable uniformly distributed over (α, β) . 5

- (c) Suppose the joint density of X and Y is given by

$$f(x) = \begin{cases} 12x^2y, & 0 < x < 1, 0 < y < 1 \\ 0, & \text{otherwise} \end{cases}$$

Compute the conditional expectation of X given that $Y = y$, where $0 < y < 1$. 5

3. (a) A Markov chain has the following transition matrix :

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

Let the states be S_0, S_1, S_2 . Using the Chapman-Kolmogorov equation, compute the probability that the process is in state S_0 after 2 steps, given that it started in state S_2 . 5

- (b) Suppose X has the following probability mass function :

$$p(0) = 0.2, p(1) = 0.5, p(2) = 0.3.$$

Calculate $E[X^2]$. And check if $E[X^2] = E[X]^2$. 5

- (c) The joint density of X and Y is given by

$$f(x, y) = \begin{cases} \frac{1}{2}ye^{-xy}, & 0 < x < \infty, 0 < y < 2 \\ 0, & \text{otherwise} \end{cases}$$

What is $E\left[e^{\frac{X}{2}} \mid Y = 1\right]$? 5

4. (a) Calculate $E[X]$, when X is binomially distributed with parameters n and p . 5

- (b) Let X be the number of times that a fair coin is flipped 40 times, lands heads. Find the probability that $X = 20$ using normal approximation. 5

- (c) A company produces 70% of its products in *Location "A"* and 30% in *Location "B"*. The fault rate is 2% for products in *Location "A"* and 5% for products in *Location "B"*. If a randomly selected product is found to have a fault, calculate the probability of product being produced in *Location "A"* ? 5

5. (a) A set of **four cards numbered 1 through 4**, is contained in a bag. One card is randomly selected. Given the following events :

$$X = \{1, 3\}, Y = \{1, 2\}, Z = \{1, 4\}.$$

Check if these events X , Y and Z are jointly independent or not. 5

- (b) Let X be a random variable with finite mean μ and variance σ^2 . Using **Markov's Inequality**, prove that for any $k > 0$,

$$P(|X - \mu| \geq k) \leq \sigma^2/k^2.$$

Also, name the inequality obtained. 5

- (c) Suppose a Markov chain contains states 0, 1, 2 and 3 and

$$P = \begin{vmatrix} 0 & 0 & .5 & .5 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 \end{vmatrix}$$

Find which state is recurrent. 5

P.T.O.

6. (a) Rajit will read either one chapter of his probability book or one chapter of his history book. If the number of misprints in a chapter of his probability book is Poisson distributed with mean 3 and if the number of misprints in his history chapter is Poisson distributed with mean 6, then assuming Rajit is equally likely to choose either book, what is the expected number of misprints that Rajit will come across ? 5
- (b) Consider a weather model where if it rains today (state 0), it will rain tomorrow with probability α ; and if it does not rain today (state 1), it will rain tomorrow with probability β . If we say that the state is 0 when it rains and 1 when it does not rain, then find the limiting probabilities π_0 and π_1 . 5
- (c) If X and Y are independent, then for any functions h and g , prove that : 5

$$E[g(X)h(Y)] = E[g(X)]E[h(Y)].$$

7. (a) Suppose there are 25 different types of coupons and suppose that each time one obtains a coupon, it is equally likely to be any one of the 25 types. Compute the expected number of different types that are contained in a set of 10 coupons. 5
- (b) Suppose the number of customers arriving at a store in a day is a random variable with a mean of 200. 5
- (i) What can be said about the probability that today's customer count will be at least 300 ?

(ii) If the variance of the daily customer count is known to be 50, what can be said about the probability that the customer count will be between 180 and 220 ?

(c) In answering a question on a multiple-choice test, a student either knows the answer or guesses. Let p be the probability that the student knows the answer, and $1 - p$ be the probability that the student guesses. If the student guesses, the probability of answering correctly is $\frac{1}{4}$, where 4 is the number of multiple-choice alternatives.

What is the conditional probability that the student knew the answer, given that she answered the question correctly ?

5

5
[This question paper contains 12 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5527

J

Unique Paper Code : 2342012401

Name of the Paper : Design and Analysis of Algorithms

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

Semester : IV

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) Consider the recurrence relation for Strassen's matrix multiplication algorithm. (2)

$$T(n) = 7T(n/2) + \Theta(n^2)$$

Explain which operations contribute to the cost component $\Theta(n^2)$.

- (b) Given that Vertex Cover $\leq$ p Independent Set, fill the blanks in the following statement with these terms appropriately : Vertex Cover, Independent Set. (2)

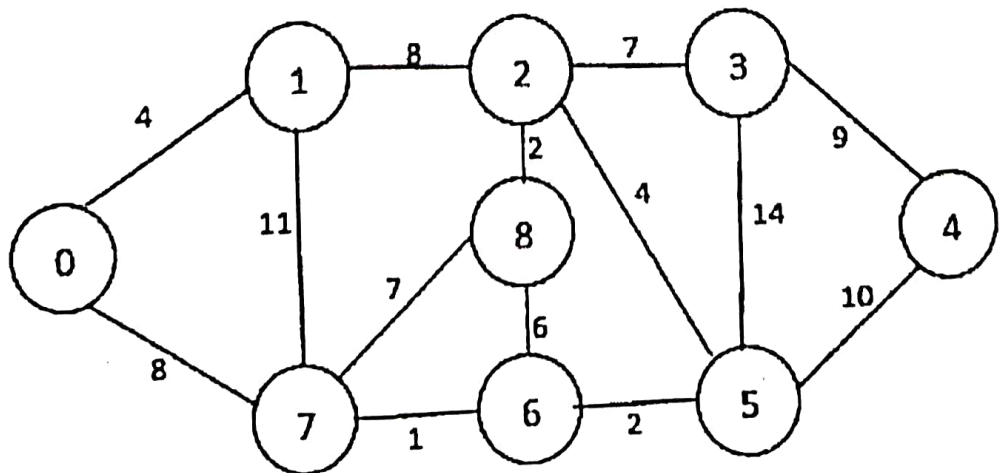
Statement: _____ is at least as hard as _____ .

- (c) Demonstrate through an array of length 5 that the selection sort algorithm is not stable. (3)
- (d) Give an example of a 4-node graph that does not have a topological ordering. (3)

- (e) Modify the counting sort algorithm to sort an array that includes negative integers in the range $[-50, 50]$. (3)
- (f) Consider an optimal solution O to an unweighted interval scheduling problem on set of intervals S . Let i be the interval in O that finishes first. Further, let $S' \subseteq S$ be the subset of intervals compatible with i . Show that $O \setminus \{i\}$ must be an optimal solution to interval scheduling problem on S' . (4)
- (g) Explain the terms : (4)
- (i) NP Hard problem
 - (ii) NP Complete problem
- (h) Show that the greedy method based on profit-to-weight ratio does not always give an optimal solution for the 0-1 knapsack problem? (4)
- (i) Establish the correctness of the insertion sort algorithm using an appropriate loop invariant. (5)

Section B

2. (a) Suppose an $n \times n$ array A consists of 1's and 0's such that in any row of A all the 1's come before any 0's in that row. Give an $O(n \log_2 n)$ algorithm for counting the number of 1's in A . (5)
- (b) Given an undirected graph $G = (V, E)$, a source node S and a target node T , can we use the DFS algorithm to find the shortest path from S to T ? Justify your answer. (5)
- (c) For the graph given below, find a minimum spanning tree using the Prim's algorithm considering node 0 as the start node. Also, state the time complexity of the same. (5)



3. (a) Compare the worst-case time complexities of the standard and randomized versions of Quick Sort algorithm. In standard version of Quicksort, assume that the last element is always chosen as the pivot. Explain how the use of randomization impacts the worst-case time complexity. (5)
- (b) You are helping a child plan his cartoon-watching schedule. Each cartoon show has a start time and end time, and the child can watch only one show at a time. The goal is to watch maximum number of cartoons shows. The child suggests watching the longest cartoon first. You suspect this may not lead to watching the maximum number of shows. (5)
- (i) Give an example wherein choosing the longest cartoon first does not result in maximum shows being watched.
- (ii) Suggest a better strategy to help the child watch as many different shows as possible.

- (c) Run the build-max-heap procedure (that internally uses the max-heapify procedure) on the following array and report the number of swap operations done: $\langle 89, 19, 50, 27, 32, 65, 2, 5, 7 \rangle$ (5)

4. (a) Consider a stack that supports the following three operations : (7)

- PUSH(x): Pushes an element x onto the stack.
- POP(): Removes the top element from the stack.
- COPY(): Copies the current contents of the stack into an array and empties the stack. The cost of COPY is proportional to the current size of the stack.

Now, assume that after every sequence of exactly k push and pop operations (in any order), a copy operation is invoked. Further, COPY() is not called at any other time. Thus, the number of elements in the stack never exceeds k.

You are given a sequence of n push, pop and copy operations on an initially empty stack (where n is large and includes many copy operations). Use the accounting method of amortized analysis to show that the total cost of performing this sequence of n operations is $O(n)$, even though the copy operation can have a worst-case cost of $O(k)$.

(b) Suppose you have a function MEDIAN that returns the index of the median of a given array in linear time in the worst case.

(i) Use it to modify the QUICKSORT algorithm to make it run in $O(n \log_2 n)$ time in the worst case.

(ii) Consider the following algorithm that uses the function MEDIAN as a black-box to solve the selection problem for finding the i^{th} order statistic in array $A[p: r]$.


```
SELECT_NEW(A, p, r, i)
```

```
    If p == r
```

```
        return A[p]
```

```
    x = MEDIAN(A, p, r)
```

```
    q = PARTITION-
    AROUND(A, p, r, x)
```

```
    k = q - p + 1
```

```
    if i == k
```

```
        return A[q]
```

```
    elseif i < k
```

```
        return SELECT_NEW(A, p, q-
        1, i)
```

```
    else
```

```
        r e t u r n
        SELECT_NEW(A, q+1, r, i-k)
```

Give the recurrence for the worst-case running time of the above algorithm and solve it.

5. (a) For each of the following scenarios, construct an input example of size 8 that demonstrates the specified behaviour of the merge procedure:

(i) Best-case behaviour

(ii) Worst-case behaviour

Also, compute the total number of comparisons performed for each of the above cases. (7)

(b) You are given a list of advertisements, each with a start time, finish time, and the payment offered. No two ads can overlap in time. Your task is to select a subset of non-overlapping advertisements that maximizes the total payment.

(i) Find the maximum total payment.

(ii) Determine a subset of advertisements that maximizes the total payment. (8)

Adv No.	Start Time	Finish Time	Payment
A1	0	3	3
A2	1	4	2
A3	0	5	4
A4	3	6	1
A5	4	7	2
A6	3	9	5
A7	5	10	2
A8	8	10	1

6. (a) A student named Bhanu aims to improve his skills by enrolling in several online courses. Each course requires a registration fee, and upon successful completion, awards a certain number of credits. Bhanu has a limited amount of savings and must select from the available courses in a way that maximizes the total credits earned while staying within his budget.

Given that Bhanu has a budget of Rs. 70, employ an appropriate algorithm to identify the courses

he should pursue for the specified scenario.

S. NO.	COURSE	FEE	CREDIT
1	OC1	40	12
2	OC2	20	8
3	OC3	30	16
4	OC4	10	9
5	OC5	30	5

(7)

- (b) Let $G = (V, E)$ be an undirected graph. Prove that a subset $S \subseteq V$ is an independent set if and only if its complement $V \setminus S$ is a vertex cover and vice-versa.

(8)

7. (a) A group of people wants to cross a river. There are several boats available each with a different upper limit on the number of people it could accommodate. Each boat costs the same and you wish to hire minimum number of boats. Give a greedy strategy that works and discuss its time complexity.

(7)

- (b) Prove that a graph G is bipartite if and only if it does not contain an odd cycle. (8)

[This question paper contains 12 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5587

J

Unique Paper Code : 2342012402

Name of the Paper : Database Management Systems

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

Semester : IV

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. Attempt all parts of a question together.

Section A

1. (a) For each of the following applications, indicate whether a traditional file system or a database approach is better. Also state the reason. (3)

- (i) Employee management system
 - (ii) Computer-aided design (CAD) tools
- (b) List 3 schema definition languages that support three-schema architecture. Also specify the level of schema they support. (3)
- (c) Give the Entity Relationship diagram (ERD) representation for the following entity STUDENT. The 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. (3)
- (d) Consider the following relation: (3)

STUDENT COURSE

<u>SNO</u>	<u>CourseID</u>	<u>Date-of-enrollment</u>
1	C1	2022-05-05
2	C2	2023-06-07
2	C1	2022-05-05
4	C3	2024-07-07

SNo and CourseID together form a primary key. For each of the following operations, which database constraints may be violated? Justify your answer.

(i) Insert <4, 'C1', '2022-05-05'>

(ii) Insert <4, 'C3', '2022-05-05'>

(iii) Update <4, NULL, '2023-06-07'>

(e) Consider the two relations : (3)

SUPPLIER (Sid, Sname, Pnumber)

PART (Pno, Pname)

Sid is the primary key of SUPPLIER and Pno is the primary key of PART. Pnumber is a foreign key in SUPPLIER relation.

What happens when the following clause is added with the foreign key constraints in SQL query?

(i) ON UPDATE CASCADE

(ii) ON DELETE SET NULL

(f) Consider the tables T1 and T2. (3)

T1

P	Q	R
2	20	b
1	10	b
3	30	c
5	40	a

T2

A	B	C
1	10	a
2	20	b
3	10	a
4	30	d

The domain of A, B, C are compatible with P, Q, R, respectively. Show the result for each of the following :

(i) T1 INTERSECTION T2

(ii) T1 FULL OUTER JOIN on T1.P = T2.A

(g) Convert the following relational algebraic expressions defined on two relations R(a, b, c) and S(a, d), into their equivalent SQL statements :

(i) $\pi_{c,a}(\sigma_{b=20}(R))$

(ii) $\pi_{b,d}((R * S))$

(h) Consider the following relation

(3)

Q	R	S	T
Q1	50	S1	20
Q2	60	S2	20
Q1	60	S3	30

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) $R \rightarrow T$

(i) State lost update problem that occurs if the concurrency is not controlled in transaction processing. (3)

(j) Consider the following relation. (3)

CANDIDATE (Ssn, Name, {JOB_HIST
(Company, High_pos)})

Convert the relation into First Normal Form.

Section B

2. (a) Describe the three-schema architecture. Also draw its diagram. Why do we need mappings among schema levels? (9)
- (b) Give any two differences between relational database schema and database state.

A company wants to store employee records containing the following information: Employee Id, Employee name, Date of birth, Address, Department no and Project No.

Clearly depict, making any assumptions required, the relational database schema and a possible database state for the Employee entity. (6)

3. (a) Consider a hospital management system. The system should manage information about patients, doctors, appointments, treatments, and rooms. The data requirements are summarized as follows:

- PatientID, Name, Gender, DateOfBirth, Address, and ContactNumber are recorded for patient.
- The data for Doctors include DoctorID, Name, Specialization, and ContactNumber.

- Appointments information includes AppointmentID, AppointmentDate, Time, and Status. A patient can have many appointments with different doctors, and each doctor can have multiple appointments with different patients.
- Each treatment is prescribed to a patient by a doctor. Treatment information includes TreatmentID, Description, Cost, and Date.
- A patient can be assigned to a room, and a room can have one patient at a time. Rooms information includes RoomNumber, RoomType, and AvailabilityStatus.

