

COMPUTER

SCIENCE

PROJECT

NAME	SHAURRYA BAHETI
CLASS	XII
SECTION	A
ROLL NUMBER	3239
SESSION	2021-2022
SCHOOL NAME	M. C. KEJRIWAL VIDYAPEETH

Acknowledgements

I would like to take this opportunity to thank our dear principal sir, Mr. Neelkanth Gupta, for giving me a chance to be in this school with my stream as Science with Computer.

I would like to thank our Computer Teacher Mr. Spondon Ganguli sir, to select such interesting programs for the project that required so much logic and understanding of the subject to complete.

I would like to thank my friends and my family for being as helpful as they could so that I could complete my project on time.

~SHAURRYA BAHETI

Index

<i>Sl. No.</i>	<i>Contents</i>	<i>Page No.</i>
1	Introduction to OOPs and JAVA	4
2	System Specifications	5
3	Program 1	6
4	Program 2	10
5	Program 3	19
6	Program 4	24
7	Program 5	35
8	Program 6	40
9	Program 7	44
10	Program 8	51
11	Program 9	57
12	Program 10	65
13	Program 11	70
14	Program 12	76
15	Program 13	88
16	Program 14	95
17	Program 15	101
18	Program 16	109
19	Program 17	114
20	Program 18	120
21	Program 19	127
22	Program 20	141
23	Bibliography	155

Introduction

OOP: Object Oriented Programming (OOP) Language or Technique is a type of programming language or technique, in which objects are used to pass information between classes and decrease the programs latency, unlike Procedural Oriented Programming (POP) Language or technique which is completely procedure based.

JAVA: Java is a programming language that uses both POP and OOP concepts and technique. It is a case sensitive programming language that is used to make applications that can run on any platform and any computer, and thanks to its web plug-in, you can even run those apps in your browser.



System Specifications

Hardware specifications:

- 128MB RAM or above
- 400MHz processor or above
- 500MB Free space for storage.

Software specifications:

- Windows 7 or later with a 64bit architecture

PROGRAM 1

Question)

Avoltri Travels were taking a group of 200 tourists to Balaji Temple. A class clTravel is designed, some of whose functions/methods are shown below –

Class name : clTravel

Data members/ instance variables:

- int arAge[200] – an array to store the age of 200 tourists.
- int arFreqDist[5] – an array to store the number of people in various age groups :-
 - cell 0 – number of people up to 20 years
 - cell 1 – number of people between 21 to 40 years
 - cell 2 – number of people between 41 to 60 years
 - cell 3 – number of people between 61 to 80 years
 - cell 4 – number of people above 80 years

Member functions/methods:

- clTravel(): Constructor
- void fnReadAge(): To input age of 200 tourists in arAge[]
- void fnFrequency(): To fill arFreqDist[] from arAge[]
- void fnShowFreq(): To show the frequency of age group in a table format.

Specify the class clTravel giving details of the mentioned functions. You need to write the main() method and create an object of the class and call the functions accordingly.

Algorithm)

- Start
- Take Input
- Run a loop over the array and increment the number at the respective position of the frequency distribution
- Display the distribution in tabular form
- End

Code)

```
import java.util.*;

class clTravel
{
    // Declaring class variables
    int arAge[]/* To store the ages of the tourists */, arFreqDist[]/* To store the
age distribution frequency table */;

    // Default constructor to initialise class variables to default values
    clTravel()
```

```

{
    arAge=new int[200];
    arFreqDist=new int[5];
    for (int i = 0;i < 5;i++)
    {
        arFreqDist[i] = 0; // Initialising each element to 0
    }
}

```

// Function to take input of the ages of all the tourists

```

void fnReadAge()
{
    Scanner sc=new Scanner(System.in);
    int i = 0/* LCV */, x/* Temporary variable */;
    while(i < arAge.length)
    {
        System.out.print("Enter the age of tourist number " + (i+1) + ": ");
        x = sc.nextInt();

        // Validating input
        if(x <= 0)
        {
            System.out.println("Age should be greater than zero");
        }
        else
        {
            arAge[i] = x; // Putting the validated input in the array
            i++;
        }
    }
}

```

// Function to fill the distribution array

```

void fnFrequency()
{
    for(int i = 0; i < arAge.length; i++)
    {
        // Incrementing the respective age group's slot by 1 each time
        there is a age inside that age group
        if(arAge[i] <= 20)
            arFreqDist[0]++;
        else if(arAge[i] <= 40)
            arFreqDist[1]++;
    }
}

```

```

        else if(arAge[i] <= 60)
            arFreqDist[2]++;
        else if(arAge[i] <= 80)
            arFreqDist[3]++;
        else
            arFreqDist[4]++;
    }
}

// Function to print the results in tabular form
void fnShowFreq()
{
    System.out.println("Age groups:\t1-20\t21-40\t41-60\t61-80\t80<");
    System.out.println("Frequency
:\t"+arFreqDist[0]+\t"+arFreqDist[1]+\t"+arFreqDist[2]+\t"+arFreqDist[3]+\t"+arFr
eqDist[4]);
}

// Main method to create object and call the required functions
public static void main(String[] args)
{
    clTravel clt=new clTravel();// Creating object
    // Calling functions accordingly
    clt.fnReadAge();
    clt.fnFrequency();
    clt.fnShowFreq();
}
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	int[]	arAge	An array to store the age of 200 tourists.
2	int[]	arFreqDist	An array to store the number of people in various age groups
3	-	clTravel()	Default constructor
4	void	fnReadAge()	To input age of 200 tourists in arAge[]
5	void	fnFrequency()	To fill arFreqDist[] from arAge[]

6	void	fnShowFreq()	To show the frequency of age group in a table format
7	void	main(String[])	To create an object of the class and call the functions accordingly

Output)

```

Enter the age of tourist number 190: 65
Enter the age of tourist number 191: 121
Enter the age of tourist number 192: 100
Enter the age of tourist number 193: 89
Enter the age of tourist number 194: 115
Enter the age of tourist number 195: 79
Enter the age of tourist number 196: 40
Enter the age of tourist number 197: 43
Enter the age of tourist number 198: 41
Enter the age of tourist number 199: 81
Enter the age of tourist number 200: 48
Age groups:      1-20    21-40    41-60    61-80    80<
Frequency :      29      26      39      33      73

```

THE UPPER PART OF THE
OUTPUT WAS CUT TO MAKE IT
SHORT.

Program 2

Question)

Write a program in Java that will accept a string from the user that must be comprises of N sentences, where N will be entered by the user and must be greater than 1. Every sentence in the string must be ended with either '?' or '.' or '!'. The string should be a continuous string entered by the user. If the input string does not match with the conditions given above, user should be asked to re-enter the string again. Now ask the user to choose a sentence from the entered string and print that sentence on the screen in Sentence case. Now print a histogram on the frequency of each alphabet present in that sentence with the help of '#' or '*' only. The histogram should be a column chart on the above-mentioned data.

Algorithm)

- Start
- Take required inputs
- Store the sentences in an array where each element is a sentence.
- According to user choice get the sentence to work on
- Make an array containing the frequency of each alphabet in the sentence
- Make a 2-dimensional array with one side being 26 and the other side being the frequency of the most appearing alphabet
- Fill that array originally with " ".
- Now for each alphabet's frequency fill that column up to the frequency of the alphabet with "*" in place of " ".
- Print the 2-dimensional array
- End

Code)

```
import java.util.*;
```

```
class Alphagram
```

```
{
```

```
    // Declaring class variables
```

```
    String s_arr[]; // To store the sentences in array
```

```
    int n /* To store number of sentences user will enter */, choice/* To store
    number of sentence user wants a graph for */;
```

```
// Default constructor to initialise class variables to default values
```

```
Alphagram()
```

```
{
    n = 0;
}
```

```
// Function to take input of an integer with explicit error handling recursively
```

```
int get_int(String s)
```

```
{
    Scanner sc=new Scanner(System.in);
    System.out.print(s);
    try
    {
        int x = sc.nextInt();
        return x;
    }
    catch(Exception e) // Catching error when user enters something other
than integer
    {
        System.out.println("\nPlease enter an integer only");
        get_int(s);
    }
    return 0;
}
```

```
// Function to take necessary inputs and checking them as well
```

```
void input()
```

```
{
    while(true)
    {
```

```

        n = get_int("Enter the number of sentences for the string : ");
        if(n > 1) // Checking if the number complies with the rules
            break; // Breaking when true
        System.out.println("number of sentences should be at least 2");
    }
    s_arr = new String[n]; // Initialise the array
    while(true)
    {
        Scanner sc=new Scanner(System.in);
        // Taking input of the sentences
        System.out.println("Enter a string having " + n + " sentences
ended with either '?' or '.' or '!");
        String s = sc.nextLine();
        s = s.trim();
        int l = s.length();
        // Filling the array with the sentences
        String ns="";
        int a = 0;int e = 0;
        for(int i = 0; i < l; i++)
        {
            char ch = s.charAt(i);
            if(ch=='?'||ch=='.'||ch=='!')
            {
                try
                {
                    s_arr[a] = ns + ch;
                    a++;
                }

                catch(ArrayIndexOutOfBoundsException ex) //
catching error when user enters more sentences

```

```

        {
            System.out.println("Please only enter as many
sentences as you specified");

            e = 1;
            break;
        }
        ns = "";
    }
    else if(a<n && i==l-1) // Checking if user entered less
sentences as required
    {
        System.out.println("Please enter as many sentences
as you specified");

        e = 1;
        break;
    }
    else
    {
        if(i == l-1) // Checking if the string does not follow the
rules
        {
            System.out.println("Please make sure your
sentences are properly punctuated");

            e = 1;
            break;
        }

        else // Else appending sentence
            ns = ns + ch;
    }
}

```

```

        if(s_arr[n-1]==null) // Final check if the user entered less
sentences
        System.out.println("Please enter as many sentences as you
specified");

        else if(e==0)
        {
            break; // finally breaking out of the infinite loop
        }
    }
    while(true)
    {
        // Taking input of the choice of sentence from user
        choice = get_int("Enter the sentence number of your choice : ");
        if(choice >= 1 && choice <= n)
            break; // breaking from infinite loop if the input is valid
        System.out.println("The choice is not within the limits of number
of sentences");
    }
}