Identify all entities, their primary keys, relationships, cardinalities, and participation constraints. Design a clear ER diagram based on these requirements. (9)

- (b) Distinguish between binary relationship type and recursive relationship type. Also give an example of each relationship type. (6)

4. Consider the following relations for a database that keeps track of automobile sales in a car dealership: (15)

CAR(Serial no, Model, Manufacturer, Price)

SALE(Salesperson id, Serial no, Date,
Sale price)

SALESPERSON(Salesperson id, Name,
Phone)

Serial_no is the primary key in CAR relation.
Salesperson_id is the primary key in
SALESPERSON relation. Salesperson_id and
Serial_no together form a primary key in SALE
relation.

Answer the following :

- (i) Specify the foreign keys in each relation (if exists).
- (ii) Populate the relations with data and give an example of an updation in the SALE relation that violates the referential integrity constraints.
- (iii) Write SQL query to create table SALE. (Assume that SALESPERSON and CAR tables are already created).

The following constraints should also be specified:

- Primary Key and Foreign key.

- The attribute Sale-price should take the values between 10000 to 50000.

5. (a) Consider the following relational database schema. (9)

SUPPLIER (Sno, Sname)

PART (Pno, Pname)

PROJECT (Jno, Jname)

SUPPLY (Sno, Pno, Jno)

The database records information about suppliers, parts, projects and includes a ternary relationship SUPPLY between suppliers, parts, and projects.

Write SQL queries to perform the following :

- Retrieve the part numbers and part names that are supplied to exactly two projects.
- Create a view to keep the track of project names with the total number of suppliers supplying each project.
- Retrieve the project names, supplier names and part names supplied by suppliers whose name starts with letter 'R'.

(b) Suppose we have an ordered data file with $r = 30,000$ 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. A primary index for the file has ordering key field $V = 9$ bytes long and a block pointer $P = 6$ bytes long. (6)

Compute the following :

- (i) blocking factor of data file (b_{fr})
 - (ii) number of file blocks in data file (b)
 - (iii) record size of index file (r_i)
 - (iv) blocking factor of index file (b_{fr_i})
 - (v) number of blocks in index file (b_i)
 - (vi) Total no. of block accesses needed for binary search on index file
6. (a) Specify the following queries in Relational Algebra on the following database schema : (9)

CUSTOMER (Cust_no, Cname, City)
ORDER (Order_no, Odate, Cust_no, Ord_amt)
SHIPMENT (Order_no, Warehouse_no, Ship_date)

- (i) List the Order_no and Ship_date for all orders shipped from Warehouse_no 'W1'.
- (ii) List the Warehouse_no from where the orders were shipped for the customer

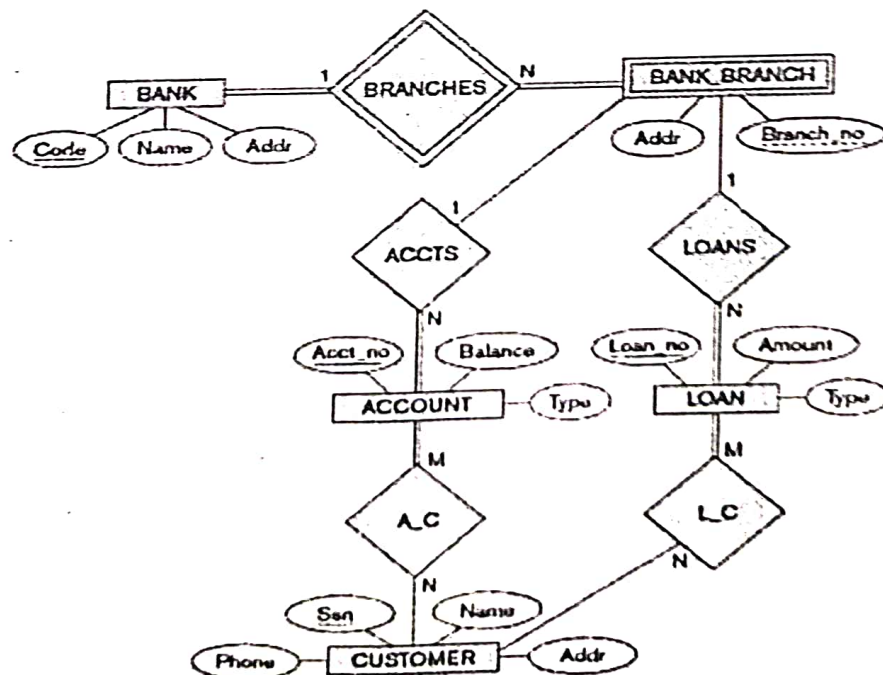
named "ABC". Also, list the corresponding Order_no.

(iii) List the Customer names who were shipped exactly two orders.

(b) Consider the universal relation $R = \{A, B, C, D, E, F, G, H\}$ and the set of functional dependencies $F = \{\{A, B\} \rightarrow \{C\}, \{B, D\} \rightarrow \{E, F\}, \{A, D\} \rightarrow \{G, H\}\}$.

What is the key for R? Decompose R into 2NF. (6)

7. (a) Consider the ER diagram shown below for part of a BANK database. Each bank can have multiple branches, and each branch can have multiple accounts and loans. (9)



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

- (b) Consider two transactions, W1 and W2, executing concurrently (assuming concurrency control is not in place).

Time	W1	W2
T ₀		sum:=0;
T ₁		read_item(A);
T ₂		sum:=sum + A;
T ₃	read_item(X);	
T ₄	X:=X - N;	
T ₅	write_item(X);	
T ₆		read_item(X);
T ₇		sum=sum + X;
T ₈		read_item(Y);
T ₉		sum=sum + Y;

After the completion of transactions W1 and W2, name the problem that may occur when concurrent execution is uncontrolled. Justify your answer.

(6)

This question paper contains 8 printed pages]

Roll No.

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S. No. of Question Paper : 8079

Unique Paper Code : 2343012005

Name of the Paper : Data Mining-I

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

Semester : IV

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. Section A is compulsory.

Attempt any four questions from Section B.

Parts of the question must be answered together.

The use of simple calculator is allowed.

Section A

1. (a) What is class imbalance ? Why accuracy is not the right evaluation measure for classification of datasets having class imbalance ? 2
- (b) What are the two major categories of data mining tasks ? Give examples of each. 3
- (c) Why is sampling needed in data mining ? Name any two sampling methods. 3
- (d) What is the purpose of dimensionality reduction techniques ? 3
- (e) State the key differences between lazy learners and eager learners. Give an example of each type of learner. 3

P.T.O.

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- (f) In the following dataset, identify the types of attributes, as nominal, ordinal, interval or ratio : 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	28	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

- (g) Standardize the salary attribute and explain the significance of standardization : 4

Customer ID	Salary (in \$)	Age
C1	30,000	51
C2	45,000	34
C3	55,000	44
C4	65,000	43
C5	75,000	36

- (h) State any *two* methods for dealing with missing values. Explain each approach. 4
- (i) What are the estimates used for handling zero conditional probabilities ? 4

Section B

2. (a) Consider the following dataset containing information about customers and their income. The income attribute has been discretized into two different ways : Discretized Income Category I and Discretized Income Category II. Compute the entropy for these two discretized categories and determine which discretized category better helps in predicting whether the customer Purchased Product or not.

5

Customer ID	Income (in \$)	Discretized Income Category I	Discretized Income Category II	Purchased Product (Target)
1	20,000	Low	Lower	No
2	35,000	Medium	Lower	Yes
3	50,000	Medium	Upper	Yes
4	75,000	High	Upper	Yes
5	95,000	High	Upper	Yes
6	30,000	Medium	Lower	No
7	40,000	Medium	Lower	Yes
8	60,000	High	Upper	No
9	15,000	Low	Lower	No
10	55,000	Medium	Upper	Yes

Some logarithmic values are provided below :

$$\log_2(0.333) = -1.5864, \log_2(0.4) = -1.322, \log_2(0.5) = -1.0,$$

$$\log_2(0.6) = -0.737, \log_2(0.666) = -0.5864, \log_2(0.75) = -0.415.$$

P.T.O.

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

(c) Consider the following confusion matrix for a learning model to predict whether a patient is at risk of developing a particular disease : 5

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

Evaluate the performance of the classifier using the following evaluation metrics :

Accuracy, Precision, Recall, True Positive Rate and True Negative Rate.

3. (a) Consider the following dataset, where each email is represented by features such as the presence or absence of certain words : 12

Email ID	Contains "Free"	Contains "Win"	Contains "Money"	Contains "Offer"	Label (Spam/Not Spam)
1	Yes	Yes	No	Yes	Spam
2	Yes	No	Yes	Yes	Spam
3	No	No	No	No	Not Spam
4	Yes	Yes	Yes	No	Spam
5	No	Yes	No	No	Not Spam
6	Yes	Yes	Yes	Yes	Spam
7	No	No	No	No	Not Spam
8	Yes	No	No	Yes	Spam
9	No	No	Yes	No	Not Spam
10	Yes	Yes	No	Yes	Spam

Use the Naive Bayes classifier to predict if a new email is spam or not based on the following features :

Contains "Free"=Yes, Contains "Win"=No, Contains "Money"=Yes",
Contains "Offer"=No

- (b) How does the presence of missing values affect the performance of the Naive Bayes classifier ? 3

P.T.O.

4. Consider a transaction dataset as shown in the following table :

Transaction ID	Items Purchased
T1	{A, B, D}
T2	{A, B, C, D}
T3	{A, B, C, D, E}
T4	{B, C}
T5	{A, B, D, F}
T6	{E, F}
T7	{A, B, F}
T8	{C, E}

- (a) Given minimum support as 40% apply the Apriori Algorithm to generate frequent itemsets. 10
- (b) Generate all association rules for the frequent itemsets. Compute the confidence of each generated rule. Taking the minimum confidence as 60%, final all strong association rules. 5
5. (a) Consider the following sample dataset and apply decision tree classifier. Calculate the gain in the Gini index when splitting on Gender, Income Level and Previous Purchase. Which attribute would the decision tree induction algorithm choose ? Justify your answer. 12

Customer ID	Gender	Income Level	Previous Purchase	Purchase (Target)
1	Male	Low	Yes	Yes
2	Female	High	No	No
3	Female	Medium	Yes	Yes
4	Male	Medium	No	No
5	Female	High	Yes	Yes
6	Male	Low	Yes	No
7	Female	Medium	No	No
8	Male	High	Yes	Yes
9	Female	Low	No	No
10	Male	Medium	Yes	Yes

- (b) How k -fold cross validation method is used for model evaluation ? 3

6. (a) 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. 10
- (i) consider $k = 3$ for classification
- (ii) consider $k = 6$ for classification

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
6.3	6.0	Virginica
5.8	5.1	Virginica
7.1	5.9	Virginica
6.3	5.1	Virginica

- (b) What are outliers in a dataset ? Why is it important to detect and analyze them in data mining ? Are all noise points considered outliers ?

7. (a) 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 : 12

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	3	5	2
6	1	3	5

- (b) Describe well-separated clusters and density-based clusters, providing examples of each type. 3

[This question paper contains 12 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5547

J

Unique Paper Code : 2342013602

Name of the Paper : Machine Learning

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

Semester : VI

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.
5. Use of **Scientific Calculator** is allowed.

SECTION A

1. (a) How can logistic regression, originally for binary classification, be extended to handle multiclass problems? Give one example. (3)
(b) Consider a binary classification model that achieves an accuracy of over 99% on the training data. However, it fails to perform well on the test dataset. Identify whether it is a case of overfitting or underfitting. Justify your answer. Suggest one practical strategy to address this issue. (3)

(c) Consider two clustering algorithms which when applied to the same dataset of N data points.

- Algorithm 1 produces two equally sized clusters (each of size $N/2$),
- Algorithm 2 produces two clusters with $N/4$ and $3N/4$ data points respectively.

Evaluate which clustering solution is better. List one clustering evaluation metric you would use? Justify your answer. (3)

(d) Why is non-linearity through activation functions introduced in hidden neurons of Neural Network? Give an example of any one non-linear activation function suitable for the hidden layer for the classification problem. (4)

(e) What is the curse of dimensionality problem? Explain any one feature subset selection technique to deal with this problem. (4)

(f) Consider the following dataset containing two numerical attributes, Age and Salary: (4)

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)

- (g) For the following test dataset, consider the actual class labels and the class labels predicted by the machine learning model Z provided below: (4)

Instance	A	B	C	Target Class	Predicted Class
1	T	T	1	+	+
2	T	T	6	+	+
3	T	F	5	--	+
4	F	F	4	+	--
5	F	T	7	--	+
6	F	T	3	--	+
7	F	F	8	--	--
8	T	F	7	+	--
9	F	T	5	--	--
10	F	F	10	--	--
11	T	F	1	+	+
12	F	T	9	+	+

Draw the confusion matrix depicting the number of records correctly/incorrectly classified. Evaluate the performance of the machine learning model Z in terms of accuracy, and F1-Score.

- (h) Given the following scenarios, identify whether each case falls under Supervised Learning, Unsupervised Learning, or Reinforcement Learning.

Justify your answer in one line for each.

(5)

- (i) A retail company uses customer purchase history to segment customers into groups.
- (ii) A mobile app learns to identify spam messages.
- (iii) A robot learns to walk by trial and error and gets a reward when it moves forward.
- (iv) A weather prediction model trained on past temperature and humidity data.
- (v) An AI system groups articles from different news sources based on topic similarity.

SECTION B

2. (a) Using the data given below, build a logistic regression model to predict whether a customer will purchase (1) or not purchase (0) a product based on their Age and Income, using the gradient descent algorithm. Assume the initial values of the model parameters as $\theta_0 = 0$, $\theta_1 = 0$, $\theta_2 = 0$, and the learning rate as 0.01. Perform one iteration of the gradient descent algorithm to update the model parameters. (5)

Age	Income (in 1000s)	Purchased (Y)
25	40	0
30	60	0
45	85	1
35	75	1
40	65	1

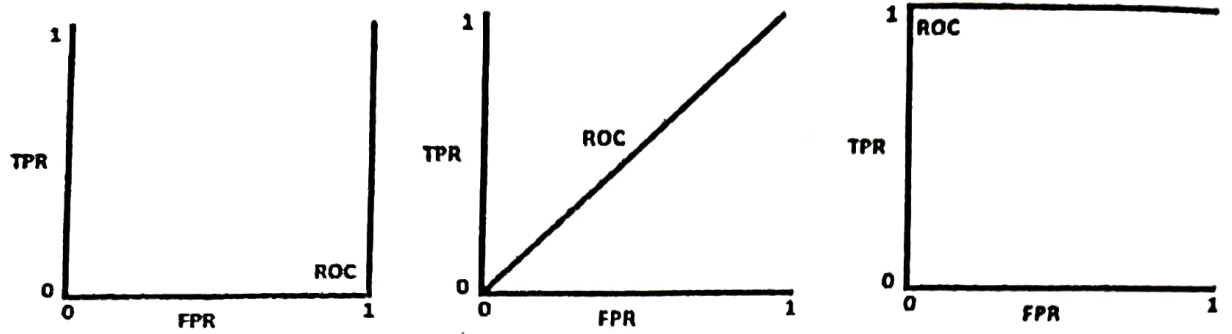
- (b) Consider the following dataset that records student behavior and whether they (5)

Study Hours	Attendance	Sleep Quality	Part-time Job	Pass/Fail
Low	Poor	Bad	Yes	Fail
High	Good	Good	No	Pass
Medium	Good	Good	Yes	Pass
Low	Poor	Bad	No	Fail
High	Good	Bad	No	Pass
Medium	Poor	Good	Yes	Fail
High	Good	Good	Yes	Pass
Low	Good	Bad	Yes	Fail
Medium	Good	Good	No	Pass
High	Poor	Good	No	Pass

Using the Naive Bayes classifier, predict whether the following student will pass or fail:

- Study Hours = Medium, Attendance = Good, Sleep Quality = Good, Part-time Job = No

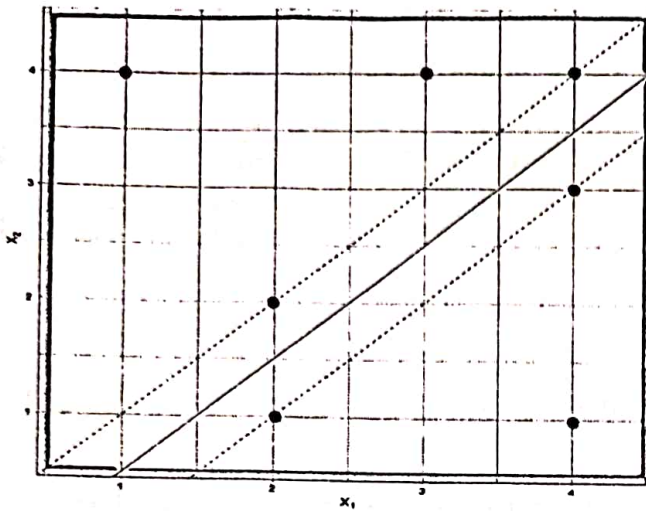
- (c) What is an ROC curve? Why is it used in classification problems? Given the ROC curves below for three different classifiers, determine the AUC (Area Under the Curve) for each and identify the best-performing model: (5)



3. (a) Consider the following two-dimensional dataset: (5)

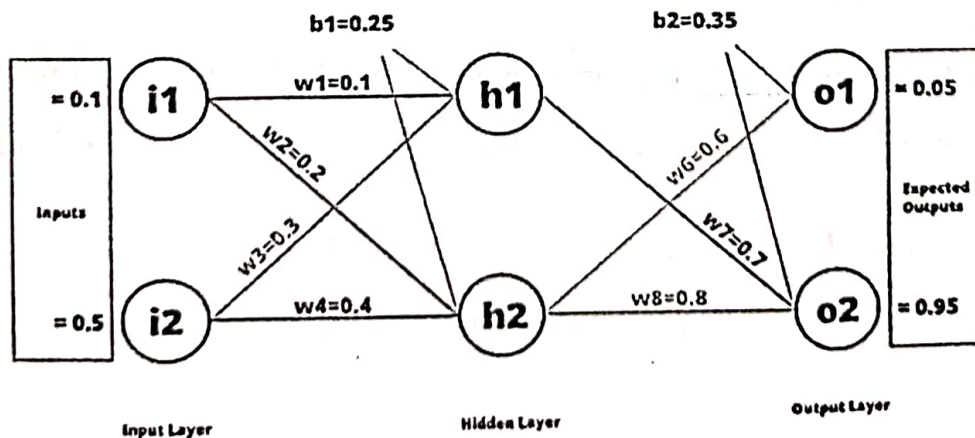
Obs.	X_1	X_2	Y
1	3	4	Red
2	2	2	Red
3	4	4	Red
4	1	4	Red
5	2	1	Blue
6	4	3	Blue
7	4	1	Blue

The dataset is graphically represented below, with a decision boundary separating instances of the Red and Blue classes:



- (i) Based on the figure above, provide the equation of the optimal separating hyperplane for the Support Vector Machine (SVM).
- (ii) Identify the support vectors for the SVM classifier applied to this dataset.
- (iii) Define the term margin in the context of SVM.
- (b) Use forward propagation to determine the output and prediction error for the following neural network (use ReLU for hidden and output layers):

(5)



- (c) (i) Write the mathematical expression of the sigmoid function and state its output range. (5)
- (ii) Why is Mean Squared Error (MSE) not commonly used as the cost function in logistic regression? Which cost function is used for logistic regression?
- (iii) What does the output value of logistic regression represent?
4. (a) Consider the following dataset for binary classification problem: (6)

Instance	A	B	C	Target Class
1	T	T	1	+
2	T	T	6	+
3	T	F	5	-
4	F	F	4	+
5	F	T	7	-
6	F	T	3	-
7	F	F	8	-
8	T	F	7	+
9	F	T	5	-

Calculate the information gain when splitting on A and B. Which attribute would the decision tree induction algorithm choose from A and B?

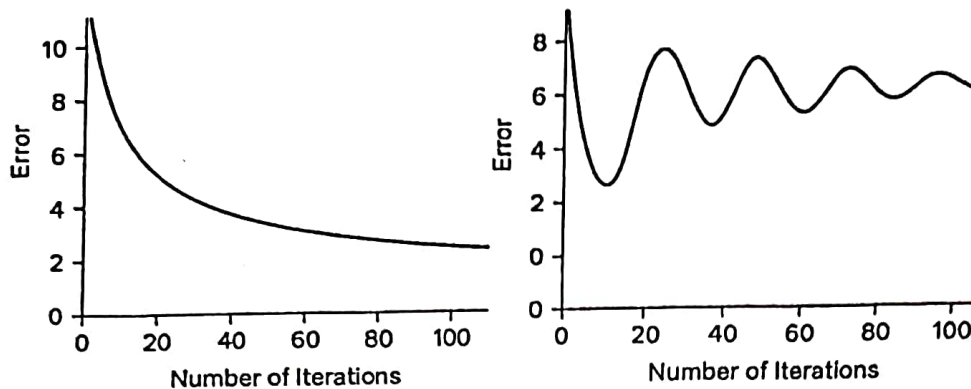
- (b) Explain Lasso Regression in the context of Logistic Regression. Explain how the regularization parameter λ controls bias-variance tradeoff. (5)

- (c) For evaluating the performance of a classifier, how does the holdout method differ from k-fold cross-validation? For k=5 and datapoints- D1, D2, D3, D4, D5, D6, D7, D8, D9, and D10 in the dataset, mention one possible dataset distribution between training and test partition for k-fold cross-validation. (4)

5. (a) Given below is the data of five students who took a proficiency test as well as language course. Proficiency test score Language Course Performance (6)

Proficiency test score	Language Course Performance
95	85
85	95
80	70
70	65
60	70

- (i) Use the least square approximation to estimate the linear equation that best predicts language course performance, based on proficiency test scores?
- (ii) Considering the above scenario in which these linear regression model parameters are learned using gradient descent with two different learning rates (one high, one low), identify which of the following curves represents the higher and lower learning rates. Justify your answer.



(b) How does the PCA (Principal Component Analysis) algorithm help reduce dimension in machine learning? Write the steps of the PCA algorithm.

(5)

(c) A data scientist builds a linear regression model to predict a student's final exam score based on the number of study hours and attendance rate. After training the model, the following metrics are reported:

(4)

- Mean Squared Error (MSE): 36.0
- Coefficient of Determination (R^2): 0.82

(i) Define both Mean Squared Error (MSE) and Coefficient of Determination (R^2). Write the mathematical formulas for each.

(ii) In the context of model evaluation, explain when R^2 is preferred over MSE.

6. (a) Consider the following data set: {4, 8, 12, 20, 32, 36, 48}. Assume $k=2$, and initial cluster centers for k-means clustering as 32 and 48. Perform the k-means clustering to arrive at the final set of clusters. Also, at the end of every iteration, compute the SSE. (7)

- (b) Consider the following optimization problem for Support Vector Classifiers: (5)

$$\begin{aligned} & \underset{\beta_0, \beta_{11}, \beta_{12}, \dots, \beta_{p1}, \beta_{p2}, \epsilon_1, \dots, \epsilon_n, M}{\text{maximize}} \quad M \\ & \text{subject to } y_i \left(\beta_0 + \sum_{j=1}^p \beta_{j1} x_{ij} + \sum_{j=1}^p \beta_{j2} x_{ij}^2 \right) \geq M(1 - \epsilon_i) \\ & \sum_{i=1}^n \epsilon_i \leq C, \quad \epsilon_i \geq 0, \quad \sum_{j=1}^p \sum_{k=1}^2 \beta_{jk}^2 = 1. \end{aligned}$$

In Support Vector Classifiers (SVC), the optimization problem includes a regularization parameter C that controls the tradeoff between maximizing the margin and minimizing classification errors. Explain how different values of C affect the bias-variance tradeoff in SVC:

- (i) When C is large
- (i) When C is small
- (c) List two scenarios where K-means clustering technique may not perform well. (3)
7. (a) The DM Pizza Parlour sells pizzas with optional toppings: pepperoni, pineapple, and pickled-onion. Suppose, you have tried five pizzas (P1 to P5) and kept a record of which you liked: (5)

	Pepperoni	pineapple	pickled-Onion	liked
P1	True	True	True	False
P2	True	False	False	True
P3	False	True	True	False
P4	False	True	False	True
P5	True	False	False	True

Show binarization of the above data and use it to calculate Euclidean distances, to demonstrate how the k-Nearest-Neighbor (k-NN) classifier with majority voting would classify a tuple $\langle \text{False}, \text{True}, \text{True} \rangle$, for $k = 3$.

- (b) Use the distance matrix given below to perform agglomerative hierarchical clustering using single link and show the dendrogram. (5)

	P1	P2	P3	P4	P5
P1	0				
P2	0.24	0			
P3	0.22	0.15	0		
P4	0.37	0.20	0.05	0	
P5	0.34	0.14	0.28	0.29	0

- (c) Explain why a single layer perceptron cannot be used to solve XOR problem. (5)

(9)
This question paper contains 7 printed pages]

Roll No.

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S. No. of Question Paper : 5666

Unique Paper Code : 2342012403

Name of the Paper : Computer Networks

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

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

Semester : IV

Duration : 3 Hours

Maximum Marks : 90

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

This question paper has two Section A and B.

Question 1 in Section-A is compulsory.

Attempt any *four* questions from Section-B.

Parts of a question must be attempted together.

Section A carries 30 marks and each question in Section B carries 15 marks.

Section-A

1. Answer the following questions :

(a) Explain the *three* types of services provided by the Data Link Layer. 3

(b) What is the purpose of the following flag bits with respect to the TCP header ? 3

(i) SYN

(ii) ECE

(iii) URG.

- (c) State the purpose of the following IP addresses : 3
- (i) 0.0.0.0
 - (ii) 127.xx.yy.zz
 - (iii) 255.255.255.255
- (d) Name the layer of the TCP/IP model which performs the following services : 3
- (i) Process-to-Process Delivery
 - (ii) Source-to-Destination Delivery
 - (iii) Framing.
- (e) Write the different kinds of transfer modes used in HDLC protocol. What is the purpose of using I-frame and S-frame ? 3
- (f) State Shannon Capacity theorem. Consider an extremely noisy channel in which the signal-to-noise ratio is 40 dB. Compute the bit rate if the bandwidth of the channel is 1 kHz. 3
- (g) Evaluate the Ring, Star, and Mesh topology based on the following criteria : 3
- (i) Security
 - (ii) Cost
 - (iii) Scalability.

- (h) Compare the Virtual Circuit approach and Datagram Network approach based on the following parameters : 3
- (i) Quality of Service
 - (ii) Effect of Router Failure
 - (iii) Congestion Control.
- (i) What type of unguided media is used for the following applications ? 3
- (i) Satellite networks
 - (ii) AM and FM
 - (iii) Television remotes.
- (j) A URL has three components. Extract the three components of the given URL : <http://www.abc.india.edu/index.html> 3

Section-B

2. (a) Explain the *three* CSMA protocols. 3
- (b) How long does it take for a station to detect a collision in the CSMA/CD protocol ? Justify your answer with the help of a diagram. 4
- (c) Define Hamming code. Consider a coding scheme with the following legal codewords : 00010111, 11110010. Calculate its Hamming distance. 2
- (d) Compute the bit stream transmitted using Hamming code with even parity for the message $M = 1101101$. Show the steps to detect and correct an error at the receiver's end if the third bit from the left is inverted during transmission. 6

3. (a) Discuss the different types of transmission impairment. 3
- (b) Analyse Frequency Division Multiplexing (FDM) and Wavelength Division Multiplexing (WDM) based on the parameters such as Bandwidth utilization, Interference/Crosstalk, Cost, and Signal type. 4
- (c) The following character encoding is used in a data link layer protocol : 8

A : 11010101

B : 10101001

FLAG : 01111110

ESC : 10100011

Show the bit sequence transmitted (in binary) for the five-character frame A ESC B ESC FLAG when each of the following framing methods is used :

- (i) Character count
- (ii) Flag bytes with byte stuffing
- (iii) Starting and ending flag bytes with bit stuffing.

Also, find the original data for the given output obtained after applying the byte-stuffing technique :

FLAG A B ESC ESC C ESC FLAG ESC FLAG D E FLAG

4. (a) "Distance Vector Routing algorithm reacts rapidly to good news but leisurely to bad news". Justify the statement. 2

(b) Consider a network of six routers labelled A, B, C, D, E and F. The cost of the links between the routers is as follows : 5

(i) A-B : 4

(ii) A-E : 5

(iii) B-C : 2

(iv) B-F : 6

(v) C-D : 3

(vi) C-E : 1

(vii) D-F : 7

(viii) F-E : 8

The following information has just arrived at the router C :

- From B : (5, 0, 8, 12, 6, 2)
- From D : (16, 12, 6, 0, 9, 10)
- From E : (7, 6, 3, 9, 0, 4)

The measured delays to B, D and E are 6, 3 and 5 respectively. Using distance vector routing algorithm, give the new routing table for C specifying both the delay and the outgoing line to use.

(c) How IPv6 is more secure than the IPv4 protocol ? Discuss the various fields of IPv6 headers with the help of a diagram. Why is the Header checksum of an IPv4 packet computed at every hop from source to destination ? 8

5. (a) Explain the working of Stop and Wait protocol. 4
- (b) What kind of duplexing mode is used in the following applications : 3
- (i) Voice over IP
 - (ii) Walkie-Talkie
 - (iii) Telephone.
- (c) Given the IP address 200.1.2.30, an organization needs to create two subnets : 6
- (i) Find the class of the given IP address using classful addressing.
 - (ii) Determine the starting IP address and the last IP address of each subnet.
 - (iii) Give the subnet mask for the given IP address.
 - (iv) How many hosts can be on each subnet ?
- (d) Explain the purpose of DHCP protocol. 2
6. (a) Compare and contrast TCP and UDP with respect to the following parameters : 7
- (a) Connection
 - (b) Speed of data transfer
 - (c) Header size
 - (d) Reliability
 - (e) Sequence of the segment received at the destination.
- Also, give the minimum and maximum size of a TCP segment.

- (b) Discuss the various request methods provided by HTTP. 4
- (c) Ravi writes an email to his friend and clicks the "Send" button. During this process, a protocol is responsible for transferring Ravi's message from his mail server to the recipient's mail server over the internet. Which protocol is involved in this transfer, and how does it facilitate communication between the mail servers ? 4
7. (a) Describe the various phases that a PPP connection goes through. Also give the Transition Phase diagram. 5
- (b) We need to send 265 Kbps data over a noiseless channel with a bandwidth of 20 kHz. How many signal levels do we need ? 2
- (c) Give any *two* advantages and *two* disadvantages of Optical Fiber. 4
- (d) Eight 1-Kbps connections are multiplexed together using TDM. Each unit is 1-bit. Find : 4
- (i) The duration of 1 bit before multiplexing
 - (ii) The transmission rate of the link
 - (iii) The duration of a time slot
 - (iv) The duration of a frame.