// Function to get the frequency of every alphabet in the sentence of user's
choice
int[] AlphaFrequency(String s)
{
    int freq[]=new int[26]; // initialising the array for frequencies
    for(int i = 0;i < 26;i++)
        freq[i] = 0; // initialising every element to 0
    s = s.toUpperCase(); // Converting to uppercase to make things easy
    int l = s.length();
    for(int i = 0; i < l; i++)
    {

```

```

        int p = (int)(s.charAt(i)) - 65;
        if(p >= 0 && p < 26)
            freq[p]++; // increasing the frequency of the alphabet found
    }
    return freq; // returning the array containing the frequencies
}

// Function to create a 2-dimensional array to print
char[][] ArrToPrint(int max, int arr[])
{
    char ch[][] = new char[max+1][26]; // The array to be printed is initialised
    for(int i = 0; i < max; i++)
        for(int j = 0; j < 26; j++)
            ch[i][j] = ' '; // Initialising each element of the array to a
    space
    char c = 'A';
    for(int i = 0; i < 26; i++)
    {
        ch[max][i] = (char)(c + i); // Initialising the last row of the array to
        each alphabet respectively
    }

    // Filling the array with * to indicate 1 instance of the respective
    alphabet
    for(int i = 0; i < 26; i++)
    {
        int a = max - 1;
        while(arr[i] > 0)
        {
            ch[a][i] = '*';

```

```

        arr[i]--;
        a--;
    }
}
return ch; // Returning the array to be printed
}

```

// Function to print the graph

```
void display()
```

```
{
```

```
    input(); // Calling input
```

```
    String s = s_arr[choice - 1]; // Getting the sentence of choice
```

```
    int array[] = AlphaFrequency(s); // Getting the frequency of each
    alphabet in the sentence of choice
```

```
    // Getting the maximum frequency shown by any alphabet
```

```
    int max = 0;
```

```
    for(int i = 0; i < array.length; i++)
```

```
        if(array[i] > max)
```

```
            max = array[i];
```

```
    char arr[][] = ArrToPrint(max, array); // Getting the array to be printed
```

```
    // Printing the things required
```

```
    System.out.println("The sentence of your choice is : " + s);
```

```
    for(int i = 0; i < max+1; i++)
```

```
{
```

```
    for(int j = 0; j < 26; j++)
```

```
{
```

```
        System.out.print(arr[i][j] + " ");
```

```
}
```



```

        System.out.println();
    }
}

// Main method to create object and call required functions
public static void main(String[] args)
{
    Alphagram alpg=new Alphagram();
    alpg.display();
}
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	String[]	s_arr	To store the sentences in array
2	int	n	To store number of sentences user will enter
3	int	choice	To store number of sentence user wants a graph for
4	-	Alphagram()	Default Constructor
5	int	get_int(String)	to take input of an integer with explicit error handling recursively
6	void	input()	to take necessary inputs and checking them as well
7	int[]	AlphaFrequency(String)	to get the frequency of every alphabet in the sentence of user's choice
8	char[][]	ArrToPrint(int, int[])	to create a 2-dimensional array to print
9	void	display()	to print the graph

10 void

main(String[])

create object and call
required functions

Output)

```

Enter the number of sentences for the string : 3
Enter a string having 3 sentences ended with either '?' or '.' or '!'
Hello World! I am Shaurrya Baheti. This is for output of the program.
Enter the sentence number of your choice : 3
The sentence of your choice is : This is for output of the program.
                                     *      *
                                     *      *      *
                                *      *      *      *
*      *      *      *      *      *      *      *      *
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

```

Program 3

Question)

Input a sentence from the user and change the vowels to next alphabet and the consonant to previous alphabet of that word in that string. Display both the input and changed string. Class description is given below:-

Class name : WordChange

Data members/instance variable

- String s: input string
- String r: resultant string

Member functions:-

- WordChange(String): parameterized constructor to initialize the data members accordingly
- String change(String): return the changed word as instructed in the question
- void extract(void): extract each word from the string s and pass to the change() and form the new string.
- void display(): display both the strings

Specify the class WordChange giving the details of constructor and all the functions mentioned in the question. You need to write the main() method and create an object of the class and call the functions accordingly.

Algorithm)

- Start
- Take required inputs
- Make an array of extracted words and send them one by one to change(String)
- Int change(String), loop over the extracted word
- Increment each vowel character by 1 and decrement each consonant character by 1 and add the formed character to a new string
- Return the changed string
- Form the new string with the changed words
- Display the changed string
- End

Code)

```
import java.util.*;
```

```

class WordChange
{
    // Declaring class variables
    String s/* To store the string entered by user */, r/* To store the changed
string */;

    // Parameterized constructor to initialise the class variables
    WordChange(String str)
    {
        s = str;
        r = "";
    }

    // Function to change the passed word
    String change(String word)
    {
        int l = word.length(); // Length of the word passed
        String chWord = ""; // To store the changed word
        for(int i = 0; i < l; i++)
        {
            char ch = word.charAt(i); // getting the character at position i in
the word

            char cH = Character.toUpperCase(ch); // Getting the uppercase
version as well to make the work easy

            if(ch >= 'A' && ch <= 'Z') // Checking if the character is an alphabet
or not
            {
                if(cH=='A'||cH=='E'||cH=='I'||cH=='O'||cH=='U') // Checking if the
character is a vowel or not
                {

```

```

        chWord = chWord + (char)(ch+1); // Changing the vowel
with the next alphabet and adding it to chWord
    }
    else
    {
        chWord = chWord + (char)(ch-1); // Changing the
consonant with the previous alphabet and adding it to chWord
    }
}

else
    chWord = chWord + ch; // Adding the non-alphabet
character as it is
}
return chWord; // Returning the changed word
}

```

// Function to extract each word and pass it to the change function then add the changed word to new string

```

void extract()
{
    String arrS[] = s.split(" "); // Getting the array of words
    int l = arrS.length; // Length of the array

    for(int i = 0; i < l; i++)
    {
        r = r + change(arrS[i]) + " "; // Adding the changed words to new
string
    }

    r = r.trim(); // Trimming extra spaces

```

```

}

// Function to display the original string and changed string
void display()
{
    extract();
    System.out.println("Entered string : " + s);
    System.out.println("Changed String : " + r);
}

// Main method to create object and call required functions
public static void main(String[] args)
{
    Scanner sc=new Scanner(System.in);
    // Taking input of the string to change
    System.out.print("Enter a string : ");
    String str = sc.nextLine();
    WordChange wch=new WordChange(str);
    wch.display();
}
}

```

Variable Description Table)

No.	DataType/Return Type	Variable/Method	Description
1	String	s	input string
2	String	r	resultant string
3	-	WordChange(String)	parameterized constructor to initialize the data

members accordingly			
4	String	change(String)	return the changed word as instructed in the question
5	void	extract()	extract each word from the string s and pass to the change() and form the new string.
6	void	display()	display both the strings
7	void	main(String[])	create an object of the class and call the functions accordingly

Output)

```
Enter a string : Hello World! I am Shaurrya Baheti.
Entered string : Hello World! I am Shaurrya Baheti.
Changed String : Gfkkip Vpqkc! J bl Rgbvqqxb Abgfsj.
```

Program 4

Question)

A tourist company plans to organize tour to visit N major cities of India. WAP to accept minimum name of 4 cities and the starting location from the user. Now print the possible combinations to travel all those cities so that each city is to be routed only once.

Algorithm)

- Start
- Take required inputs
- Call the recursive function and give the parameters an empty array and the array with the cities without the selected city
- Base case of the recursive function prints the route number, selected city, the first array which initially was empty, and the second array if it is not empty, if the second array's size is less than or equal to 1.
- In the recursive case there is loop that loops over the cities array, takes a city and joins the left and right side of the array from the taken city, adds the taken city to the empty array and then calls itself again, with the parameters being the empty array + the taken city, and the left array + the right array.
- End

Code)

```
import java.util.*;

class Routes
{
    // Declaring class variables
    int n/* To store the number of cities */, rn/* To store the route number */;
    String cities[]/* To store the cities */, start/* To store the starting city */;

    // Default Constructor to initialize the class variables to default values;
    Routes()
    {
```



```

    n = 0;
    rn = 1;
    start = "";
}

```

// Function to validate and get the number of cities

```
void get_number(String s)
```

```
{
```

```
    Scanner sc=new Scanner(System.in);
```

```
    System.out.print(s);
```

```
    try
```

```
    {
```

```
        n = sc.nextInt();
```

```
        if(n < 4) // Validating input
```

```
        {
```

```
            System.out.println("At least 4 cities are required");
```

```
            get_number(s); // Calling the function again when user
```

```
entered an invalid input
```

```
        }
```

```
    }
```

```
    catch(Exception e) // Handling error when user enters something other
than an integer
```

```
    {
```

```
        System.out.println("\nPlease enter an integer only");
```

```
        get_number(s); // Calling the function again when user entered an
```

```
invalid input
```

```
    }
```

```
    cities = new String[n]; // Initializing the cities array
```

```
}
```

```

// Function to validate and get the names of cities from the user
void get_cities(String str)
{
    // Taking input
    Scanner sc=new Scanner(System.in);
    System.out.println(str);
    String s = sc.nextLine();
    s = s.trim(); // Trimming extra spaces
    int l = s.length();
    String ns=""; // temporary variable
    int a = 0, e = 0;
    for(int i = 0; i < l; i++)
    {
        char ch = s.charAt(i);
        if(ch==',' || ch==';')
        {
            try
            {
                cities[a] = ns.trim(); // Placing the name of the city into
the cities

                if(ch==';')
                    break; // breaking from loop when semi colon
detected

                a++;
            }
            catch(ArrayIndexOutOfBoundsException ex) // catching
error when user enters more cities

            {
                System.out.println("Please only enter as many cities
as you specified");

```

```

        e = 1;
        break;
    }
    ns = "";
}
else if(a<n && i==l-1) // Checking if the user entered a smaller
number of cities
{
    System.out.println("Please enter as many cities as you
specified");

    e = 1;
    break;
}
else
{
    if(i == l-1) // Checking if the user ended the list with a semi
colon or not
    {
        System.out.println("Please make sure you placed a
semi-colon(;) at the end");

        e = 1;
        break;
    }

    else
        ns = ns + ch;
}
}

if(cities[n-1]==null && e==0) // Final checking if the user entered a
smaller number of cities
{