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[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5567

J

Unique Paper Code : 2342013603

Name of the Paper : Introduction to Parallel Programming

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

Semester : VI

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 a question must be answered together.

SECTION A

1. (a) Explain the fork/join parallelism with the help of a diagram. (3)
- (b) Explain the Single Program Multiple Data (SPMD) model depicting its capabilities and the typical platforms that support it. (3)
- (c) Suppose that a quad-core computer capable of running four processes at once (one process per core). Now, consider a program where 40% of the execution time is inherently sequential, while the remaining 60% can be divided into six equal parts that may be executed concurrently. What is the maximum speedup achievable when:
 - Program is run using all four cores
 - Program is run on a single core (3)
- (d) Describe any two diverse applications of parallel computing. (4)
- (e) Define the critical section in OpenMP. Differentiate between named and unnamed `#pragma omp critical` directives. (4)

- (f) Consider a 5-stage pipelined processor with Instruction Fetch (IF), Instruction Decode (ID), Operand Decode (OD), Instruction Execute (IE), and Write Back (WB) stages. The processor has the ability to simultaneously issue two instructions in the same cycle. Draw the execution schedule for the following sequence of instructions executed by the processor. (4)

Load R1, @1000

Load R2, @1008

Add R1, @1004

Add R2, @100C

Add R1, R2

Store R1, @2000

- (g) What are threads? Rewrite the following code segment to provide a mechanism where threads can be scheduled on multiple processors. (5)

```
for (row = 0; row < n; row++)
```

```
    for (column = 0; column < n; column++)
```

```
        c[row][column] =
```

```
dot_product (get_row (a ,  
row) , get_col (b, col));
```

- (h) Explain the structure of message passing programming paradigm. What are the two key attributes that characterize it? (4)

SECTION B

2. (a) Compare and contrast the multithreading and prefetching approaches used for hiding memory latency. (4)
- (b) Explain the Single Instruction Stream Multiple Data Stream (SIMD) architecture using a diagram. Explain the following conditional statement executing in two steps on a SIMD computer with four processors. (5)

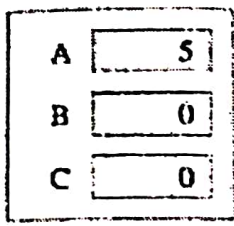
```
if (B==0)
```

```
    C=A;
```

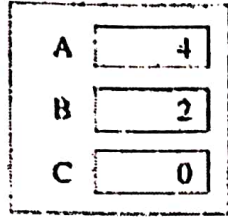
```
else
```

```
    C=A/B;
```

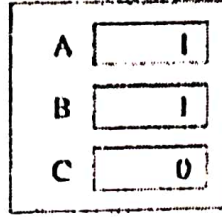
Initial Values are as follows :



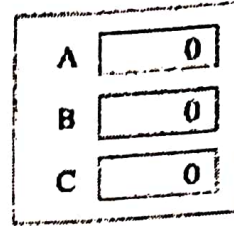
Processor 0



Processor 1



Processor 2



Processor 3

(c) Consider a system with a 1 GHz processor that uses DRAM with a 100 ns latency and a 32 KB cache with a latency of 1 ns (or one clock cycle). The task is to multiply two 32×32 matrices, A and B, where each element occupies 4 bytes (32 bits), and the CPU is capable of executing four instructions per cycle. Address the following :

(i) Compute the total number of floating-point operations needed to multiply matrices A and B.

(ii) Determine the peak computational throughput of the processor in GFLOPS.

(6)

3. (a) Define the shared memory consistency model and the sequential consistency model in the context of compiler optimizations.

(4)

(b) Write an OpenMP code segment for computing the cumulative sum of a list using the ordered directive.

(5)

- (c) Explain the following OpenMP functions : (6)
- `omp_get_num_procs`
 - `omp_get_num_threads`
 - `omp_get_thread_num`
 - `omp_set_num_threads`
4. (a) Explain completely-connected network topology for parallel computers using an example. Why are sparser network topologies like linear arrays and meshes often preferred over completely-connected networks? (5)
- (b) Explain Send and Receive Operations in message passing programming paradigm with an example. Describe how the idling overheads in blocking non-buffered send/receive communication can lead to deadlocks. (5)
- (c) Write a program that prints out a "Hello World" message from each processor using the MPI functions `MPI_Init`, `MPI_Finalize`, `MPI_Comm_size` and `MPI_Comm_rank`. (5)
5. (a) Explain recursive task spawning in OpenMP and identify the common pitfalls associated with it.

(4)

(b) Consider the following OpenMP code segment:

(5)

```
double area = 0.0, pi, x;  
int i, n;  
#pragma omp parallel for private(x, i)  
for (i = 0; i < n; i++) {  
    x = (i + 0.5) / n;  
    area += 4.0 / (1.0 + x * x);  
}  
pi = area / n;
```

(i) Identify the race condition in the above code and explain why it occurs.

(ii) Modify the code to remove the race condition using a critical section.

(c) Write a parallel program using OpenMP to calculate the square of each element in an array using all three OpenMP data-sharing clauses: private, firstprivate and shared. Clearly specify which variables are associated with each clause and provide a justification for your choices.

(6)

6. (a) Show step by step implementation of Odd-Even Sorting algorithm in the following sequence of elements [8, 2, 7, 3] using 4 processors. (4)
- (b) Write the calling sequence of MPI_Sendrecv function and describe its parameters. What are the limitations of using MPI_Sendrecv function in MPI programming and how can they be resolved? (5)
- (c) Describe predefined reduction operations MPI_MAXLOC and MPI_MINLOC. Give an example for each. (6)
7. (a) Differentiate between uniform memory access (UMA) and non uniform memory access (NUMA) multicomputer. (4)
- (b) Write the pseudocode for block matrix multiplication algorithm for two $n \times n$ matrices with a block size of $\frac{n}{q} \times \frac{n}{q}$. (5)
- (c) How can loops be scheduled in OpenMP using the schedule clause? Explain with the help of its syntax. Also, explain the following scheduling strategies with suitable examples:

(i) Static Scheduling

(ii) Dynamic Scheduling

(1500)

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11
[This question paper contains 8 printed pages]

Your Roll No. :

Sl. No. of Q. Paper : **8078** **I**

Unique Paper Code : 2343010020

Name of the Paper : Research Methodology
(Computer Science)

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

Semester : VI

Time : 3 Hours

Maximum Marks : 90

Instructions for Candidates :

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

Section - A

- (a) What do you mean by Research ? Explain its significance. 3

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- (b) What is difference between deductive and inductive research ? 3
- (c) What is a citation-index ? Explain the significance of SCI and SCIE indexing in academic publishing. 3
- (d) Give any **three** reasons on the basis of which a paper might be rejected by the journal. 3
- (e) Name any **six** general tools of research. 3
- (f) The marks obtained by 5 students in a test are : 45, 50, 55, 60, 65. Calculate the Standard Deviation (SD) of the marks. 3
- (g) A student has a Z-score of 4.5 : 4
- (i) Calculate its IQ score.
- (ii) Calculate its stanine score.
- (h) Identify whether the following statements are **True** or **False** : 4
- (i) Intellectual property is often divided into two categories-industrial property and copyright and related rights.
- (ii) Research methodology and research methods are exactly the same.
- (iii) The research problem should be stated after the data collection.
- (iv) Plagiarism can occur even if the source is cited incorrectly.

- (v) WoS indexed articles are considered credible in academic research.
- (vi) Impact factor is used to measure author's research impact.
- (vii) Bibliography is always placed at the end of the research article.
- (viii) Exploratory research is conducted when the problem is not clearly defined.

(i) Select the most appropriate answer for the following multiple-choice questions : 4

1. Which of the following is **not** a characteristic of research ?

- (a) Systematic approach
- (b) Objective analysis
- (c) Random guesswork
- (d) Logical reasoning

2. In research, a hypothesis is :

- (a) a proven fact
- (b) a temporary assumption
- (c) a statistical error
- (d) a variable

3. Which of the following is an example of primary data ?

- (a) Census reports
- (b) Research articles
- (c) Data from experiments
- (d) Textbooks

4. The first step in the research process is :
 - (a) Data collection
 - (b) Hypothesis formulation
 - (c) Identifying the research problem
 - (d) Literature review
5. Quantitative research deals with :
 - (a) Feelings and emotions
 - (b) Descriptive data
 - (c) Numerical data
 - (d) Visual interpretation
6. Which research design is best for studying cause-effect relationships ?
 - (a) Exploratory research
 - (b) Descriptive research
 - (c) Experimental research
 - (d) Qualitative research
7. A literature review is used to :
 - (a) Publish new results
 - (b) Identify gaps in existing research
 - (c) Create statistical models
 - (d) Eliminate errors in experiments
8. Patent is an intellectual right related to :
 - (a) Inventions
 - (b) Watermark
 - (c) Rights of authors
 - (d) Geographical indication

Section - B

2. (a) What is plagiarism ? Name any **two** plagiarism tools. Mention **three** ways to avoid plagiarism. 5
- (b) The following data gives the number of hours studies and marks obtained by 5 students : 10

Hours Studied (X)	Marks Obtained (Y)
2	40
4	50
6	60
8	70
10	80

- (i) Compute the average deviation of marks obtained.
- (ii) Compute geometric mean of hours studied.
- (iii) Compute the standard deviation of marks obtained.
- (iv) Find Z-score of marks 65.
- (v) Pearson correlation coefficient (r) is 1 and Coefficient of determination (r^2) is 1. Interpret the relation between X and Y.
3. (a) Consider the following propositions : 5

Section - B

2. (a) What is plagiarism ? Name any **two** plagiarism tools. Mention **three** ways to avoid plagiarism. 5
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- (v) Pearson correlation coefficient (r) is 1 and Coefficient of determination (r^2) is 1. Interpret the relation between X and Y.
3. (a) Consider the following propositions : 5

Case 1 : Proposition : All humans are mortal.

Socrates is a human.

Conclusion : Therefore, Socrates is mortal.

Case 2 : Observation: All humans lived and died.

Pattern : All observed humans have eventually died implies they are mortal.

Which research method – deductive or inductive – is demonstrated in Case 1 and Case 2 respectively ? Justify your answer.

- (b) You are given the number of days taken to complete each of 11 different tasks. Use the data below to compute the mean, median, mode, second quartile and IQR of tasks completion times. 10

Tasks	No. of Days
Task 1	2
Task 2	6
Task 3	11
Task 4	14
Task 5	20
Task 6	20
Task 7	8
Task 8	7
Task 9	6
Task 10	3
Task 11	2

4. (a) Calculate and interpret the difference in the variance of marks obtained by a student in nine subjects in semester I (S1) and Semester II (S2). 5

S1	45	46	49	25	17	18	13	56	58
S2	47	49	43	27	29	38	37	60	50

- (b) Differentiate between the following using examples : 10

- (i) Basic and Applied Research
- (ii) Evaluation Research and Development Research
- (iii) Quantitative and Qualitative Research

5. (a) What do you understand by peer-review ? Who all are considered as the peers in the peer-review process ? 5

- (b) In a standard normal distribution, what percentage of data falls within each of the following intervals : 10

- (i) within 1 standard deviation of the mean (-1σ to $+1\sigma$)
- (ii) within 2 standard deviation of the mean (-2σ to $+2\sigma$)
- (iii) within 3 standard deviation of the mean (-3σ to $+3\sigma$)

Represent the same using a graph. Show the change in the graph :

- (i) if the data is positively skewed ?
- (ii) if the data is negatively skewed ?

6. (a) What does TRIPS stand for ? Identify and briefly explain any **four** key areas of intellectual property that are covered under the TRIPS Agreement. 5
- (b) Explain Nominal, Ordinal, Interval and Ratio data with examples. 10
7. (a) What is a hypothesis ? What are the steps involved in hypothesis testing ? 5
- (b) (i) A researcher has published 7 papers, and the citation counts for each paper are : 21, 18, 12, 9, 7, 4, 2. Calculate the h-index and i10 index for this researcher. 5
- (ii) A journal cites 1220 articles in 2024, and publishes 100 articles in 2023, 150 articles in 2022, 310 articles in 2021. Calculate its impact factor and CiteScore for the year 2024. 5

[This question paper contains 2 printed pages.]

Your Roll No.....
आपका अनुक्रमांक.....

Sr. No. of Question Paper : 3995

J

Unique Paper Code : 3206000002

Name of the Paper : Political Leadership and Communication

Name of the Course : Skill Enhancement Course [SEC]

पाठ्यक्रम का नाम : स्किल एनहांसमेंट कोर्स [एसईसी]

Semester/Annual : II

सेमेस्टर/वार्षिक

Duration : 1 Hour

Maximum Marks : 30

समय : 1 घण्टा

पूर्णांक : 30

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **Any Three** questions.
3. **All** questions carry equal marks.
4. Answers may be written either in English or Hindi; but the same medium should be used throughout the paper.

छात्रों के लिए निर्देश

1. इस प्रश्न-पत्र के मिलते ही ऊपर दिए गए निर्धारित स्थान पर अपना अनुक्रमांक लिखिए।
2. किन्हीं तीन प्रश्नों के उत्तर दीजिए।
3. सभी प्रश्नों के अंक समान हैं।
4. इस प्रश्न-पत्र का उत्तर अंग्रेजी या हिंदी किसी एक भाषा में दीजिए, लेकिन सभी उत्तरों का माध्यम एक ही होना चाहिए।

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1. What is political communication, and how has its scope evolved in the digital age?

राजनीतिक संचार क्या है तथा डिजिटल युग में इसका क्षेत्र किस प्रकार विकसित हुआ है?

2. How do national cultural frameworks shape the behavior and decision-making styles of political leaders? Discuss with examples.

राष्ट्रीय सांस्कृतिक संरचना राजनीतिक नेताओं के व्यवहार तथा निर्णय लेने की शैली को किस प्रकार आकार देते हैं? उदाहरणों सहित विवेचना कीजिए।

3. Examine the relationship between political communication, leadership, and the development of effective policies.

राजनीतिक संचार, नेतृत्व तथा प्रभावी नीतियों के विकास के मध्य संबंधों का परीक्षण कीजिए।

4. Do you believe that effective leadership relies on strong political communication? Provide reasons to support your view.

क्या आप मानते हैं कि प्रभावी नेतृत्व सुदृढ़ राजनीतिक संचार पर निर्भर करता है? अपने विचार के समर्थन में कारण दीजिए।

5. Discuss how effective leadership serves as a catalyst for change through innovation and strategic improvement.

प्रभावी नेतृत्व किस प्रकार नवाचार तथा राजनीतिक सुधार के माध्यम से परिवर्तन के लिए उत्प्रेरक का कार्य करता है। विवेचना कीजिए।

6. To what extent do opinion polls influence electoral outcomes and voter behavior in India? Analyse with reference to the recent elections.

भारत में जनमत सर्वेक्षण किस प्रभाव तक चुनावी परिणामों तथा मतदाता व्यवहार को प्रभावित करते हैं? हाल के चुनावों के संदर्भ में विश्लेषण कीजिए।

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5960

J

Unique Paper Code : 2342571201

Name of the Paper : Data Structures

Name of the Course : B.A. Prog. With CS As Minor/Non-Major &
B.Sc. (Phy. Sc. & MS) With CS

Semester : II

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

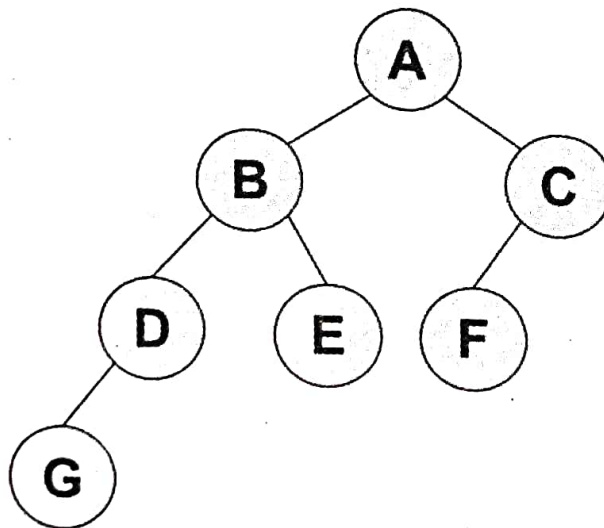
1. Write your Roll No. on the top immediately on receipt of this question paper.
2. The paper has two sections. Section A is compulsory.
3. Attempt any four questions from Section B.
4. All parts of a question must be answered together.

Section A

1. (a) Draw all possible binary search trees for the three elements A, B, and C. 3
- (b) Explain the operation performed by the following code on a singly linked list. 3

```
void func(int x)
{
    head = new node (x, head);
    if (tail == 0)
        tail = head;
}
```


- (c) 'Stack data structure plays an important role in the implementation of recursion'. Justify the statement with suitable example. 3
- (d) Where in a max-heap might the smallest element reside, assuming that all elements are distinct? Justify your answer. 3
- (e) Consider the following list of numbers: 3 3
3, 28, 45, 23, 12, 26, 90, 56, 76
To search a given number in the above list, which of the searching techniques (linear/binary) is best suited in terms of time complexity? What is the time complexity of the suggested technique?
- (f) What will happen if we attempt to remove a node from an empty queue? Give one way to solve this problem. 3
- (g) In the balanced binary tree given below, how many nodes will become unbalanced when a node is inserted as a child of the node "G"? Justify your answer. 3



- (h) Explain the meaning of the following expressions: 4

- i. $f(n)$ is $O(1)$.
- ii. $f(n)$ is $\Theta(1)$.

- (i) Consider the following sequence of operations on an empty stack:

5

push(54); push(52); pop(); push(55); push(62); s=pop();

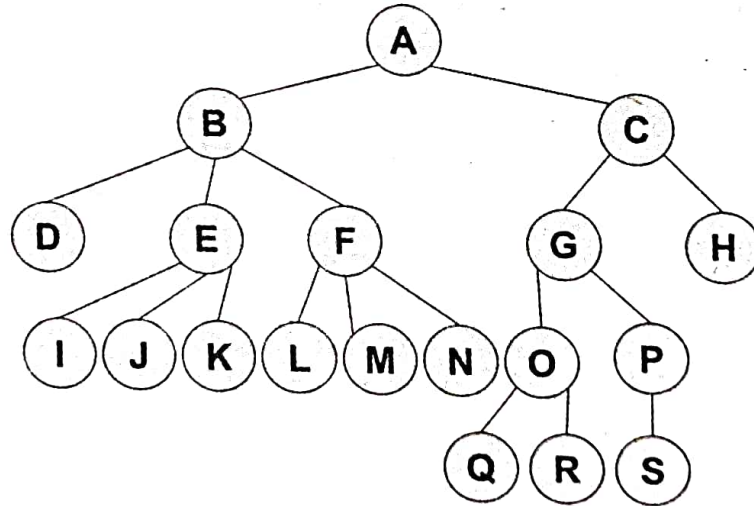
Consider the following sequence of operations on an empty queue:

enqueue(21); enqueue(24); dequeue(); enqueue(28);
enqueue(32); q=dequeue();

After performing these operations, what would be the value of the expression $(s+q)$? Also show the contents of stack and queue.

Section B

2. (a) Differentiate between Binary Search Tree and Balanced Search Tree. 4
(b) Consider the following tree: 5



- i. Name the internal nodes.
- ii. How many descendants and ancestors does node B have?

- iii. What are the siblings of node E?
- iv. What is the depth of node O?
- v. What is the height of the tree?

(c) Write member functions to perform the following operations on Queue using array: 6

- i. isEmpty()
- ii. isFull()
- iii. enqueue(x)
- iv. dequeue()

3. (a) Differentiate between min-heap and max-heap. 4

(b) Sort the following set of elements using insertion sort: 5

29, 10, 14, 37, 13, 25, 7, 18, 5, 33

Show the content of array after every iteration.

(c) Consider the following recursive function: 6

```
int myFunc(int n) {  
    if (n >= 0 && n <= 9)  
        return n;  
    return (n % 10) + myFunc(n/10);  
}
```

- i. What will be the output of myFunc(234) ?
- ii. How many recursive calls will be performed to compute myFunc(234) ?
- iii. Write the iterative version of the above function.

4. (a) Convert the following infix notations to postfix notations:

4

$$A * ((B + C) / D)$$

Show the contents of stack at each step.

- (b) i. Calculate the asymptotic time complexity of the following code:

5

```
for (i=0; i<n; i++)  
{  
    for (j=0; j<n; j++)  
    {  
        Statement;  
    }  
}
```

- ii. Prove that $5n^2 + 3n \log n + 2n + 5$ is $O(n^2)$. Find the values of the constants n_0 and c .

- (c) Explain how Master's theorem can be used for solving recurrences giving suitable example.

6

- 5 (a) Consider the following recursive function:

4

```
void fun(int x)  
{  
    if (x > 0)  
    {  
        fun(x-1);  
        cout << x << " ";  
        fun(x-1);  
    }  
}
```

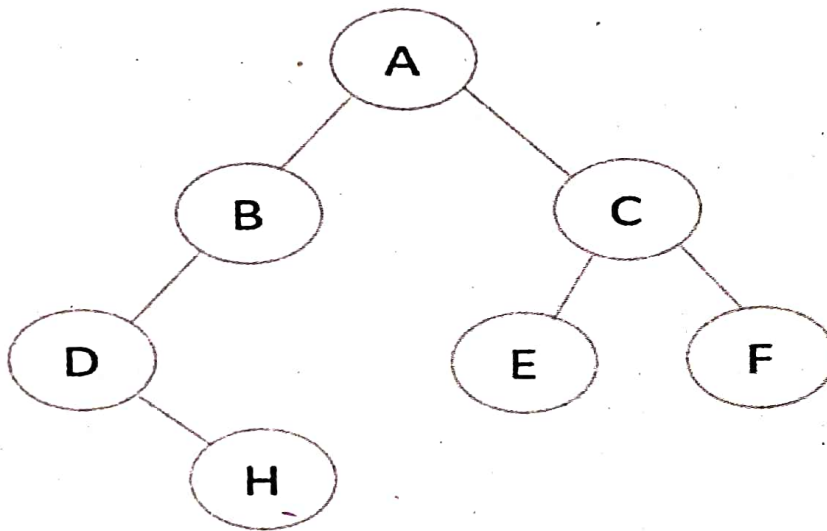
Draw the recursion tree when $\text{fun}(4)$ is called.

- (b) Create a Binary search tree with the keys inserted in following order: 5

50, 30, 70, 20, 40, 60, 80, 10, 25, 35

Draw the tree after each insertion.

- (c) Determine the preorder, inorder and postorder traversals of the following tree: 6



- 6 (a) Compare and contrast priority queue and deque. Also, give one real life application of priority queue. 4

- (b) Consider the following array-based queue of characters, where queue is allocated $n=6$ memory cells: 5

Queue: b, d, a, g, _, _

(where “_” means empty memory cell)

Perform the following sequence of operations on the given queue:

- i. enqueue ('p')
- ii. dequeue ()
- iii. enqueue ('c')
- iv. enqueue ('z')
- v. front ()

After every operation, show the contents of the queue with front and rear pointers.

(c) Write member functions to perform the following operations on Doubly Linked List: 6

- i. Insertion at head
- ii. Deletion from head
- iii. Search an element 'x' in linked list

7 (a) Consider a circular linked queue: (9, 8, 7, 6, 5, 4, 3, 2) such that the cursor 4 points to 5. After performing following operations on this queue, what would be the front and rear elements of the queue?

Enqueue (1), Dequeue (), Dequeue (), Enqueue (12),
Dequeue (), Dequeue ()

Also draw the resultant queue.

(b) Write a program to implement the following operations for stack using linked list: 5

- i. isEmpty ()
- ii. size ()
- iii. push ()
- iv. pop ()

(c) Build a max heap from the following array of numbers:

6

4, 10, 3, 5, 1, 12, 7, 9

Draw the heap after each insertion.

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7665

J

Unique Paper Code : 2342571201

Name of the Paper : Data Structures

Name of the Course : B.A. Prog. With CS As Minor/Non-Major &
B.Sc. (Phy. Sc. & MS) With CS

Semester : II

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 the question must be answered together.

Section A

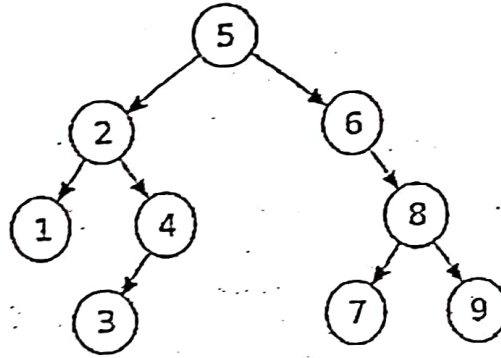
1. (a) Sort an array $A = [10, 7, 12, 8, 5]$ using insertion sort. Write the elements of the array after each iteration. How many comparisons will be needed to sort the array. 5
- (b) Solve the recurrence using Master's theorem 5
$$T(n) = 3T\left(\frac{n}{4}\right) + n \lg n$$
- (c) Consider the given series of operations to be performed on an empty stack : 5
push(5), push(3), pop(), push(7), top(), empty(),
push(7), pop(), push(12), size(), pop(), top()

Show the output and stack contents after each stack operation.

P.T.O.

- (d) Write a recursive program in C++ to calculate
 $a_r = a_{r-1} + a_{r-2}$, for $r \geq 2$, where $a_0 = 0$ and $a_1 = 1$
 taking 'r' input from the user. Also draw the recursion trace for a_5

- (e) Consider the following binary tree:



- Write the Preorder, Postorder and Inorder traversal.
- Determine the Height of the tree.

- (f) Construct a binary search tree with the following numbers:

41, 8, 51, 5, 10, 47, 70, 2, 6, 25, 50, 15.

Delete the root node and show the steps for construction of the resultant binary search tree.

Section B

- Solve the recurrence using Substitution methods
 $T(n) = 2T(\lfloor \sqrt{n} \rfloor) + \lg n$
 - Write a C++ program to implement a stack using linked list. Write code for push and pop operations.
 - What is an abstract data type (ADT)? Differentiate between Stack and Queue.
- Write the time complexity for the following operations for the input of size 'n':
 - Insert element into binary search tree
 - Insert element into stack
 - Insert element into doubly link list
 - Insert element into singly link list
 - Find largest element in array

- (b) Define Big-Oh notation. Show that asymptotic analysis of $5n^2 + 3n \log n + 2n$ is $O(n^2)$ 5
- (c) Which of the following is/are correct Inorder traversal for a binary search tree. Justify your answer. 5
- (i) 2, 4, 6, 7, 11, 15, 20
- (ii) 4, 6, 7, 12, 10, 11, 15
4. (a) Consider the given series of operations to be performed on an empty Deque (double ended queue): 5
- insertFront(20), insertFront(30), front(), eraseFront(), insertback(70),
eraseFront(), back(), eraseback(), size(), empty()
- Write the output and contents of the Deque after each operation.
- (b) Define circular linked list? Explain different operations performed on a circular linked list. 5
- (c) Write a C++ program to create a singly linked list of integers. Write functions to insert and delete an element from the beginning of the list. 5
5. (a) Define height of a binary tree. Write a C++ function to compute it. 5
- (b) Suppose a circular queue of capacity $(n - 1)$ elements is implemented with an array of n elements with initial value 0 for Rear and Front. 5
- What are the conditions to detect:
- (i) queue is full.
- (ii) queue is empty
- (c) Write short notes on 5
- (i) Complete binary tree
- (ii) AVL tree
6. (a) Convert the following infix expression to postfix notation using stack 5
- $a + b * (c ^ d - e) ^ (f + g * h) - i$
- where ^ represents exponentiation.
- (b) Define heap data structure? Construct max heap for the following array: 5
- A = [4, 1, 3, 2, 16, 9, 10, 14, 8, 7, 12].
- (c) What is priority queue and its types? Explain its real-life applications. 5
7. (a) Write a function in C++ to calculate factorial using: 5
- (i) iteration
- (ii) recursion

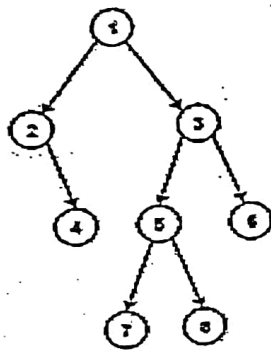
- (b) Consider the given series of operations to be performed on an empty queue :
enqueue(A), enqueue(B), front(), dequeue(), size(),
dequeue(), front(), empty(), size()

5

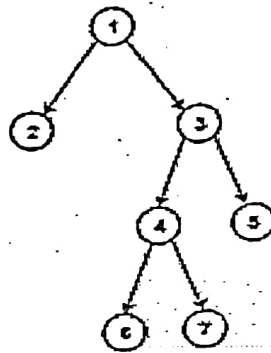
Show the output and queue contents after each queue operation.

- (c) What is height balanced tree? Determine which of the following tree is height balanced. Justify your answer

5



Tree-A



Tree-B

[This question paper contains 4 printed pages.]

Your Roll No.....

J

Sr. No. of Question Paper : 7708

Unique Paper Code : 2272201201

Name of the Paper : Introductory Macro Economics

Name of the Course : B.A. (Programme) with Economics as a Major

Semester : II

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 any five questions.
3. All questions carry equal marks.
4. Use of simple calculator is allowed.
5. Answers may be written either in English or Hindi; but the same medium should be used throughout the paper.

छात्रों के लिए निर्देश

1. इस प्रश्न-पत्र के मिलते ही ऊपर दिए गए निर्धारित स्थान पर अपना अनुक्रमांक लिखिए।
 2. किन्हीं पाँच प्रश्नों के उत्तर दीजिए।
 3. सभी प्रश्नों के अंक समान हैं।
 4. साधारण कैलकुलेटर उपयोग की अनुमति है।
 5. इस प्रश्न-पत्र का उत्तर अंग्रेजी या हिंदी किसी एक भाषा में दीजिए, लेकिन सभी उत्तरों का माध्यम एक ही होना चाहिए।
-
1. (a) Macro Economics has been described as a study of aggregates. Explain the major issues analysed in Macro Economics. (10)
(b) In the calculation of GDP from the expenditure approach, exports are added and imports are subtracted. Explain. (8)
 2. (a) Define private savings. How are private savings used in the economy? (10)

P.T.O.

(8)

(b) How is national wealth linked to national savings?