```

```

        System.out.println("Please enter as many cities as you specified");
        get_cities(str);
    }
    else if(e!=0) // if there was any error
        get_cities(str); // calling the function again
    else
    {
        // Checking if the user entered the same city twice
        For:
        for(int i = 0; i < n; i++)
        {
            String city = cities[i];
            for(int j = i + 1; j < n; j++)
                if(city==cities[j])
                {
                    System.out.println("You entered one city two
times");
                    get_cities(str); // calling function when invalid
input found
                    break For;
                }
            }
        return;
    }
}

// Function to get the name of the starting city
void get_starting_city()
{
    // Taking input

```

```

Scanner sc=new Scanner(System.in);
System.out.print("Enter the city you want to start with : ");
start = sc.nextLine().trim(); // trimming extra spaces
//Checking if the name of the city exists in the list entered
boolean found = false; // setting found as false
int i = 0; // LCV
while(i < n)
{
    if(found==true)
        break; // breaking if already found
    if(cities[i].equals(start))
        found=true; // setting found as true if found
    i++;
}
if(found)
{
    // if found, removing the city from the array to make things easy
    String newarr[]=new String[n-1]; // initialising a temporary array
    with size 1 less than the original array
    int a = 0;
    for(int j = 0; j < n; j++)
    {
        if(j==i-1)
            continue; // continuing if the city is the starting city
        else
        {
            newarr[a] = cities[j];
            a++;
        }
    }
}

```



```

        String p[]=new String[s1.length + x.length]; // Temporary
array to store the elements of s1 and x arrays respectively
        for(int j = 0; j < p.length; j++) // Filling the array p
            if(j < s1.length)
                p[j] = s1[j];
            else
                p[j] = x[j-s1.length];

        String q[]=new String[y.length + z.length]; // Temporary
array to store the elements of y and z arrays respectively
        for(int j = 0; j < q.length; j++) // Filling the array q
            if(j < y.length)
                q[j] = y[j];
            else
                q[j] = z[j-y.length];
        display(p, q); // Calling the function with p and q as the
parameters
    }
}
}

// Function that calls the display function because display function is
recursive
void displayRoutes()
{
    System.out.println("Possible routes are :-");
    String x[]=new String[0]; // initialising a null array
    display(x, cities); // calling the display function with null array and cities
array respectively
}

// Main method to create object and call the required functions

```



```

public static void main(String[] args)
{
    Routes rts=new Routes();
    rts.get_number("Enter the number of cities you want to travel to : ");
    rts.get_cities("Enter the names of the cities SEPERATED BY COMMAS(,)
and END THE LIST BY A SEMICOLON(;)"");
    rts.get_starting_city();
    rts.displayRoutes();
}
}

```

Variable Description Table)

No.	Data Type/Return Type	Variable/Method	Description
1	int	n	To store the number of cities
2	int	rn	To store the route number
3	String[]	cities	To store the cities
4	String	start	To store the starting city
5	-	Routes()	Default Constructor
6	void	get_number(String)	to validate and get the number of cities
7	void	get_cities(String)	to validate and get the names of cities from the user
8	void	get_starting_city()	to get the name of the starting city
9	void	display(String[], String[])	to display the possible routes
10	void	displayRoutes()	To call the display function because display function is recursive
11	void	main()	to create object and call the required functions

Output)

```
Enter the number of cities you want to travel to : 4
Enter the names of the cities SEPERATED BY COMMAS(,) and END THE LIST BY A SEMICOLON(;)
New Delhi, Kolkata, Mumbai, Chennai;
Enter the city you want to start with : Kolkata
Possible routes are :-
Route 1: Kolkata => New Delhi => Mumbai => Chennai
Route 2: Kolkata => New Delhi => Chennai => Mumbai
Route 3: Kolkata => Mumbai => New Delhi => Chennai
Route 4: Kolkata => Mumbai => Chennai => New Delhi
Route 5: Kolkata => Chennai => New Delhi => Mumbai
Route 6: Kolkata => Chennai => Mumbai => New Delhi
```

Program 5

Question)

Anagram of a word is all the possible combination of alphabets present in that particular word. Write a program in Java to accept one single word of any length from the user and print the anagrams of that word. The program should check that the word should consist of alphabets and can be of any length. Also print the total number of words displayed.

Algorithm)

- Start
- Take necessary inputs
- Call the recursive function and give the parameters an empty String and the word
- Base case of the recursive function, first checks if the formed anagram was already printed before if yes it just returns, if no it prints the first string which initially was empty, and the second string if it is not empty, and adds the printed anagram to the anagram collection for future use. If the second string's length is less than or equal to 1, base case is fulfilled.
- In the recursive case there is loop that loops over the word, takes a character and joins the left and right side of the word from that character, adds the character to the empty string position parameter, and then calls itself again, with the parameters being the empty string position parameter + the character, and the left + the right of that word from the character.
- After the complete recursion is over print the number of anagrams formed
- End

Code)

```
import java.util.*;
```

```
class Anagram
```

```
{
    // Declaring class variables
    String word; // To store the word entered by user
    int count; // To store the number of anagrams generated
    String anag[]; // To store the anagrams generated
```

```

// Default constructor to initialise class variables to default values
Anagram()
{
    count = 0;
    word = "";
    anag = new String[0];
}

// Function to take input
void input()
{
    // Taking input for the word with whose letters we need to print the
anagrams
    Scanner sc = new Scanner(System.in);
    System.out.print("Enter a word : ");
    word = sc.next();
}

// Function to display the possible anagrams recursively
void display(String s1, String s2)
{
    if (s2.length() <= 1)
    {
        // Checking if the anagram generated is already printed or not
        String newanag = (s1 + s2).toUpperCase();
        boolean found = false; // Initialising found to false to denote not
found
        for(int i = 0; i < anag.length; i++)
        {

```

```

    if(anag[i].equalsIgnoreCase(newanag)) // Checking if found
    {
        found = true; // Changing the found to true
        break; // Breaking out of loop if found
    }
}
if(found==false) // When not printed already
{
    count++; // Increase the count of the anagrams by 1
    System.out.println(newanag); // Print the anagram

    // Add the new anagram to the previous list
    String temp[]=new String[anag.length]; // Initialising a
temporary array
    for(int i = 0; i < temp.length; i++)
        temp[i] = anag[i]; // Filling the temporary array
    anag=new String[temp.length + 1]; // Re-initialising the
original array
    anag[0] = newanag; // Adding the anagram just printed
    for(int i = 1; i < anag.length; i++)
    {
        anag[i]=temp[i-1]; // Re-filling the original array using
the temporary array
    }
}
else
{
    // Loop to generate anagrams
    for (int i = 0; i < s2.length(); i++)

```

```

        {
            String x = s2.substring(i, i + 1); // Getting the i th character as
a String
            String y = s2.substring(0, i);
            String z = s2.substring(i + 1);
            display(s1 + x, y + z); // Calling the function again with
changed parameters
        }
    }
}

// Function to display whatever is required
void display()
{
    System.out.println("The Anagrams of the word "+ word +" are : ");
    display("", word);
    System.out.println("Total Number of Anagrams = " + count);
}

// Main method to declare object and call required functions
public static void main(String args[])
{
    Anagram ang = new Anagram();
    ang.input();
    ang.display();
}
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
-----	---------------------	-----------------	-------------

1	String	word	To store the word entered by user
2	int	count	To store the number of anagrams generated
3	String[]	anag	To store the anagrams generated
4	-	Anagram()	Default constructor
5	void	input()	to take input
6	void	display(String, String)	to display the possible anagrams recursively
7	void	display()	to display whatever is required
8	void	main(String[])	to declare object and call required functions

Output)

```

Enter a word : WORD
The Anagrams of the word WORD are :
WORD
WODR
WROD
WRDO
WDOR
WDRO
OWRD
OWDR
ORWD
ORDW
ODWR
ODRW
RWOD
RWDO
ROWD
RODW
RDWO
RDOW
DWOR
DWRO
DOWR
DORW
DRWO
DROW
Total Number of Anagrams = 24

```

Program 6

Question)

A prime number is a number that is divisible by 1 and that number. Twin prime numbers are the pair of 2 prime numbers whose difference is 2, e.g. (3,5), (5,7), (11,13) etc. The sum of reciprocals of the twin primes converges to a sum, known as Brun's Constant. Declare a class named "Primes" with one data member double sum, and three member functions, int primeCheck(int, int), double sumTwinPrime(int) and void BrunConstant (int). WAP to declare the above class with its member functions. Use recursive technique in primeCheck() function. Write the main method also.

Algorithm)

- Start
- Take necessary inputs
- Check for prime in the recursive function
- Add the twin primes in another function
- Run a loop from 1 to the number user enters, increment only if there was something added to the sum.
- Check for primes from 3, find twin prime and pass the first number in the twin prime pair to the sumTwinPrime function which will give the sum of the twin primes, add that sum to the sum of the previous twin primes.
- Once the loop is over, display the sum as Brun's Constant.
- End

Code)

```
import java.util.*;

class Primes
{
    // Declaring class variables
    double sum;// To store the Brun constant

    // Function to check if the number is prime or not
    int primeCheck(int n, int i)
    {
```



```

// Base cases
if(n==3)
    return n;
if(n % i==0)
    return 0;
if(i>=(int)Math.sqrt(n))
    return n;

// Recursive case
return primeCheck(n, i+1);
}

// Function to calculate the sum to the reciprocal of twin primes
double sumTwinPrime(int n)
{
    return (1.0/n) + (1.0/(n+2));
}

// Function to calculate the Brun's constant
void BrunConstant(int n)
{
    sum = 0.0;// Sum at the start
    int a = 1;// Term number
    int p = 3;// Number to check

    // Calculating the constant
    while(a <= n)
    {
        if(primeCheck(p, 2)==p && primeCheck(p+2, 2)==p+2)

```

```

        {
            a++;
            sum += sumTwinPrime(p);
        }
        p++;
    }
}

```

// Main method to create object and call functions accordingly

```

public static void main(String[] args)
{
    Primes prm=new Primes();// Creating object

    // Taking input and calling functions
    Scanner sc=new Scanner(System.in);
    System.out.print("Enter the number of terms : ");
    int n = 0;
    try
    {
        n = sc.nextInt();
        // Validating the input
        if(n<=0)
        {
            System.out.println("Number of terms should be more than 0");
            main(args);// Calling function again if invalid input detected
            return;
        }
    }
    else
    {

```

```

        prm.BrunConstant(n);
        System.out.println("The Brun's Constant for " + n + " is " +
prm.sum);
    }
}
catch(Exception e)// Input mismatch
{
    System.out.println("Enter an integer only please");
    main(args);// Calling function again if invalid input detected
    return;
}
}
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	double	sum	To store the Brun constant
2	int	primeCheck(int, int)	to check if the number is prime or not
3	double	sumTwinPrime(int)	to calculate the sum to the reciprocal of twin primes
4	void	BrunConstant(int n)	to calculate the Brun's constant
5	void	main(String[])	to create object and call functions accordingly

Output)

```

Enter the number of terms : 100
The Brun's Constant for 100 is 1.582726249444065

```

Program 7

Question)

Write a program to perform the following task: Input a number, say mak. Now create a number, say tip, by arranging the digits of the number in ascending order. Create another number, say tap, by arranging the arranging digits of the number in descending order. List all the Perfect Squares that lie in between tip and tap. [A perfect square is a number that has an integer square root.]