3. Explain the demand and supply of Central Bank money using relevant equations and diagrams. (18)

4. (a) Differentiate between Classical and Keynesian approaches to Macro Economics. (8)

(b) For the given economy,

$$C = 50 + 0.8 Y_d$$

$$I = 70$$

$$G = 200$$

$$TR = 100$$

$$t = 0.20$$

where C is consumption, Y_d is disposable income, I is autonomous investment, G is autonomous government expenditure, TR is transfer payment, and t is tax rate-

Calculate the equilibrium level of income and budget surplus. (10)

5. A higher marginal propensity to consume makes the IS curve flatter. Do you agree? Explain using a diagram. (18)

6. (a) Derive the Aggregate Demand curve using the IS-LM framework. (10)

(b) What is the Liquidity trap? If the economy were stuck in it, would you advise the use of monetary policy or fiscal policy? (8)

7. Consider an economy where :

$$C = 0.8 Y_d$$

$$T = 1000$$

$$I = 800 - 20i$$

$$G = 1000$$

$$L = 0.4Y - 40i$$

$$M/P = 1200$$

where C is Consumption, Y_d is Disposable income, T is Lumpsum tax, I is investment, i is interest rate, G is autonomous Government Expenditure, L is Real Money Demand, M/P is Real Money Supply.

- (a) Derive the IS equation. (6)
- (b) Derive the LM equation. (6)
- (c) Find equilibrium income and interest rates for this economy. (6)
8. Write short notes on any three of the following : (6×3)
- (a) Open market Operations
- (b) Monetary policy tools
- (c) Crowding Out
- (d) Balanced Budget Multiplier
- (e) Savings Function
1. (क) समष्टि अर्थशास्त्र को समुच्चयों के अध्ययन के रूप में वर्णित किया गया है। समष्टि अर्थशास्त्र में विश्लेषित प्रमुख मुद्दों की व्याख्या कीजिए। (10)
- (ख) व्यय दृष्टिकोण से सकल घरेलू उत्पाद की गणना में निर्यात जोड़े जाते हैं और आयात घटाए जाते हैं। व्याख्या कीजिए। (8)
2. (क) निजी बचत को परिभाषित कीजिए। अर्थव्यवस्था में निजी बचत का उपयोग कैसे किया जाता है? (10)
- (ख) राष्ट्रीय धन राष्ट्रीय बचत से कैसे जुड़ा है? (8)
3. प्रासंगिक समीकरणों और आरेखों का उपयोग करके केंद्रीय बैंक के पैसे की मांग और आपूर्ति की व्याख्या कीजिए। (18)
4. (क) समष्टि अर्थशास्त्र के शास्त्रीय और कीनेसियन दृष्टिकोणों के बीच अंतर कीजिए। (8)
- (ख) दी गई अर्थव्यवस्था के लिए,
- $$C = 50 + 0.8 Y_d$$
- $$I = 70$$
- $$G = 200$$
- $$TR = 100$$
- $$t = 0.20$$

जहाँ C उपभोग है, Y_d प्रयोज्य आय है, I स्वायत्त निवेश है, G स्वायत्त सरकारी व्यय है, TR हस्तांतरण भुगतान है, और t कर दर है-

आय और बजट अधिशेष के संतुलन स्तर की गणना कीजिए।

(10)

5. उपभोग करने की उच्च सीमांत प्रवृत्ति आईएस चक्र को सपाट बनाती है। क्या आप सहमत हैं? एक आरेख का उपयोग करके समझाइये।

(18)

6. (क) आईएस-एलएम ढाँचे का उपयोग करके समग्र माँग चक्र प्राप्त कीजिए।

(10)

(ख) तरलता जाल क्या है? यदि अर्थव्यवस्था इसमें फँस गई होती, तो क्या आप मौद्रिक नीति या राजकोषीय नीति के उपयोग की सलाह देते?

(8)

7. एक ऐसी अर्थव्यवस्था पर विचार कीजिए जहाँ :

$$C = 0.8Y_d$$

$$T = 1000$$

$$I = 800 - 20i$$

$$G = 1000$$

$$L = 0.4Y - 40i$$

$$M/P = 1200$$

जहाँ C उपभोग है, Y_d प्रयोज्य आय है, T एकमुश्त कर है, I निवेश है, i ब्याज दर है, G स्वायत्त सरकारी व्यय है, L वास्तविक मुद्रा माँग है, M/P वास्तविक मुद्रा आपूर्ति है।

(क) आईएस समीकरण व्युत्पन्न कीजिए।

(6)

(ख) एलएम समीकरण व्युत्पन्न कीजिए।

(6)

(ग) इस अर्थव्यवस्था के लिए संतुलन आय और ब्याज दरें ज्ञात कीजिए।

(6)

8. निम्नलिखित में से किन्हीं तीन पर संक्षिप्त टिप्पणियाँ लिखिए :

(6×3)

(क) खुला बाजार संचालन

(ख) मौद्रिक नीति उपकरण

(ग) क्राउडिंग आउट

(घ) संतुलित बजट गुणक

(ङ) बचत फलन

(5000)

16
[This question paper contains 7 printed pages]

Your Roll No. :

Sl. No. of Q. Paper : **8081** **I**

Unique Paper Code : 2343012010

Name of the Paper : Software Engineering

Name of the Course : **DSE**

Semester : IV

Time : 3 Hours

Maximum Marks : 90

Instructions for Candidates :

- (i) Write your Roll No. on the top immediately on receipt of this question paper.
- (ii) The paper has **two** Sections.
- (iii) All questions in '**Section A**' are compulsory.
- (iv) Attempt any **four** questions from '**Section B**'.
- (v) Parts of a question must be answered together.

Section - A

1. (a) What is the role of use case in software development ? List the key components of a use case.

3

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- (b) Define the following two measures of Software Quality : 3
- (i) Integrity
 - (ii) Maintainability
- (c) What is the Prototyping Process Model for software development ? Give **two** situations in which it is best recommended to use this model. 3
- (d) Differentiate between Black-box testing and White-box testing. 3
- (e) Define risk in software development. Differentiate between known and unknown risks. 3
- (f) Illustrate any **three** process flows in software development with the help of diagrams. 3
- (g) At the conclusion of a project, it has been determined that 30 errors were found during the modeling activity and 12 errors were found during the construction activity that were traceable to errors that were not discovered in the modeling activity. What is the DRE for the modeling activity ? 3

- (h) Discuss the bottom-up and top-down approaches of integration testing. 3
- (i) What is a data dictionary ? Why is it important to maintain a data dictionary for a software development project ? 3
- (j) State three objectives of a good software design. 3

Section - B

2. (a) Describe the Spiral model for software development. Also illustrate with the help of a diagram. Why is the Spiral model more realistic for the development of large scale systems ? Discuss its advantages and disadvantages. 7.5

(b) List and describe the various levels defined in Capability Maturity Model Integration (CMMI). 7.5

3. (a) You have been assigned a project to design and develop an 'Online Assessment System' with the following core functionalities :

7.5

1. Allows students to upload and submit their assignments.

2. Provides a platform for teachers to assess student performance.
3. Generates results with minimal user input.

Based on these requirements :

- (i) Draw a Context Level Diagram to represent the system's interactions with external entities.
- (ii) Develop a Level 1 Data Flow Diagram (DFD) to represent the system's main processes and data flows.

(b) What is Software Requirements Specification (SRS) ? Discuss any **six** characteristics of a good quality SRS. 7.5

4. (a) Discuss the term modularity in the context of software design. How is modularity related to software cost ? In what way does the concept of coupling affect modularity in software design ? 7.5

(b) What is Cohesion in software design ? Discuss any **five** types of Cohesion. 7.5

5. (a) A software system has the following characteristics : 7.5

Component Type	Court	Complexity	Weight
External Inputs (EI)	5	Average	4
External Outputs (EO)	4	High	7
External Inquiries (EQ)	3	Low	3
Internal Logical Files (ILF)	2	Average	10
External Interface Files (EIF)	1	Low	5

Assume the processing complexity factors are :
4, 1, 0, 3, 5, 4, 4, 3, 3, 2, 2, 4 and 5.

Compute the Function Point of the system.

- (b) How does a timeline chart assist in scheduling and tracking the progress of a software development project ? Draw the structure of time line chart. 7.5
6. (a) Discuss the steps involved in managing risk in software project development. Describe Risk Mitigation, Monitoring and Management (RMMM) plan for 'Staff Turnover Risk'. 7.5
- (b) What do you mean by Software Quality Assurance (SQA) ? Discuss any **four** components of the SQA in Software development. 7.5

7. (a) Draw the flow graph and mark the regions. Compute the Cyclomatic complexity from the flow graph using three different methods. Also, list the independent paths. 7.5

```

1.  int main( )
2.  {
3.  int num1, num2, num3;
4.  cout<<"Enter three numbers: ";
5.  cin>>num1>>num2>>num3;
6.  if (num 1<= num2 && num1 <= num3) {
7.      cout<<"The smallest number is : "<<
        num1;  }
8.  else if (num2 <= num1 && num2 <=
        num3) {
9.      cout<<"The smallest number is : "<<
        num2;  }
10. else {
11.     cout<<"The smallest number is : "<<
        num3;  }
12. return 0;
13. }
```

- (b) What is Boundary Value Analysis (BVA) in software testing ? Consider a program for computing the function $f(x, y) = x + y$ where, the input variables x and y are in the range

$$1 \leq x \leq 5$$

$$10 \leq y \leq 20$$

Design the boundary value test cases for the program. 7.5

(17)
[This question paper contains 8 printed pages]

Your Roll No. :
Sl. No. of Q. Paper : **7743** **I**
Unique Paper Code : 2342202102
Name of the Paper : B. A. (P) NEP
Name of the Course : **Data Interpretation and
Visualization Using
Python**
Semester : II

Time : 3 Hours **Maximum Marks : 90**

Instructions for Candidates :

- 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 questions must be answered together.

Assume numpy has been imported as np and pandas has been imported as pd.

Section – A

(Compulsory)

- What is the purpose of the describe () function in Pandas ? Illustrate with **one** example. 2
 - Consider a dataset with a mean of 50 and a standard deviation of 10. Compute the Z – score for a data point 65. 2

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- (c) What are the two advantages of NumPy that makes it important for numerical computation in Python ? 2
- (d) Give the following array : 2
`arr = np.array ([[1, 2, 3], [4, 5, 6], [7, 8, 9]])`
 Write Python code to print the sub - array `[[2, 3], [5, 6]]`
- (e) Differentiate between Experiment and Observational studies. 2
- (f) Give a Series s :
`s = pd.Series ([100, 200, 300], index = [0, 2, 4])`
 Write output of the following Python statements :
- (i) `s1 = s.reindex ([0, 1, 3, 4], method = 'ffill')`
`print (s1)`
- (ii) `s2 = s.reindex ([0, 1, 2, 3, 4], method = 'bfill')`
`print (s2)`
- (g) Write Python code to do the following : 3
- (i) Read a file named "students. csv" into a DataFrame df.
- (ii) Display the first 5 rows of the DataFrame df.
- (iii) Save the DataFrame df to a new file "top_students.csv" using '+' as a separator.
- (h) Write Python command to create the following Series with hierarchical index levels 'Group' and 'Number'. 3

Group	Number	
A	1	10
	2	20
B	1	30
	2	40

- (i) Given the following DataFrame : 3

```
df = pd.DataFrame ({
    'Team' : ['A', 'B', 'A', 'B', 'A', 'B'],
    'Points' : [10, 20, 15, 25, 10, 30]
    'Assists' : [1, 3, 2, 4, 1, 5]
})
```

Write Python code to perform the following operations :

- (i) Group the data by "Team" and compute the total 'Points' per team.
- (ii) Compute the average 'Assists' per team.
- (j) What is the difference between Series and DataFrame in pandas ? Explain with the help of an example of each. 4
- (k) Write Python code to plot a horizontal bar chart using matplotlib for the following data : 4

Subjects = ['Math', 'Science', 'English', 'History']

Scores = [88, 75, 92, 70]

Label the x - axis as 'Scores' and y - axis as 'Subjects' and add a title 'Student Scores by 'Subject'.

Section - B

2. (a) Give an array scores : 4

scores = np.array ([45, 67, 89, 32, 76, 54, 90, 38, 50])

Write Python code for the following :

- (i) Print scores greater than 50.
- (ii) Print scores that are even numbers.
- (iii) Reshape the array scores into a 2-dimensional array scores_2 D of shape 3×3.
- (iv) Convert the data type of scores_2D to np. float 64.

- (b) Given the following DataFrame :

5

```
data = pd.DataFrame ({
    'Department' : ['HR', 'IT', 'HR', 'IT', 'HR', 'IT'],
    'Gender' : ['M', 'F', 'M', 'M', 'M', 'F']
    'Salary' : [50000, 60000, 52000, 58000, 51000, 55000]
})
```

Write Python code to perform the following operations :

- (i) Create a pivot table that shows the average salary for each department.
- (ii) Create a pivot table to display average salary by both department and gender.
- (iii) Modify the code in part (ii) to fill missing values in the pivot table with 0.

- (c) Define mean, median, and mode.

6

Give the following dataset :

```
data = [12, 15, 12, 18, 19, 15, 15, 20, 25]
```

Calculate the mean, median, and mode of the data.

3. (a) Differentiate between stack () and unstack () methods with the help of examples. 4

- (b) Write Python code to create a 2 D NumPy array of shape 3×3 filled with random integers between 5 and 15 (both inclusive) and then print its dimension, shape and transpose. 5

- (c) Write the output of the following Python code : 6

```
df1 = pd.DataFrame ({'Math' : 80, 90}, {'English' : [70, 61]},
index = ['Alice', 'Bob'])
df2 = pd.DataFrame ({'English' : [85, 75], 'Science' : [88, 92]})
```

```

index = ["Bob", "Charile"])
result 1 = df1 + df2
result 2 = df1.add (df2, fill_value = 0)
print ("Result 1 :\n", result1)
print ("\nResult2 : \n", result 2)

```

4. (a) Differentiate between descriptive statistics and inferential statistics with examples. 5

- (b) Given the DataFrame marks :

```

marks = pd.DataFrame ({
    "Math" : [78, 85, np.nan, 88, 74]
    "Science" : [82, np.nan, 95, 91, 76],
    "English" : [75, 80, 88, np.nan, 70]
}, index = ['Amit', 'Rina', 'John', 'Meera', 'Raj'])

```

Write Python code to do the following :

- (i) Compute the average marks for each student (row – wise), ignoring missing values.
- (ii) Identify the name of the student with the highest average marks.
- (iii) Print only those students whose average marks (from part a) are greater than 80.
- (iv) Count the total number of missing values in the DataFrame.
- (v) Fill all missing values in the DataFrame with 'Absent'.

5. (a) Give an array arr :

5

```
arr = np.array ([10, 20, 30, 40, 60, 70])
```

Write Python code for the following :

- (i) Create a slice `s_arr` of `arr` and assign elements from index 2 to 4.
- (ii) Assign a new value (999) to all elements in the `s_arr`.

What will be the contents of `s_arr` and `arr` after the above code is executed ?

(b) Write the output of the following Python code : 10

```
df1 = pd.DataFrame ({
    'Employee ID' : [101, 102, 103, 104],
    'Name' : ['Alice', 'Bob', 'Charlie', 'David'],
    'dept' : ['HR', 'IT', 'Finance', 'Marketing']
})
df2 = pd.DataFrame ({
    'Employee ID' : [102, 103, 105],
    'Salary' : [60000, 75000, 50000],
    'Bonus' : [5000, 7000, 4000]
})
m1 = pd.merge (df1, df2, how = 'inner')
m2 = pd.merge (df1, df2, how = 'left')
m3 = pd.merge (df1, df2, how = 'right')
m4 = pd.merge (df1, df2, how = 'other')
print (m1)
print (m2)
print (m3)
print (m4)
```


6. (a) Give a dictionary data : 4

```
data = {
    'Name' : ['Amit', 'Rina', 'John', 'Meera', 'Raj'],
    'Age' : [21, 23, 25, 22, 24],
    'Score' : [45, 78, 49, 88, 35]
```

Write Python code to perform the following operations :

- (i) Create a DataFrame df from data.
 - (ii) Print all rows of DataFrame df where Age > 22.
 - (iii) Add a new column 'Grade' with values ['A', 'B', 'A', 'C', 'D'] in df.
 - (iv) Delete the column 'Score' from df.
- (b) Explain how missing data is represented in Pandas. With the help of suitable examples, show the use of isnull(), notnull(), dropna(), and fillna() functions in handling missing data. 5
- (c) Write the output of the following Python code : 6

```
I = np.identity(4, dtype = int)
print (I)
diag = I [[0, 1, 2, 3], [0, 1, 2, 3]]
print (diag)
I [[0, 1, 2, 3], [0, 1, 2, 3]] += 5
print (I [[1, 3]])
```

7. (a) Given a Series of exam scores : 5

```
scores = pd.Series ([45, 67, 89, 52, 76, 90, 33, 84, 59, 100])
```

Write Python code to :

- (i) Discretize the scores into bins : 'Poor' (0–50), 'Average' (51–70), 'Good' (71–85) and 'Excellent' (86–100).
 - (ii) Display the frequency count of each bin.
 - (iii) Divide the scores into 4 equal – sized groups (quartiles).
- (b) Write Python code to create a figure with two subplots arranged in a single row using matplotlib.
- 10
- (i) Generate a *blue* coloured line plot of the square of numbers from 1 to 5 in the first subplot. Use a dashed line style ('—') and set the title as 'Line Plot of x^2 '.
Set x-axis label as 'x' and y-axis label as ' x^2 '.
Add custom x-tick labels as ['one', 'two', 'three', 'four', 'five'].
 - (ii) Generate a scatter plot of the same data in the second subplot. Use *green* coloured circle marker ('o') and set the title as 'Scatter plot of x^2 '. Set x-axis label as 'x' and y-axis label as ' x^2 '. Add custom y-tick labels as [1^2 , 2^2 , 3^2 , 4^2 , 5^2].

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[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5859

J

Unique Paper Code : 2342572401

Name of the Paper : Operating Systems

Name of the Course : B.A. Prog. / B.Sc. (Phy. Sc. & MS)

Semester : IV

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) What is a multiprocessor system? Give one advantage of it. (3)

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- (b) List various file operations in file system. (3)
- (c) Explain briefly the task of a dispatcher. (3)
- (d) Give any three services of an operating system. (3)
- (e) Describe the information contained in an open-file table and its use. (3)
- (f) Assume that the system takes 120 nanoseconds to reference the main memory. If number of hits is 75%, then calculate effective access time for a paging scheme. (3)
- (g) What is race condition in critical section problem? (3)
- (h) Explain circular wait condition in deadlock. (3)
- (i) What is a system call? Name the system call used for creating a process. (3)
- (j) Write the three main operations performed by an operating system to deal with page fault. (3)

Section – B

2. (a) Describe design objectives of an operating system from system point of view. (5)

(b) Explain the following terms : (2+3)

(i) Trap

(ii) Dual Mode operation

(c) For the given sets P (processes), R (resources) and E (edges) (5)

$$P = \{P1, P2, P3\}$$

$$R = \{R1, R2, R3\}$$

$$E = \{P1 \rightarrow R1, R1 \rightarrow P2, P3 \rightarrow R2, R1 \rightarrow P3, R3 \rightarrow P3, R2 \rightarrow P1, R2 \rightarrow P2\}$$

There are two instances each of resources R1 and R2 and 3 instances of resource R3. Draw Resource allocation graph. Is the given system in deadlock state? Justify your answer.

3. (a) Explain process control block and its content with the help of a diagram. (6)

(b) Consider the following change of state of process : (4)

(i) Process moves from wait state to ready state

(ii) Process moves from running to wait state

(iii) Process moves from running to ready state

(iv) Process terminates

State the choice of preemptive and non preemptive CPU scheduling algorithm in each of above cases.

(c) Consider a 40-bit logical address. Find the number of bits required to represent the page number and page offset fields. It is given that the page size is 4 KB. (5)

4. (a) Describe first-fit and best-fit memory allocation strategies. (5)
- (b) Give examples of software applications that run as multi-threaded process. (4)
- (c) Consider a program consists of five segments: $S_0 = 500$ KB, $S_1 = 18$ KB, $S_2 = 120$ KB, $S_3 = 670$ KB, and $S_4 = 85$ KB. Assume at that time, the available free space partitions of memory are 900-1850, 40-130, 280-400, and 2100-2600.

Answer the following :

- (i) Allocate space for each of 5 segments S_0 , S_1 , S_2 , S_3 , S_4 in memory using segmentation method.
- (ii) Will the allocation done in part (i) result in fragmentation? If yes, give type and size of fragmentations. (6)
5. (a) Define the following : (6)
- (i) Seek time

(ii) Rotational latency

(iii) Bandwidth

(b) Distinguish between sequential and direct file access methods. (4)

(c) Consider a disk queue with requests for I/O to blocks on cylinders as follows : (5)

98, 183, 37, 122, 14, 124, 65, 67

The drive is currently serving a request at cylinder 58. Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending request for FCFS (First come First serve) scheduling algorithms?

6. (a) What are the three necessary' conditions required for solution of the critical section problem? (5)

(b) Consider the following set of processes, with the length of CPU burst time given in milliseconds :

(10)

Process ID	Arrival Time	Burst Time	Priority
P1	0	8	2
P2	1	10	4
P3	2	5	3
P4	3	2	1

(i) Draw Gantt chart for Shortest Job First algorithm and calculate turnaround time for even' process.

(ii) Draw Gantt chart for Priority based (preemptive) algorithm and calculate waiting time for every process.

7. (a) Explain tree-structured directories with the help of a diagram. (5)

(b) Describe the issue involved in swapping In/Out a process and how it can be resolved? (5)

(c) Consider the following page reference string:

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

Assuming demand paging with four frames, how many page faults would occur, if optimal replacement algorithm is applied. Consider that all frames are initially empty. (5)

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[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7310 **J**

Unique Paper Code : 2342572401

Name of the Paper : Operating Systems

Name of the Course : B.A. Prog./ B.Sc.
(Phy. Sc. & MS)

Semester : IV

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.

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Section A

1. (a) A system uses a logical address composed of 8 bits for the page number and 12 bits for the offset. Calculate the total size of the logical address space. (3)
- (b) Write the steps involved in handling a page fault in an operating system. (3)
- (c) List three operations that can be performed on a file. (3)
- (d) How can we handle the problem of starvation in Priority Scheduling algorithm? (3)
- (e) Explain the concept of Dual-Mode Operation in an operating system and its importance. (3)
- (f) Write three advantages of multi-threaded systems. (3)
- (g) What is a System Call? Name any two system calls used in file handling. (3)

- (h) Define Deadlock. Mention any two necessary conditions required for a deadlock to occur. (3)
- (i) Discuss why progress and bounded waiting are essential requirements in solving the Critical Section Problem. (3)
- (j) Explain the concept of a Process Control Block (PCB) and name any three essential elements it comprises. (3)

Section B

2. (a) The system uses the non-preemptive Shortest Job First scheduling algorithm. Consider the following processes: (7)

Process	Arrival Time	Burst Time
P1	0	8
P2	1	4
P3	2	2
P4	3	1

- (i) Draw the Gantt chart showing the execution order.
 - (ii) Calculate waiting time and turnaround time for each process.
 - (iii) Calculate average waiting and average turnaround time
- (b) Explain the role of long-term, short-term, and medium-term schedulers. (6)
- (c) How does multiprogramming improve system performance? (2)
3. (a) Consider a memory system with available partitions of sizes: 180 KB, 300 KB, 120 KB, 500 KB, 220 KB. Three processes request memory in the following order: P1: 215 KB, P2: 125 KB, P3: 400 KB: (8)
- (i) For each of the contiguous memory allocation strategies (First-Fit, Best-Fit, and Worst-Fit), identify the partition each process would be allocated to.

(ii) Rank the algorithms in terms of how efficiently they use memory. Briefly justify your ranking.

(b) Explain how the translation of logical addresses to physical addresses occurs in paging technique.

(4)

(c) Distinguish between internal fragmentation and external fragmentation.

(3)

4. (a) Explain the concept of demand paging in an operating system. What are the advantages of using demand paging? Consider the following page reference string:

(10)

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

Assuming demand paging with three frames, how many page faults would occur if optimal replacement algorithm is used?

(b) Compare single-level, two-level, and tree-structured directories.

(5)

5. (a) A disk scheduling system has the following queue of pending requests (in the order they arrive): [98, 183, 37, 122, 14, 124, 65, 67]. The disk head starts at position 53. Answer the following: (10)
- (i) Calculate the total head movement using the First-Come, First-Served (FCFS) algorithm.
 - (ii) Calculate the total head movement using the Shortest Seek Time First (SSTF) algorithm.
 - (iii) Which algorithm results in less head movement, and why?
- (b) Explain the concept of caching in an operating system. Discuss the concept of cache coherency and its importance in multiprocessor systems. (5)
6. (a) Explain the purpose of the base register. Using the segment table provided below, calculate the physical address for the logical address (1, 10). (4)

Segment	Base	Length
0	120	600
1	2300	14
2	60	105

(b) Describe the states of a process using a suitable diagram. (5)

(c) Consider a system with 3 processes (P1, P2, P3) and 2 resource types (R1 with 1 instance, R2 with 2 instances). The current allocation and requests are as follows: (6)

P1 holds R1 and requests R2,

P2 holds one instance of R2 and requests R1,

P3 holds another instance of R2.

Draw the Resource Allocation Graph and determine whether a deadlock exists or not. Justify your answer.

7. Distinguish between the following:

(15)

- (i) Process and thread
- (ii) Preemptive and non-preemptive scheduling
- (iii) Seek time and rotational latency
- (iv) Paging and demand paging
- (v) Physical memory and virtual memory

(700)



[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7490 J

Unique Paper Code : 2342202402

Name of the Paper : Data Mining II

Name of the Course : B.A. (Programme) (NEP)

Semester : IV

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. Answer any four questions from Section B.
4. All parts of Question must be attempted together.
5. Use of Scientific Calculator is allowed.

1. (a) How do you determine the optimal number of clusters in k-means? (2)
- (b) What do you mean by Frequency Damping? (2)
- (c) What do you mean by resampling of Data with example? (3)
- (d) When would you prefer Bagging over Boosting (3)
- (e) What is Sliding Window in Stream Mining? (3)
- (f) What are common use cases of Ensemble methods? (3)
- (g) How does DBSCAN algorithm work and when it is preferred? (4)

(h) Use Z-Score to detect anomalies in the data [10, 12, 13, 15, 14, 100]. Assume threshold is 2.

(4)

(i) Differentiate between any two : (6)

I. Agglomerative and Divisive hierarchical clustering.

II. Hard and Soft clustering.

III. Single Linkage and Complete Linkage

SECTION B

2. (a) Perform hierarchical clustering using single linkage and draw the dendrogram for the following data points :- (8)

	P1	P2	P3	P4	P5
P1	0				
P2	0.12	0			
P3	0.21	0.38	0		
P4	0.32	0.33	0.16	0	
P5	0.35	0.15	0.37	0.34	0

(b) Explain the mathematical formulation of K-means clustering as optimization problem. (7)

3. (a) Mention primary techniques involved in Document Normalization and Similarity Computation in text data mining? What are the main step involved in EM Algorithm? Why Probabilistic Latent Semantic Analysis (PLSA) preferred over Latent Semantic Analysis (LSA)? (9)

- (b) Calculate TF (Term Frequency)- IDF (Inverse Data Frequency) for the word "Data" in the following documents: (6)

Doc1:- "Data mining is extracting knowledge"

Doc2:- "Text mining is a component of Data mining"

Doc3:- "Data mining is extracting pattern"

4. (a) Given the following 2D Data points with (x,y) coordinates: (9)

A(1, 1), B(1, 2), C(2, 2), D(8, 7),
E(7, 7), F(7, 8), G(15, 15)

Apply DBSCAN with Noise algorithm on the given data with $\epsilon=1.5$ and $\text{minPts}=2$ (minimum points to form a cluster). Identify the Clusters.

Find The Following Points based on DBSCAN algorithm

(i) Core Points

(ii) Border Points

(iii) Noise points

(b) Compare and Contrast various techniques for anomaly detection methods. (6)

5. (a) Consider the following 2 D data points: (9)

A(3, 6), B(2, 4), C(6, 8), D(5, 8),
E(8, 9), F(2, 5)

Perform 2 iterations of K-mean with initial centroids at (3,6)(cluster1) and (2,4)(cluster2)

(b) What are the key components of Time Series?

How do you Handle missing values in time series data? (6)

6. (a) What are the key techniques for handling data stream?

Also discuss steps involved in Time Series data into Discrete Data? (8)

- (b) What is Sliding Windows in Time Series Analysis?

Given a sliding window of size $N=4$, and the data stream : [3, 1, 5, 2, 8, 7, 6, 10, 11, 12]. Compute Rolling averages of the data. (7)

7. (a) Mention any three methods for Constructing an Ensemble Classifier? What do you mean by Random Forest? How does it Work and handle overfitting? (8)

(b) Discuss Nature of Data in Anomaly Detection

Given 2D points :

$(1, 1)$, $(1, 2)$, $(2, 2)$, $(100, 100)$

use Euclidean Distance and $k=2$ to find if $(100,100)$

is an anomaly.

(7)



[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5853

J

Unique Paper Code : 2342573601

Name of the Paper : Computer Networks

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

Semester : VI

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 (Question No. 1) is compulsory.
3. Attempt any four questions from Section B (Questions 2 to 7).
4. All questions in Section B carry equal marks.
5. Parts of a question must be answered together.

Section A

1. (a) For each of the following three networks, discuss the consequences if a connection fails: (3)
 - (i) Four devices arranged in a mesh topology
 - (ii) Four devices arranged in a bus topology
 - (iii) Four devices arranged in a ring topology
- (b) Assume that a voice channel occupies a bandwidth of 2 kHz. We need to multiplex 7 voice channels with guard bands of 250 Hz using FDM. Calculate the minimum required bandwidth. (3)
- (c) Describe simplex, half-duplex, and full-duplex modes of communication. (3)
- (d) What are the purposes of the URG, SYN, and PSH flags in a TCP header? (3)
- (e) Discuss the purpose of cladding in Optical Fibers. (3)

(f) What is the function of the IP protocol in routing data across networks? (3)

(g) What are the main roles of the Data Link Layer in network communication? (3)

(h) Using Nyquist's theorem, calculate the maximum bit rate for a noiseless channel with a bandwidth of 4 kHz transmitting a signal with four distinct signal levels. (3)

(i) HTTP is a stateless protocol. Justify. (3)

(j) Find the class of the following IP addresses. (3)

(i) 208.34.54.12

(ii) 238.34.2.1

(iii) 129.14.6.8

Section B

2. (a) What is the use of checksum in data communication, and how does it help in detecting errors during data transmission? (1+2=3)
- (b) What are the key differences between virtual-circuit and datagram networks? (5)
- (c) List different layers of the TCP/IP reference model and briefly describe the responsibility of the Transport layer in TCP/IP. (3+4=7)
3. (a) Consider an extremely noisy channel in which the value of the signal- to-noise ratio is 31. Compute the bit rate if the bandwidth of the channel is 1 kHz. (4)
- (b) What is the need for multiplexing in computer networks? Discuss the types of multiplexing. (2+3=5)

(c) The following character encoding is used in a data link protocol: A: 01000111 B: 11100011 FLAG: 01111110 ESC: 11100000

Show the bit sequence transmitted (in binary) for the Six-character frame

A B ESC FLAG FLAG B

When each of the following framing methods is used:

(i) Flag bytes with byte stuffing.