Algorithm)

- Start
- Take necessary inputs
- Use a recursive function to make tap
- Reverse Tap to get Tip
- Run a loop from tip up to Tap
- Check every number in between for perfect square
- If perfect square then print it
- End

Code)

```
import java.util.*;

class TipTap
{
    // Declaring class variables
    int tip/* stores the lower bound */, tap/* stores the upper bound */, mak/*
Stores the number user enters */;

    // Default constructor
    TipTap()
    {
        // Initialising class variables to default values
        tip = 0;
        tap = 0;
```

```

        mak = 0;
    }

// Function that takes input
void input()
{
    try
    {
        // Taking input
        Scanner sc=new Scanner(System.in);
        System.out.print("Enter the number : ");
        mak = sc.nextInt();// Getting mak
    }
    catch(Exception e)// Input mismatch
    {
        System.out.println("Please enter an integer only");
        input();// Calling function again
    }
}

// Function that removes a digit i from a number n
int rmDigit(int n, int i)
{
    int a = 0;// Stores the position of the number
    for(int j=n, k=1; j>0; j/=10, k++)
    {
        if(j%10==i)
        {
            a = k;// Storing the position of i

```

```

        break;
    }
}

if(a==1)
    return n/10;// if i is the first digit from right returning n/10
else// else
{
    int p = 1;
    for(int j = 0; j < a; j++)
        p *= 10;// Place value of i
    return (n/p)*(p/10) + (n%(p/10));// Removing i from the number and
returning the new number
}

}

// Sorting a number in descending order
int desc(int n)
{
    if(n<10)
        return n;// Returning the number if the number is only 1 digit

    int min = 9;// To store the smallest digit in n, initially the highest
possible digit
    for(int i=n; i>0; i/=10)
    {
        if(i%10 <= min)
            min=i%10;// storing the smallest digit in n
    }
}

```

```

        n = rmDigit(n, min); // Removing the min from the number
        return desc(n)*10 + min; // Recursively returning the number in
descending order
    }

    // Reversing a number
    int reverse(int n)
    {
        if(n < 10)
            return n; // Returning the number if the number is only 1 digit

        int c = 0; // Number of digits in the number
        for(int i = n; i > 0; i/=10)
            c++;

        int p = 1; // Highest place value of the number
        for(int i = 1; i < c; i++)
            p*=10;

        return (n%10)*p + reverse(n/10); // Recursively returning the reverse of
the number
    }

    // Function to check if a number is a perfect square
    boolean perfectSqr(int n)
    {
        double sqrt = Math.sqrt(n); // Square root with decimal
        if(sqrt == Math.floor(sqrt)) // Checking if there is nothing after the
decimal

            return true; // If yes then it is perfect square
    }

```

```

        else
            return false;// else it is not a perfect square
    }

// Function to display the required things
void display()
{
    tap = desc(mak);// Getting tap
    tip = reverse(tap);// Getting tip

    // For better styling
    String tp = Integer.toString(tip);
    String tP = Integer.toString(tap);
    while(tp.length()!=tP.length())
        tp = "0" + tp;
    // Printing tip and tap
    System.out.println("New Number 1 : " + tp);
    System.out.println("New Number 2 : " + tP);
    // Printing the desired list
    System.out.println("The desired list is -");
    for(int i = tip; i <= tap; i++)
    {
        if(perfectSqr(i))
            System.out.print(i + " ");// Printing a number if it is a perfect
square
    }
    System.out.println();// Changing the line
}

// Main method to create objects and call functions accordingly

```



```

public static void main(String[] args)
{
    TipTap tPt=new TipTap();// Creating object
    // Calling functions accordingly
    tPt.input();
    tPt.display();
}
}

```

Variable Description Table)

No.	Data Type/Return Type	Variable/Method	Description
1	int	tip	stores the lower bound
2	int	tap	stores the upper bound
3	int	mak	Stores the number user enters
4	-	TipTap()	Default Constructor
5	void	input()	To take input
6	int	rmDigit(int, int)	To remove a digit from a number
7	int	desc(int)	To sort a number's digits in descending order
8	int	reverse(int)	To reverse the digits of a number
9	boolean	perfectSqr(int)	To check if a number is a perfect square
10	void	display()	To display the required things
11	void	main(String[])	To create object and call functions accordingly

Output)

```
Enter the number : 457
New Number 1 : 457
New Number 2 : 754
The desired list is -
484 529 576 625 676 729
```

Program 8

Question)

Given the following series

$$S = m! / p^m + (m-1)! / p^{m-1} + (m-2)! / p^{m-2} + \dots + (m-m)! / p^{m-m}$$

A class called clSomeSeries has been defined to calculate the sum of the series. Some of the function/ methods in clSomeSeries are shown below:

Class name: clSomeSeries

Data members:

- int m
- int p
- double sum

Member functions/methods:

- clSomeSeries(): Constructor
- int fnFact(int num): Calculates and returns the factorial of num
- long fnPower(int a, int p): Calculates and returns the value of a^p , without using header file <math.h>
- void fnCalculate(void): Calculates the sum of the given series in “sum” using other member functions
- void fnInput(void): Inputs the value of m, p.
- void fnPrint(void): Shows the sum of the series.

Specify the class clSomeSeries, giving details of constructor() and mentioned functions. Write the main method also.

Algorithm)

- Start
- Take necessary inputs
- create recursive factorial function
- create recursive power function
- set sum initially to 1.0
- start loop from 1 up to m
- change sum to factorial of i divided by (ith power of p + previous value of sum)
- When the loop ends display the required things
- End

Code)

```
import java.util.*;

class clSomeSeries
{
    // Declaring class variables
    int m/* Storing the value of m */, p/* Storing the value of p */;
    double sum;// storing the sum of the series

    // Default constructor
    clSomeSeries()
    {
        // Initialising class variables to default values
        m = p = 0;
        sum = 0.0;
    }

    // Function that returns the factorial of a number num
    int fnFact(int num)
    {
        if(num == 1 || num == 0)// base case
            return 1;

        return num * fnFact(num-1);// recursive case
    }

    // Function that returns the a to the power p
    long fnPower(int a, int p)
    {
        if(p==0 || a==1)// base case
```

```

        return 1;

    return a * fnPower(a, p-1); // recursive case
}

// function that calculates the sum of the series
void fnCalculate()
{
    sum = 1.0;
    for(int i = 1; i <= m; i++)
    {
        sum = (double)fnFact(i)/(double)((fnPower(p, i) + sum);
    }
}

// Function that takes input
void fnInput()
{
    // Taking input
    Scanner sc=new Scanner(System.in);
    while(true)// While loop used to valid input or else continue taking input
    {
        System.out.print("Enter the value of m : ");
        try
        {
            m = sc.nextInt();
            if(m > 0)// Checking if the input is valid
                break;
            else// Else continuing with an error message

```

```

        System.out.println("m cannot be less than 1");
    }
    catch(Exception e)// Checking if the input was mismatched
    {
        System.out.println("Please enter an integer only");
    }
}
while(true)// While loop used to valid input or else continue taking input
{
    System.out.print("Enter the value of p : ");
    try
    {
        p = sc.nextInt();
        if(p > 0)// Checking if the input is valid
            break;
        else// Else continuing with an error message
            System.out.println("p cannot be less than 1");
    }
    catch(Exception e)// Checking if the input was mismatched
    {
        System.out.println("Please enter an integer only");
    }
}

// Function to print the sum of the series
void fnPrint()
{
    System.out.println("The sum of the series for which m = " + m + " and p
= " + p + " is : " + sum);// Printing sum

```

```

    }

    // Main method to create objects and call the functions accordingly
    public static void main(String[] args)
    {
        clSomeSeries css=new clSomeSeries();// Creating object

        // Calling functions accordingly
        css.fnInput();
        css.fnCalculate();
        css.fnPrint();
    }
}

```

Variable Description Table)

No.	Data Type/Return Type	Variable/Method	Description
1	int	m	To store the value of m as entered by the user
2	int	p	To store the value of p as entered by the user
3	-	clSomeSeries()	Constructor
4	int	fnFact(int)	To calculate the factorial of a number
5	long	fnPower(int, int)	To calculate a power of a number
6	void	fnCalculate()	Uses other functions to calculate the sum of the series
7	void	fnInput()	To take input
8	void	fnPrint()	To display the required things
9	void	main(String[])	To create object and call functions accordingly

Output)

```
Enter the value of m : 5  
Enter the value of p : 5  
The sum of the series for which m = 5 and p = 5 is : 0.03839952818281023
```


Program 9

Question)

Write a program to generate a 3X3 magic square i.e., a square in which the sum of all the numbers in each row, in each column. Now display the sum along with the array elements as a single unit.