(ii) Starting and ending flag bytes with bit stuffing. (2*3=6)

4. (a) Define HDLC protocol. Which OSI layer does it belong to, and how does it work? (1+1+2=4)

(b) A message $M(x)$ 10110010 is transmitted using the CRC method. The generator polynomial is

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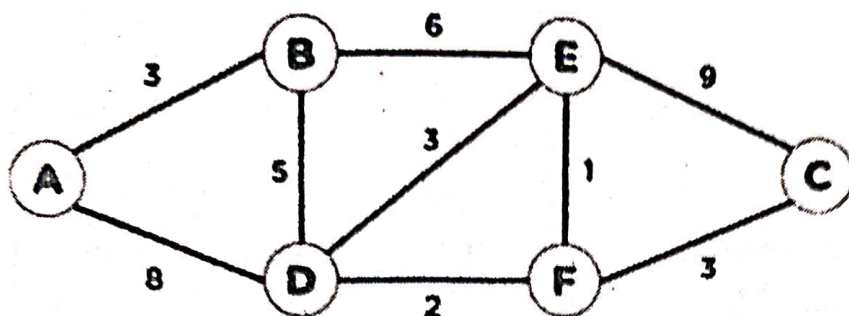
$x^4 + x + 1$. Compute the bit stream transmitted, which includes the message and CRC. Suppose that the third bit from the left is inverted during transmission. Show that this error is detected at the receiver's end. (3+2=5)

(c) What are the key characteristics of radio waves and microwaves? (6)

5. (a) Discuss the basic difference between a switch, repeater, router, and gateway. (4)

(b) What is the CSMA/CD protocol? What is the minimum frame size required to ensure collision detection in the CSMA/CD protocol? (3+2=5)

(c) Consider the following network with the indicated link cost. Using the shortest path Algorithm, find the shortest path from source node A to F and from A to C. (6)



6. (a) What is a Subnet Mask? If you were given a subnet mask of 255.255.255.192, how many hosts could each subnet accommodate? (2+2=4)
- (b) Describe the UDP header format with the help of a diagram. Give one example of a scenario where UDP packets are used for data transmission. (5)
- (c) Ten-bit messages are transmitted using a Hamming code. (3+3=6)
- (i) How many check bits are needed to ensure that the receiver can detect and correct single-bit errors?



(ii) Show the bit pattern transmitted for the message 1010110011. Assume that even parity is used in the Hamming code.

7. (a) What are the advantages and disadvantages of using satellite as a communication medium? (5)

(b) Write short notes on the following: (2*5=10)

(i) Hub

(ii) ICMP

(iii) Bridge

(iv) WWW

(v) SMTP

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7351

J

Unique Paper Code. : 2342573601

Name of the Paper : Computer Networks

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

Semester : VI

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 (Question No. 1) is compulsory.
3. Attempt any four questions from Section B (Questions 2 to 7).
4. All questions in Section B carry equal marks.
5. Parts of a question must be answered together.

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Section A

1. (a) Describe the notion of transmission impairment. Briefly discuss the difference between distortion and attenuation. (1+2=3)
- (b) Consider a noiseless channel with a bandwidth of 3000 Hz transmitting a signal with two signal levels. Calculate the maximum bit rate of the channel. (3)
- (c) Discuss the concept of byte stuffing used for framing. (3)
- (d) Assume six devices are arranged in a mesh topology. How many cables are needed? How many ports are needed for each device? (3)
- (e) Give three key differences between UDP and TCP. (3)
- (f) What are the periodic signals, and why are they commonly used in analog transmission? (3)

- (g) What is flow control? How is it handled at the data link layer? (3)
- (h) What is subnetting? A network on the internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle? (3)
- (i) List different parts of a URL. Give an example. (3)
- (j) In IPv4 addressing, what are the identifiers (starting bit patterns and address ranges) for Class A, Class B, and Class C addresses? (3)

Section B

2. (a) In a bus topology with n devices, how many cable links are necessary assuming full-duplex communication? Additionally, how does this number of links compare to what is required in star topology and ring topology? (4)

- (b) What are the differences between Packet switching and Circuit switching? (5)
- (c) Consider a coding scheme with two legal codewords: 01010 and 10101. (2)
- (i) Calculate its Hamming distance. (2)
- (ii) How many bit errors can be detected by this code? (2)
- (iii) How many bit errors can be corrected by this code?
3. (a) Briefly discuss the concept of multiplexing. Differentiate between time division and frequency division multiplexing. (2+2=4)
- (b) Describe the structure of a TCP header. (5)
- (c) A message $M(x)$ 1101101101 is transmitted using the CRC method. The generator polynomial is $x^3 + 1$.

(i) Compute the transmitted bit string, which includes the message and CRC. (3)

(ii) Suppose that the fifth bit from the left is inverted during transmission. Show that this error is detected at the receiver's end. (3)

4. (a) List different layers of the OSI model. What are the main tasks of the Data Link Layer and Network Layer? (3+2+2=7)

(b) Consider a network comprising five routers labelled as A, B, C, D, and E. The interconnection and its associated costs are as follows:

- Link between A and B: Cost 2

- Link between A and C: Cost 4

- Link between B and C: Cost 1

- Link between B and D: Cost 5

- Link between C and D: Cost 3
- Link between C and E: Cost 7
- Link between D and E: Cost 2

Using the Shortest Path Algorithm (Dijkstra's algorithm), illustrate the step-by-step process of determining the shortest path from router A to router E. (8)

5. (a) What does the following address mean, and when are they used? (3)

(i) 0.0.0.0

(ii) 127.xx.yy.zz

(iii) 156.76.255.255

- (b) What are the advantages and disadvantages of using optical fiber as a medium for transmission? (6)

(c) Briefly explain the following CSMA protocols:

(3+3=6)

(i) 1-persistent

(ii) p-persistent

6. (a) What is the role of the HTTP protocol in data communication? (3)

(b) Discuss the count to infinity problem in distance vector routing. (4)

(c) Describe the structure of an IPv4 address, discuss why IPv6 was introduced, and mention the address length in IPv6. (8)

(a) What is the Point-to-Point Protocol (PPP)? (3)

(b) Write short notes on the following: (2*6=12)

(i) Switch

- (ii) DNS
- (iii) HDLC
- (iv) WWW
- (v) Router
- (vi) Unguided Media

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 7380

J

Unique Paper Code : 2342573601

Name of the Paper : Computer Networks

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

Semester : VI

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 (Question No. 1) is compulsory.
3. Attempt any four questions from Section B (Questions 2 to 7).
4. All questions in Section B carry equal marks.
5. Parts of a question must be answered together.

Section A

1. (a) Consider a noiseless channel with a bandwidth of 4000 Hz transmitting a signal with eight signal levels. Calculate the maximum bit rate of the channel. (3)
- (b) Differentiate between unicast, multicast, and broadcast communication. (3)
- (c) Identify the OSI layer responsible for each of the following operations:
 - (i) Ensures reliable end-to-end message delivery between processes.
 - (ii) Responsible for moving packets from the source to the destination and enabling internetworking between networks.
 - (iii) Responsible for transmitting raw bits over a physical medium and defining the mechanical and electrical specifications of the interface. (3)

(d) Give any two differences between IPv4 and IPv6.

(3)

(e) What is the full form of DNS? What is its use?

(3)

(f) Compare the advantages and disadvantages of star topology when compared to mesh topology. (3)

(g) Describe the store-and-forward technique used in data communication. (3)

(h) What is bandwidth, and how would you calculate the bandwidth of a signal? Find the highest frequency when the lowest frequency is 1 kHz with a frequency range of 4 kHz. (3)

(i) Consider a noiseless channel with a bandwidth of 3000 Hz transmitting a signal with four signal levels. Calculate the maximum bit rate of the channel. (3)

- (j) Describe routing and its use in the computer network. (3)

Section B

2. (a) Describe the differences between circuit switching and packet switching, using appropriate examples to illustrate each. (4)
- (b) If a periodic signal is decomposed into five sine waves with frequencies of 100, 300, 500, 700, and 900 Hz, what is its bandwidth? Draw the spectrum, assuming all components have a maximum amplitude of 10 V. (2+3=5)
- (c) What are the key differences between error detection and error correction? Discuss how the Hamming Code is used for single-bit error correction with an example. (6)
3. (a) Compare and contrast analog and digital transmission. (4)

- (b) Give three differences between connectionless and connection-oriented services in networking. Give one example of each. (3+2=5)
- (c) What do you mean by CS and CD in CSMA/CD protocol? Discuss the binary exponential back-off algorithm. (2+4=6)
4. (a) Differentiate between adaptive and non-adaptive routing algorithms. (4)
- (b) What is the size (in bytes) of the minimum TCP header without options? List any four fields present in the TCP header and specify their purpose. (1+4=5)
- (c) For Class A, Class B, and Class C IP addresses, specify their address ranges and default subnet masks. (6)
5. (a) Given an IP address of 192.168.1.0/26, how many subnets and hosts per subnet are possible? (4)

(b) Describe wavelength division multiplexing. How it differs from the time division multiplexing technique. (2+3=5)

(c) Write the services provided by the physical and data link layer of the TCP/IP model. (3*2=6)

6. (a) Explain the purpose of byte stuffing in data link layer protocols. How does it differ from bit stuffing? (2+2=4)

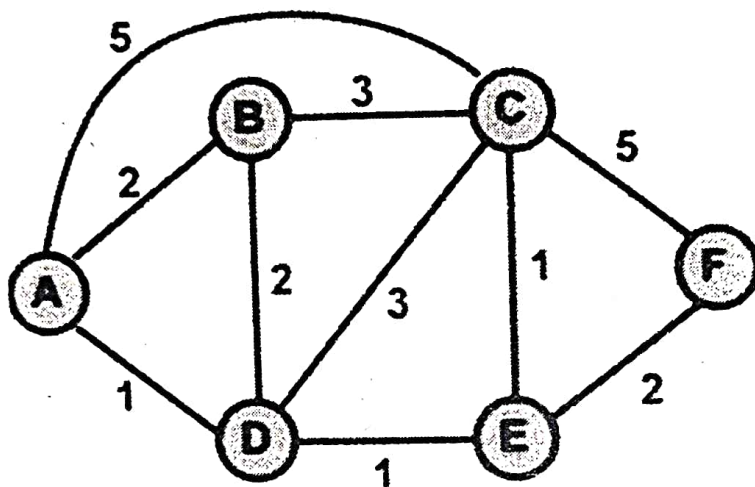
(b) What is unguided media in data communication? What are the most commonly used types of unguided media in modern communication systems? (2+3=5)

(c) Briefly explain the following CSMA protocols: (3*2=6)

(i) 1-persistent

(ii) non-persistent

7. (a) Consider the following network with the indicated link cost. Using the shortest path Algorithm, find the shortest path from source node A to F. (5)



- (b) Write short notes on the following: (2*5=10)

- (i) LAN
- (ii) WAN
- (iii) MAN

(iv) Port Address

(v) URL

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This question paper contains 4 printed pages]

Roll No.

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S. No. of Question Paper : 7461

Unique Paper Code : 2342203602

Name of the Paper : Deep Learning

Name of the Course : B.A. (P) DSC

Semester : VI

Duration : 3 Hours

Maximum Marks : 90

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

Question No. 1 (Section A) is compulsory.

Attempt any four questions from Section B.

Parts of a question should be attempted together.

Use of Scientific Calculator is allowed.

Section-A

1. (a) Differentiate between Perceptron and a Multilayer Feedforward Neural Network. 3
- (b) Given a 5×5 input matrix and a 3×3 filter (kernel) with a stride of 1 and no padding. What is the size of the feature map, that will you get after one convolution operation ? Show computation. 3
- (c) What are the challenges in neural networks optimization ? 4
- (d) What is an autoencoder and what are its applications ? 3
- (e) Why is dropout used during the training of neural networks ? 3
- (f) Discuss any two applications of deep neural networks. 4

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(g) Give *one* word for the following :

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- (i) RNN variant designed to remember long-term dependencies.
- (ii) Normalization method used between layers to speed up training.
- (iii) The operation that extracts features from images.
- (iv) The technique that reduces the spatial size of feature maps.
- (v) The problem that occurs when gradient becomes too small.
- (vi) A key strategy for reducing the cost of inference in a machine learning model and to replace the original expensive model with a smaller model that requires less memory and runtime to store and evaluate.
- (vii) This parameter in a neural network determines the strength of the connection between two neurons.
- (viii) An optimization algorithm which updates weights in the direction that reduces the loss function.
- (ix) Optimization algorithm that combines momentum and adaptive learning rates.
- (x) The process that involves adjusting parameters like learning rate and batch size to improve a model's performance.

Section-B

2. (a) Describe the structure of a feed forward neural network with appropriate diagram. 7
- (b) How does the backpropagation algorithm work ? Also, explain the chain rule of calculus with respect to backpropagation. 8

3. (a) Discuss Adam and RMSProp optimization techniques. 6
 (b) What is the role of activation functions in neural networks. 9

Write the activation function for the following :

(i) Sigmoid

(ii) ReLU

(iii) Linear

Also compute the output on the above activation functions when input is $x = 2$.

- (a) Perform a 2D convolution on the following input using the given kernel, stride = 2 and no padding. 7

Fliter/Kernal :

1	0
-1	1

Input Matrix :

1	2	0	1	3	3
4	1	1	0	2	2
2	3	2	1	0	0
1	0	1	3	2	2
2	1	0	1	1	1
3	2	1	4	1	1

- (b) On the above obtained matrix from part (a), apply ReLU activation function and max pooling (2×2) with stride = 1. 5
 (c) Which regularization method leads to weight sparsity ? Explain why ? 3
5. (a) Consider a simple feedforward neural network with : 10
- One input layer with two inputs : $x_1 = 0.5$, $x_2 = 0.4$

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- One hidden layer with two neurons (h_1 and h_2), both using the ReLU activation function.
- One output layer with one neuron using a linear activation.

The weights and biases are as follows :

- Weights from input to hidden layer :
 - Neuron h_1 : $w_{11} = 0.2$, $w_{12} = 0.4$, bias = 0.1
 - Neuron h_2 : $w_{21} = -0.3$, $w_{22} = 0.1$, bias = 0.2
 - Weights from hidden to output layer :
 - $w_{01} = 0.6$, $w_{02} = 0.5$, bias = 0.3

Draw the neural network structure for the above and perform a forward pass through the network and compute the final output.

Assuming the target value as 1.5, compute the Mean Squared Error (MSE).

- (b) Define convolution and pooling in the context of CNNs. 5
6. (a) Explain architecture and working of Recurrent Neural Networks. 10
- (b) Give *two* benefits of using convolutional layers instead of fully connected ones for visual tasks. 5
7. Write short notes any *five* of the following : 15
- (a) Global Contrast Normalization
- (b) Overfitting
- (c) Stochastic Gradient Descent
- (d) Bidirectional RNN
- (e) LSTM
- (f) Graphics Processing Unit
- (g) Mean Absolute Error.