Finally perform :

- (i) Row-wise sorting in ascending order
- (ii) Column-wise sorting in descending order

Algorithm)

- Start
- Run a loop from 1 to 9
- place 1 at the middle of the first row
- now decrement the row and column by 1
- if the row becomes -1 shift to the last row and if the column becomes -1 shift to the last column
- try to place the next value in the loop at the new position
- if the position is occupied already, go to the previous column and drop down 1 row and place the loop value there
- continue the same logic until you reach 9
- after the loop ends, print the array
- sort the array row-wise in ascending order and print it
- then sort the array in column-wise descending and print it
- End

Code)

```
import java.util.*;
```

```
class MagicSqr
```

```
{
```

```
    // Declaring class variables
```

```
    int[][] msqr;// Array to store the magic square
```

```
    int n/* int to store the number of rows */, sum/* int to store the sum of each row or column */;
```

```

// Default constructor
MagicSqr()
{
    // Initialising class variable to appropriate values
    n = 3;
    msqr=new int[3][3];
    for(int i = 0; i < n; i++)
        for(int j = 0; j < n; j++)
            msqr[i][j] = 0;
}

// Function to fill the magic square
void generate()
{
    int number = 1;// stores the current number to be placed in the magic
square
    int row = 0;// stores the row position at which number was stored
    int column = n / 2;// stores the column position at which number was stored
    int curr_row;// stores current row position
    int curr_col;// stores current column position
    while (number <= n * n)// loop to fill the magic square
    {
        msqr[row][column] = number;// placing number at row X column
        number++;// incrementing number
        curr_row = row;// updating current row position
        curr_col = column;// updating current column position
        row -= 1;// decrementing row position
        column += 1;// incrementing column position

        // Taking care of out of bounds

```

```

    if (row == -1)
        row = n - 1;
    if (column == n)
        column = 0;

    // if next position is filled shifting to next row
    if (msqr[row][column] != 0)
    {
        row = curr_row + 1;
        column = curr_col;

        // Taking care of out of bounds
        if (row == -1)
            row = n - 1;
    }
}

// function to get the sum of a row or column
void findSum()
{
    sum = msqr[0][0] + msqr[0][1] + msqr[0][2];
}

// function to sort an array
int[] sort(int arr[], char c)
{
    switch(c)
    {

```

```
case 'a':// Sorting in ascending order using selection sort
for(int i = 0; i < arr.length; i++)
{
    int min = i;
    for(int j = i + 1; j < arr.length; j++)
    {
        if(arr[j] < arr[min])
            min = j;
    }
    int temp = arr[min];
    arr[min] = arr[i];
    arr[i] = temp;
}
break;
case 'd':// Sorting in descending order using selection sort
for(int i = 0; i < arr.length; i++)
{
    int max = i;
    for(int j = i + 1; j < arr.length; j++)
    {
        if(arr[j] > arr[max])
            max = j;
    }
    int temp = arr[max];
    arr[max] = arr[i];
    arr[i] = temp;
}
break;
}
```

```

        return arr;// returning the sorted array
    }

// Function to print arrays after sorting
void sortPrint()
{
    System.out.println("\nRow wise sorted array : \n");
    // Row wise sorting
    int sorted[][] = new int[3][3];
    for(int i = 0; i < 3; i++)
    {
        int temp[] = new int[3];
        for(int k = 0; k < 3; k++)
            temp[k] = msqr[i][k];
        temp = sort(temp, 'a');
        for(int k = 0; k < 3; k++)
            sorted[i][k] = temp[k];
    }
    displayArr(sorted);// printing sorted array

    System.out.println("\nColumn wise sorted array : \n");
    // column wise sorting
    for(int i = 0; i < 3; i++)
    {
        int temp[] = new int[3];
        for(int k = 0; k < 3; k++)
            temp[k] = msqr[k][i];
        temp = sort(temp, 'd');
        for(int k = 0; k < 3; k++)

```

```

        sorted[k][i] = temp[k];
    }
    displayArr(sorted);// printing sorted array
}

```

// Function to print an array

```

void displayArr(int[][] arr)
{
    for(int i = 0; i < 3; i++)
    {
        for(int j = 0; j < 3; j++)
            System.out.print(arr[i][j] + "\t");
        System.out.println();
    }
}

```

// Display function

```

void display()
{
    findSum();// calling the findSum function
    System.out.println("The 3X3 Magic Square(row-wise sum is mentioned
at the end of each row"
                                + "\nand column-wise sum is mentioned at
the end of each column) : \n");
}

```

// Printing with sum of the rows and columns mentioned

```

for(int i = 0; i <= 3; i++)
{
    for(int j = 0; j <= 3; j++)
    {

```

```

        if(i==3 && j != 3)
            System.out.print("_\t");
        else if(j==3 && i != 3)
            System.out.print("|" + sum + "\t");
        else if(i==3 && j==3)
            continue;
        else
            System.out.print(msqr[i][j] + "\t");
    }
    System.out.println();
}

System.out.println(sum + "\t" + sum + "\t" + sum);

// Printing sorted arrays
sortPrint();
}

// Main method to create objects and call functions accordingly
public static void main(String[] args)
{
    MagicSqr msq=new MagicSqr();// Creating an object

    // Calling functions accordingly
    msq.generate();
    msq.display();
}
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
-----	---------------------	-----------------	-------------

1	int[][]	msqr	to store the magic square
2	int	n	to store the number of rows
3	int	sum	to store the sum of each row or column
4	-	MagicSqr()	Default Constructor
5	void	generate()	to fill the magic square
6	void	findSum()	to get the sum of a row or column
7	int[]	sort(int[], char)	to sort an array
8	void	sortPrint()	to print arrays after sorting
9	void	displayArr(int[][])	to print an array
10	void	display()	To display the required things
11	void	main(String[])	To create object and call functions accordingly

Output)

The 3X3 Magic Square(row-wise sum is mentioned at the end of each row and column-wise sum is mentioned at the end of each column) :

```

8      1      6      | 15
3      5      7      | 15
4      9      2      | 15
-----
15     15     15

```

Row wise sorted array :

```

1      6      8
3      5      7
2      4      9

```

Column wise sorted array :

```

8      9      7
4      5      6
3      1      2

```


Program 10

Question)

Write a program to implement the following: In a private detective department, the trainee detectives were given certain rules for making their passwords.

A password would be considered valid only if

- i. It had odd number of characters less than 10.
- ii. The characters would be alternate alphabets and digits.
- iii. The alphabets would be only between J and T (both inclusive)
- iv. No even digit could be present after character J or T

Algorithm)

- Start
- Take input and check for odd characters less than 10 immediately
- check if the alphabets and digits are repeating or alternate
- check if the alphabets lie beyond J and T or not
- check if any J or T in the password is followed by an odd digit or not
- If every condition is satisfied print the validation statement
- If any condition was found false call invalid function with respective message and do System.exit(1)
- End

Code)

```
import java.util.*;

class checkPass
{
    // Declaring class variables
    String pass;// String that stores the password
    int l;// Int that stores the length of the password

    // Default Constructor
    checkPass()
    {
```

```

        // Initialising class variables to default values
        pass = "";
        l = 0;
    }

    // Function that takes input
    void input()
    {
        // Taking input
        Scanner sc=new Scanner(System.in);
        System.out.print("Enter the password : ");
        pass = sc.nextLine();
        l = pass.length();
        // Checking input and calling invalid() function with appropriate
message        if(l>10 || l%2==0)
                invalid("There are even number of digits or the password is
longer than 10 characters");
    }

    // Function that checks if the alphabets and digits are alternate and also if 'J'
or 'T' are followed by an even digit
    void alternateCheck()
    {
        int what = 0;// Variable that checks alternate-ness
        char prev = '\0';// Variable that stores the previous character
        for(int i = 0; i < l; i++)
        {
            char c = pass.charAt(i);
            c = Character.toUpperCase(c);// Converting for ease of access

```

```

        if(c >= 'A' && c <= 'Z')// Checking if the character is alphabet
        {
            if(c < 'J' || c > 'T')// Checking if the characters beyond the
range of 'J' and 'T'
                invalid("There are alphabets outside the range of 'J' to
'T");
            else// else setting prev to that character
                prev = c;

            if(what != 1)// checking if previous character was a number
or alphabet
                what = 1;
            else// If alphabet, password invalid
                invalid("There are consecutive alphabets or
numbers");
        }
    else if(c >= '0' && c <= '9')// Checking if the character is number
    {
        if(prev == 'J' || prev == 'T')// Checking if prev was a 'J' or a 'T'
            if(!(c == '1' || c == '3' || c == '5' || c == '7' || c == '9'))//
checking if the 'J' or the 'T' was followed by an odd digit
                invalid("Alphabet " + prev + " is followed by an
even digit");
            else// else setting prev to c
                prev = c;

            if(what != 2)// Checking if previous character was an
alphabet
                what = 2;
            else// If number then, password invalid
                invalid("There are consecutive alphabets or
numbers");
    }
}

```

```

    }
    else// if character is neither a number nor an alphabet password
invalid
        inValid("There are characters other than alphabets or
numbers");
    }
}

// Function to print invalid with reason
void inValid(String s)
{
    System.out.println(s);
    System.exit(1);// Exiting program after printing the reason
}

// Main method to create object and call methods
public static void main(String[] args)
{
    checkPass chp=new checkPass();// Creating object

    // Calling functions accordingly
    chp.input();
    chp.alternateCheck();

    // Printing the password is valid
    System.out.println("The password is valid");
}
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
-----	---------------------	-----------------	-------------

1	String	pass	To store the password to be checked
2	int	l	To store the length of the password
3	-	checkPass()	Default Constructor
4	void	input()	To take input of the password
5	void	alternateCheck()	To check if the password is valid or not
6	void	invalid(String)	To print respective message for Invalid password if found
7	void	main(String[])	To create object and call functions accordingly

Output)

```
Enter the password : J7S4T5K
The password is valid
```

Program 11

Question)

In Bello Labs, a group of researchers were working on a string balancing project. Their team leader declared that a string would be called “Well Balanced String” if it satisfied the following conditions –

- i. No character other than alphabet 'a' , 'z' would be present in the string
- ii. against every character 'a', character 'z' would be present
- iii. a pair of 'a' and 'z' would be such that in totality, no 'z' appears without having a preceding 'a' for it.

Algorithm)

- Start
- Take necessary inputs
- Loop over the string
- check if there is any character other than a or z if yes return false
- count the number a and z
- if they are not equal, return false
- create a string array with each element being the character appended to the position and the number of that letter
- check with position if any number of a proceeds the same number of z or vice versa if yes return false
- If no return statement encountered return true
- print the necessary statement
- End

Code)

```
import java.util.*;
```

```
class StringBalance
```

```
{
```

```
    // Declaring class variables
```

```
    String s;// String to be checked
```

```
    int l;// Length of s
```

```
    // Default constructor
```

```
StringBalance()
{
    // Initialising class variable to default values
    s = "";
    l = 0;
}
```

// Function to take input

```
void input()
{
    // Taking input
    Scanner sc=new Scanner(System.in);
    System.out.print("Enter a string : ");
    s = sc.nextLine();

    l = s.length();// Storing length in l
}
```

// Function to check if the string is balanced or not

```
boolean isBalanced()
```

```
{
    String str = s.toUpperCase();// Converting the string to uppercase for
ease of use
    int cA = 0/* Number of a's in the string */, cZ = 0/* Number of z's in the
string */;

    // Loop to count the number of a's and z's
    for(int i=0; i<l; i++)
    {
        char c = str.charAt(i);
```

```

        if(c!='A' && c != 'Z')
            return false;// Returning false if anything other than a or z is
present

```

```

        if(c=='A')
            cA++;
        if(c=='Z')
            cZ++;
    }

```

```

    if(cA != cZ)
        return false;// Returning false if number of a's is not equal to
number of z's

```

```

    String st[]=new String[l];// Store the a's and z's with positions
    int ca=1/* Number of a */, cz=1/* number of z */;
    // Loop to fill st
    for(int i = 0, a = 0; i < l; i++, a++)
    {
        char c = str.charAt(i);
        if(c=='A')
        {
            st[a] = Integer.toString(i)/* Adding position of the character
*/ + c + Integer.toString(ca)/* Adding the number of a */;
            ca++;// Incrementing the number of a
        }
        else
        {
            st[a] = Integer.toString(i)/* Adding position of the character
*/ + c + Integer.toString(cz)/* Adding the number of z */;
            cz++;// Incrementing the number of z
        }
    }

```



```

    }
}
// Loop to check if all the nth a's precede the nth z's
for(int i = 0; i < l; i++)
{
    String x = st[i];
    for(int j = 0; j < l; j++)
    {
        String y = st[j];
        if(x.charAt(1)!=y.charAt(1) && x.charAt(2)==y.charAt(2))
        {
            if(x.charAt(1)=='A' && y.charAt(1)=='Z' &&
x.charAt(0)>y.charAt(0))
                return false;// Returning false if a comes after z
            if(x.charAt(1)=='Z' && y.charAt(1)=='A' &&
x.charAt(0)<y.charAt(0))
                return false;// Returning false if z comes before
a
        }
    }
}

return true;// If no previous return statements are called the string is
balanced
}

// Function to display the required things
void display()
{
    System.out.println("Entered String : " + s);// Printing input string
    // Printing if it is a well-balanced string or not

```

```

        if(isBalanced())
            System.out.println("It is a \"Well Balanced String\".");
        else
            System.out.println("It is NOT a \"Well Balanced String\".");
    }

    // Main method to create objects and call functions accordingly
    public static void main(String[] args)
    {
        StringBalance stb=new StringBalance();// Creating objects
        // Calling functions accordingly
        stb.input();
        stb.display();
    }
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	String	s	To store the entered string
2	int	l	To store the length of the entered string
3	-	StringBalance()	Default constructor
4	void	input()	To take input of the string
5	boolean	isBalanced()	To check if the string is balanced or not
6	void	display()	To display the required things
7	void	main(String[])	To create object and call functions accordingly

Output)

```
Enter a string : aaazzazz  
Entered String : aaazzazz  
It is a "Well Balanced String".
```

Program 12

Question)

Write a program to convert a roman number to decimal equivalent and vice-versa.

Algorithm)

- Start
- Take necessary inputs
- for roman to decimal
- convert a character to its decimal equivalent
- not check if the next characters decimal value is more than this value, if yes subtract this from the next value
- if no, then continue with adding this to the previous sum
- if all the characters are done converting and values are done adding return the sum
- The sum was the converted decimal, but we need to check if the entered roman was correct. to do so, we will convert this decimal to roman through our function
- if the roman user entered was same as our roman, the roman was correct and we will print it
- else print error and quit
- for decimal to roman
- check if the number is more than 3999, if yes print error message and quit
- else continue with conversion
- start a while loop until number is 0
- if the decimal is more than 1000 (number/1000) number of Ms and, update the number to number % 1000
- else if the number is more than 500 but less than 900, put a D and update the number to number % 500
- else if the number was more than 900, put CM, and update the number to number % 100
- else if the number is more than 100 but less than 400, put (number/100) number of Cs and update the number to number % 100
- else if the number was more than 400, put a CD, and update the number to number % 100
- else if the number is more than 50 but less than 90, put a L and update the number to number % 50
- else if the number was more than 90, put XC, and update the number to number % 10
- else if the number is more than 10 but less than 40, put (number/10) number of Xs and update the number to number % 10

- else if the number was more than 40, put a XL and update the number to number % 10
- else if the number is more than 5 but less than 9, put a V and update the number to number % 5
- else if the number was 9 put a IX and update the number to 0
- else if the number is more than 1 but less than 4, put (number) number of Is and update the number to 0
- else if the number was 4 put a IV and update the number to 0
- continue this until the number is 0 as stated in the while loop
- Once fully converted return the converted roman string, no checking is required
- display the required things
- End

Code)

```
import java.util.*;
```

```
class Roman
```

```
{
```

```
    // Declaring class variables
```

```
    int n;// Stores the decimal number
```

```
    String r;// Stores the roman number
```

```
    // Default constructor
```

```
    Roman()
```

```
{
```

```
    // Initialising class variables to default values
```

```
    n = 0;
```

```
    r = "";
```

```
}
```

```
    // Function that takes integer input from user
```

```
    int get_int(String s)
```

```
{
```

```

// Taking input
Scanner sc=new Scanner(System.in);
System.out.print(s);
try
{
    int x = sc.nextInt();
    return x;// Returning input integer
}
catch(Exception e)// Input mismatch
{
    System.out.println("Please enter an integer only");
    get_int(s);// calling function again
}
return 0;
}

// Function to take input
void input()
{
    // Taking input of choice
    Scanner sc=new Scanner(System.in);
    System.out.println("Choices :- \n\t1. Roman to Integer\n\t2. Integer to Roman");
    int choice = get_int("Enter choice : ");

    // Going forward according to choice
    switch(choice)
    {
        case 1:// Roman to decimal
            System.out.print("Enter a roman numeral : ");

```

```

r = sc.next();
display('r');
break;

```

```

case 2:// Decimal to roman

```

```

n = get_int("Enter an integer : ");

```

```

while(n <= 0)// Checking for valid input

```

```

{

```

```

    System.out.println("Integer to convert must be greater than ZERO");

```

```

    n = get_int("Enter a POSITIVE integer : ");

```

```

}

```

```

display('i');

```

```

break;

```

```

default:// Wrong choice

```

```

System.out.println("Wrong choice");

```

```

input();

```

```

break;

```

```

}

```

```

}

```

```

// Function that returns the decimal value of a roman literal

```

```

int value(char r)

```

```

{

```

```

    if (r == 'I')

```

```

        return 1;

```

```

    if (r == 'V')

```

```

        return 5;

```

```

    if (r == 'X')

```

```
        return 10;
    if (r == 'L')
        return 50;
    if (r == 'C')
        return 100;
    if (r == 'D')
        return 500;
    if (r == 'M')
        return 1000;
    return -1;
}
```

// Function to convert roman to decimal

```
int romanToDecimal(String str)
{
    int res = 0;// resulting decimal number

    // Converting
    for (int i = 0; i < str.length(); i++)
    {
        int s1 = value(str.charAt(i));

        if (i + 1 < str.length())
        {
            int s2 = value(str.charAt(i + 1));

            if (s1 >= s2)
            {
                res = res + s1;
            }
        }
    }
}
```



```

    }
    else
    {
        res = res + s2 - s1;
        i++;
    }
}
else
{
    res = res + s1;
}
}

```

```

    return res;// Returning the converted number
}

```

// Function to convert decimal to roman

String decimalToRoman(int n)

```

{
    String roman = ""; // Resulting roman number
    if(n >= 4000) // Validation
    {
        System.out.println("Numbers more than 3999 are not supported");
        System.exit(1);
        return "";
    }
}

```

// Converting

while(n > 0)

```
{
    if(n >= 1000)
    {
        for(int i = 0; i < n/1000; i++)
            roman = roman + "M";
        n = n%1000;
    }
    else if(n >= 500)
    {
        if(n < 900)
        {
            roman = roman + "D";
            n = n%500;
        }
        else
        {
            roman = roman + "CM";
            n = n%100;
        }
    }
    else if(n >= 100)
    {
        if(n < 400)
        {
            for(int i = 0; i < n/100; i++)
                roman = roman + "C";
            n = n%100;
        }
        else
```

```
{
    roman = roman + "CD";
    n = n%100;
}
}
else if(n >= 50)
{
    if(n < 90)
    {
        roman = roman + "L";
        n = n%50;
    }
    else
    {
        roman = roman + "XC";
        n = n%10;
    }
}
else if(n >= 10)
{
    if(n < 40)
    {
        for(int i = 0; i < n/10; i++)
            roman = roman + "X";
        n = n%10;
    }
    else
    {
        roman = roman + "XL";
```

```
        n = n%10;
    }
}
else if(n >= 5)
{
    if(n < 9)
    {
        roman = roman + "V";
        n = n%5;
    }
    else
    {
        roman = roman + "IX";
        n = 0;
    }
}
else
{
    if(n < 4)
    {
        for(int i = 0; i < n; i++)
            roman = roman + "I";
        n = 0;
    }
    else
    {
        roman = roman + "IV";
        n = 0;
    }
}
```

```

    }
}

return roman;// Returning converted number
}

// Function to display the required things
void display(char choice)
{
    // Going according to user choice
    switch(choice)
    {
        case 'r':// Roman to decimal
            int convt = romanToDecimal(r);// Temporary storage of the value for
validation
            if(convt == romanToDecimal(decimalToRoman(convt)))// Validating the
roman number entered
                System.out.println(r + " converted to integer is " + romanToDecimal(r));//
Printing if valid
            else// Else exiting with message
            {
                System.out.println("It is not a valid Roman number");
                System.exit(1);
            }
            break;

        case 'i':// Decimal to roman
            System.out.println(n + " converted to roman is " + decimalToRoman(n));// No
checking required
            break;
    }
}

```

```

    }

    // Main method to create objects and call functions accordingly
    public static void main(String args[])
    {
        Roman rmn = new Roman();// Creating object
        // Calling functions accordingly
        rmn.input();
    }
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	int	n	To store the decimal number
2	String	r	To store the roman number
3	-	Roman()	Default constructor
4	int	get_int(String)	To take an integer input from user
5	void	input()	To take necessary inputs from the user
6	int	value(char)	to return the decimal equivalent of a roman character
7	int	romanToDecimal(String)	To convert a roman number to equivalent decimal number
8	String	decimalToRoman(int)	To convert a decimal number to equivalent roman number
9	void	display(char)	To display the required things
10	void	main(String[])	To create objects and call the functions accordingly

Output)

```
Choices :-  
    1. Roman to Integer  
    2. Integer to Roman  
Enter choice : 1  
Enter a roman numeral : MMMDCCCLXXXVIII  
MMMDCCCLXXXVIII converted to integer is 3888
```

Program 13

Question)

Write a program to convert a decimal number (whole number/fractional number) into equivalent Binary, Octal and Hexadecimal number form in a menu driven logic.

Algorithm)

- Start
- Take necessary inputs
- Store the base to be converted to in a variable
- create an alphabet array for future use to make things easier
- if the number is negative make it positive but store the sign in another variable
- now take the integer part of the number entered
- start while loop until integer part is 0
- take mod of the integer part with the base that you stored, if mod < 10, concat it to the result from front
- if mod >= 10, concat the alphabet at the position mod - 10 of the array created before
- update the number to number / base
- after the loop is over, add the sign if any, check if the entered number had any decimal part if no return
- else take the fractional part and start converting that
- multiply the fractional part with the decimal to base that you stored, then take the integer part of the product
- if the integer part of the product is < 10, concat it to the result after decimal from back
- if the integer part is >= 10, concat the alphabet at the position integer part - 10 of the array created before
- continue the loop until the fractional part is 0 or the number of loops exceeds 10
- print the converted number
- End

Code)

```
import java.util.*;
```

```
class Number
```

```
{
```



```

// Declaring class variables
double d;// To store the original decimal number
char choice;// To store the base to convert in
String converted;// To store the converted number

// Default Constructor
Number()
{
    // Initialising the class variables to their default values
    d = 0.0;
    choice = '\0';
    converted = "";
}

// Function to take input of the decimal number
void inputNum()
{
    try
    {
        // Taking input
        Scanner sc=new Scanner(System.in);
        System.out.print("Enter a decimal number : ");
        d = sc.nextDouble();
    }
    catch(Exception e)// Catching input mismatch exception and other
exceptions
    {
        System.out.println("Enter a decimal NUMBER only");
        inputNum();// Calling the function again if any exception was
caught
    }
}

```

```

    }
}

// Function to take input of choice of base to convert to
void inputChoice()
{
    // Taking input
    Scanner sc=new Scanner(System.in);
    System.out.println("Choices :-\n\t1. Decimal to Binary\n\t2. Decimal to
Octal\n\t3. Decimal to Hexadecimal");
    System.out.print("Enter choice : ");
    try
    {
        int n = sc.nextInt();
        switch(n)
        {
            case 1:
                choice = 'B';
                break;
            case 2:
                choice = 'O';
                break;
            case 3:
                choice = 'H';
                break;
            default:// Default case for unavailable choice
                System.out.println("Enter a valid choice");
                inputChoice();// Calling the function again if there was a
wrong choice
                break;
        }
    }
}

```

```

        }
    }
    catch(Exception e)// Catching input mismatch exception and other
exceptions
    {
        System.out.println("Enter a valid choice");
        inputChoice();// Calling the function again if any exception was
caught
    }
}

// Function to return the integer part of any double number n
int get_int_part(double n)
{
    return (int)Math.floor(n);
}

// Function to convert the decimal number to desired base
void convert()
{
    // Taking absolute value and checking sign.
    char sign = '\0';
    if(d < 0)
    {
        sign = '-';
        d *= -1;
    }

    // Storing a few values necessary for the conversion
    int intPart = get_int_part(d);// The integer part of the entered number

```

```
int base = choice=='B'?2:choice=='O'?8:16;// Base of conversion
```

```
// Converting the integer part of the number
```

```
while(intPart > 0)
```

```
{
```

```
    int mod = intPart % base;
```

```
    if(mod<=9)
```

```
        converted = Integer.toString(mod) + converted;
```

```
    else
```

```
        converted = (char)((int)'A' + mod%10) + converted;
```

```
    intPart = intPart/base;
```

```
}
```

```
converted = sign + converted;// Adding the sign to the converted
```

number

```
if(d - intPart == 0.0)
```

```
    return;// Returning if the entered number was an integer
```

```
else
```

```
{
```

```
    double fractPart = d - Math.floor(d);// Fractional part of the given
```

number

```
    converted = converted + ".";// Adding the decimal point
```

```
    int f = 0;// Count of the number of decimal places
```

```
// Converting the fractional part up to 10 decimal places
```

```
while(f<10 && fractPart!=0.0)
```

```
{
```

```
    f++;
```

```
    fractPart *= base;
```

```
    int prod = get_int_part(fractPart);
```

```

        if(prod <= 9)
            converted += prod + "";
        else
            converted += (char)((int)'A' + (prod % 10)) + "";
        fractPart=fractPart-Math.floor(fractPart);
    }
}

```

// Function to display the original and converted number

```
void display()
```

```

{
    if(d - get_int_part(d) == 0)
        System.out.print(get_int_part(d));
    else
        System.out.print(d);
    System.out.println(" Converted to " +
(choice=='B'?"Binary":choice=='O'?"Octal":"Hexadecimal") + " is " + converted);
}

```

// Main method to create objects and call functions accordingly

```
public static void main(String[] args)
```

```

{
    Number nbr=new Number();// Creating object

    // Calling functions accordingly
    nbr.inputNum();
    nbr.inputChoice();
    nbr.convert();
    nbr.display();
}

```

```

    }
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	double	d	To store the original decimal number entered by user
2	char	choice	To store the choice of base entered by user
3	String	converted	To store the converted number
4	-	Number()	Default constructor
5	void	inputNum()	To take input of a number
6	void	inputChoice()	To take input of the choice of base
7	int	get_int_part(double)	To get the integer part of a decimal number
8	void	convert()	To convert the decimal number to desired base
9	void	display()	To display the required things
10	void	main(String[])	To create object and call functions accordingly

Output)

```

Enter a decimal number : 450.256
Choices :-
    1. Decimal to Binary
    2. Decimal to Octal
    3. Decimal to Hexadecimal
Enter choice : 3
450.256 Converted to Hexadecimal is 1C2.4189374BC6

```

Program 14

Question)

Given a time in numbers we can convert it into words. For example,

- 5 : 00 - five o' clock
- 5 : 10 - ten minutes past five
- 5 : 15 - quarter past five
- 5 : 30 - half past five
- 5 : 40 - twenty minutes to six
- 5 : 45 - quarter to six
- 5 : 47 - thirteen minutes to six

Write a program which first inputs two integers, the first between 1 and 12 (both inclusive) and second between 0 and 59 (both inclusive) and then prints out the time they represent, in words. Your program should follow the format of the examples above.

Algorithm)

- Start
- Take necessary inputs, and validate them and there
- For converting a number to words use switch case to use fall through and recursion to your advantage
- To convert the time to words, first convert the standard times, like half past some hour, some hour o' clock quarter past some-hour, quarter to some-hour
- For minutes less than 30, convert them as it is and print like some-minutes past some-hour
- for minutes more than 30, convert minutes - 30 to words and print like some-minutes to some-hour
- End

Code)

```
import java.util.*;
```

```
class Time
```

```
{
```

```
    // Declaring class variables
```

```
    int hh/* Store the hour */, mm/* Store the minute */;
```

```

// Default constructor
Time()
{
    // Initialising class variables to default values
    hh = 0;
    mm = 0;
}

// Function that takes integer input from user
int get_int(String s)
{
    try
    {
        // Taking input
        Scanner sc=new Scanner(System.in);
        System.out.print(s);
        int x = sc.nextInt();
        return x;// Returning the input
    }
    catch(Exception e)// Input mismatch
    {
        System.out.println("Please enter an integer only");
        get_int(s);// Calling the function again
    }
    return -1;// Return is required
}

// Function that takes input

```



```

void input()
{
    // Getting hour
    hh = get_int("Enter the hour : ");
    // Validating hour
    while(hh > 12 || hh < 1)
    {
        System.out.println("Hour should be between 1 to 12 both
inclusive");
        hh = get_int("Enter the hour : ");
    }
    // Getting minute
    mm = get_int("Enter the minute : ");
    // Validating minute
    while(mm > 59 || mm < 0)
    {
        System.out.println("Minute should be between 0 to 59 both
inclusive");
        mm = get_int("Enter the minute : ");
    }
}

// Function that converts a number to words
String convt(int i)
{
    switch(i)
    {
        case 1: return "one";
        case 2: return "two";
        case 3: return "three";
    }
}

```

```
        case 4: return "four";
        case 5: return "five";
        case 6: return "six";
        case 7: return "seven";
        case 8: return "eight";
        case 9: return "nine";
        case 10: return "ten";
        case 11: return "eleven";
        case 12: return "twelve";
        case 13: return "thirteen";
        case 14:
        case 16:
        case 17:
        case 18:
        case 19: return convt(i - 10) + "teen";
        case 20: return "twenty";
        case 21:
        case 22:
        case 23:
        case 24:
        case 25:
        case 26:
        case 27:
        case 28:
        case 29: return "twenty-" + convt(i - 20);
    }
    return ""; // Return is necessary
}
```

```

// Function to display the required things
void display()
{
    if(mm==0)// Exactly an hour
        System.out.println(convt(hh) + " o' clock");
    else if(mm==30)// Half of an hour
        System.out.println("half past " + convt(hh));
    else if(mm==15)// Quarter of an hour
        System.out.println("quarter past " + convt(hh));
    else if(mm < 30)// Less than half but not a quarter
        System.out.println(convt(mm) + " minutes past " + convt(hh));
    else if(mm==45)// 3 Quarter of an hour
    {
        if(hh+1 == 13)// If the increment exceeds 12
            System.out.println("quarter to " + convt(1));
        else
            System.out.println("quarter to " + convt(hh+1));
    }
    else// More than half but not 3 quarters
    {
        if(hh+1 == 13)// If the increment exceeds 12
            System.out.println(convt(60-mm) + " minutes to " + convt(1));
        else
            System.out.println(convt(60-mm) + " minutes to " +
convt(hh+1));
    }
}

// Main method to create objects and call functions accordingly
public static void main(String[] args)

```

```

{
    Time tme=new Time();// Creating object
    // Calling functions accordingly
    tme.input();
    tme.display();
}
}

```

Variable Description Table)

No.	DataType/Return Type	Variable/Method	Description
1	int	hh	To store the hour
2	int	mm	To store the minutes
3	-	Time()	Default constructor
4	int	get_int(String)	To get an integer input from user
5	void	input()	to take the required inputs
6	String	convt(int)	To convert a number to words
7	void	display()	To display the time in words
8	void	main(String[])	To create object and call functions accordingly

Output)

```

Enter the hour : 11
Enter the minute : 29
twenty-nine minutes past eleven

```

Program 15

Question)

A class Personal contains employee details and another class Retire calculates the employee's Provident Fund and Gratuity. The details of the two classes are given below:

Class name : Personal

Instance variables:

- Name : stores the employee's name
- Pan : stores the employee PAN
- basic_pay : stores the employee basic salary (in decimals)
- acc_no : stores the employee bank account number

Member methods:

- Personal(....) : parameterized constructor to assign value to data members
- void display() : to display the employee details

Class name : Retire

Instance variables:

- yrs : stores the employee years of service
- pf : stores the employee provident fund amount (in decimals)
- grat : stores the employee gratuity amount (in decimals)

Member methods:

- Retire(.....) : parameterized constructor to assign value to data members of both the classes.
- void provident() : calculates the PF as (2% of the basic pay) * years of service.
- void gratuity() : calculates the gratuity as 12 months' salary, if the years of service is ≥ 10 years else the gratuity amount is nil.
- void display() : Display the employee details along with the Provident Fund and gratuity amount.

Specify the class Personal giving details of the constructor and member functions void display(). Using the concept of inheritance, specify the class Retire giving details of constructor, and the member functions void provident(), void gratuity() and the void display()

Algorithm)

- Start

- Create Personal class using the class description given
- Create Retire class extending Personal class using the class description
- for gratuity use ternary operator to check and then calculate the gratuity
- for pf, calculate according to the formula given
- Take inputs in main method and create object, call functions
- Display the required things
- End

Code)

```
import java.util.*;

class Personal
{
    // Declaring class variables
    String Name/* To store name of the employee */, Pan/* To store the PAN
number of the employee */;
    long acc_no;// To store the account number of the employee
    double basic_pay;// To store the Basic salary of the employee

    // Parameterized constructor
    Personal(String n, String p, long a, double b)
    {
        // Initialising the class variables
        Name = n;
        Pan = p;
        acc_no = a;
        basic_pay = b;
    }

    // Function to display the details
    void display()
    {
        System.out.println("Employee Name          : " + Name);
```

```

        System.out.println("Employee PAN          : " + Pan);
        System.out.println("Employee Basic Salary    : " + basic_pay);
        System.out.println("Employee Bank Account Number : " + acc_no);
    }
}

class Retire extends Personal
{
    // Declaring class variables
    int yrs;// To store the years of service
    double pf/* To store the provident fund */, grat/* To store the gratuity */;

    // Parameterised constructor
    Retire(String name, String pan, long accNo, int years, double salary)
    {
        super(name, pan, accNo, salary);// Calling the constructor of the super
class

        // Initialising the class variables
        yrs = years;
        pf = 0.0;
        grat = 0.0;
    }

    // Function to calculate provident fund
    void provident()
    {
        pf = (0.02 * basic_pay) * yrs;
    }

    // Function to calculate gratuity

```

```

void gratuity()
{
    grat = yrs > 10 ? basic_pay * 12 : 0.0;
}

```

// Function to display the necessary things

```

void display()
{
    String x = "";
    for(int i = 0; i < Name.length(); i++)
        x += "-";
    System.out.println("-----" + x);
    super.display();// Calling the display function of the super class
    System.out.println("Provident Fund          : " + pf);
    System.out.println("Gratuity          : " + grat);
    System.out.println("-----" + x);
}

```

// Main method to take input, create object and call functions

```

public static void main(String[] args)
{
    /*
    The try-catch blocks are so that input mis-match can be handled
    and the while loops help int re-asking the user for input as long as he
    does not input a valid input
    */
    Scanner sc=new Scanner(System.in);
    System.out.print("Enter Employee Name          : ");
    String n = sc.nextLine();
    System.out.print("Enter Employee PAN number          : ");
}

```



```

String p = sc.nextLine();
double b = 0.0;
while(true)
{
    try
    {
        System.out.print("Enter Employee Basic Salary      : ");
        b = sc.nextDouble();
        if(b > 0)
            break;
        else
            System.out.println("Basic salary can't be negative");
    }
    catch(Exception e)
    {
        System.out.println("Please enter a number only");
    }
}
long a = 0;
while(true)
{
    try
    {
        System.out.print("Enter Employee Bank Account Number : ");

        a = sc.nextLong();
        if(a > 0)
            break;
        else

```

```

        System.out.println("Bank Account number should be a
positive number");
    }
    catch(Exception e)
    {
        System.out.println("Please enter a number only");
    }
}
int y = 0;
while(true)
{
    try
    {
        System.out.print("Enter Employee Years of Service  :");
        y = sc.nextInt();
        if(y > 0)
            break;
        else
            System.out.println("Number of years should be more
than Zero");
    }
    catch(Exception e)
    {
        System.out.println("Please enter an integer only");
    }
}
Retire rtr=new Retire(n, p, a, y, b);// Creating object

// Calling functions accordingly
rtr.provident();

```

```

        rtr.gratuity();
        rtr.display();
    }
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	String	Name	stores the employee's name
2	String	Pan	stores the employee PAN
3	long	acc_no	stores the employee bank account number
4	double	basic_pay	stores the employee basic salary (in decimals)
5	-	Personal(String, String, long, double)	parameterized constructor to assign value to data members
6	void	display()	to display the employee details

No.	DataType/ReturnType	Variable/Method	Description
1	int	yrs	stores the employee years of service
2	double	pf	stores the employee provident fund amount (in decimals)
3	double	grat	stores the employee gratuity amount (in decimals)
4	-	Retire(String, String, long, int, double)	parameterized constructor to assign value to data members of both the classes.
5	void	provident()	calculates the PF as (2% of the basic pay) * years of service

6	void	gratuity()	calculates the gratuity as 12 months' salary, if the years of service is ³ 10 years else the gratuity amount is nil.
7	void	display()	Display the employee details along with the Provident Fund and gratuity
8	void	main(String[])	To take input, create object, and call the functions accordingly

Output)

```

Enter Employee Name           : Shaurrya Baheti
Enter Employee PAN number     : 123456789ABCD
Enter Employee Basic Salary   : 20000
Enter Employee Bank Account Number : 123456789087
Enter Employee Years Of Service : 17
-----
Employee Name                 : Shaurrya Baheti
Employee PAN                  : 123456789ABCD
Employee Basic Salary         : 20000.0
Employee Bank Account Number  : 123456789087
Provident Fund                : 6800.0
Gratuity                     : 240000.0
-----

```

Program 16

Question)

Design three classes: ClassTest, FinalExam and Result. The ClassTest class has data members representing marks of four-unit tests and member function to accept and display the data. The class FinalExam will inherit the class ClassTest has data member to hold the marks of Final Exam and member function to accept and display the data. Derive the Result class from the class FinalExam and add a data member to hold the marks of final exam. The class Result with a single data member total_marks and a member function to compute the total by adding 20% of total of the four-unit tests and 80% of the final exam marks and store it in its data member total_marks. It has also a function to display the total marks. In the main method, create an object of Result class and call the functions accordingly.

Algorithm)

- Start
- Create ClassTest class using the details provided
- Create the FinalExam class that inherits the ClassTest class and use the details given for the member functions and variables
- Create Result class that extends the FinalExam class
- Create methods and variables according to the given details
- For calculating the total marks, add all the UT marks and multiply it with 0.8 and the add 0.2 times the final term marks, then round the whole thing up
- Display the result
- End

Code)

```
class ClassTest
{
    // Declaring class variables
    double ut1, ut2, ut3, ut4; // Unit test marks

    // Constructor to initialise data members
    ClassTest(double a, double b, double c, double d)
    {
        // Storing UT marks
```

```

        ut1=a;
        ut2=b;
        ut3=c;
        ut4=d;
    }

    // Function to display the marks
    void disp()
    {
        // Printing the marks in tabular form
        System.out.println(" Test   \tMarks Obtained");
        System.out.println("Unit Test 1"+" \t    "+ut1);
        System.out.println("Unit Test 2"+" \t    "+ut2);
        System.out.println("Unit Test 3"+" \t    "+ut3);
        System.out.println("Unit Test 4"+" \t    "+ut4);
    }
}

class FinalExam extends ClassTest
{
    // Declaring class variables
    double ft;// Storing final term marks

    // Constructor to initialise data members
    FinalExam(double a, double b, double c, double d, double e)
    {
        super(a, b, c, d);// Calling constructor of ClassTest
        ft=e;// Storing the final term marks
    }
}

```

```

// Function to display the marks
void disp()
{
    super.disp();// Calling display of ClassTest
    System.out.println("Final Term"+"\\t    "+ft);// Printing Final Term marks
}
}

import java.util.*;

class Result extends FinalExam
{
    // Declaring class variables
    double total_marks;// To store total marks

    // constructor to initialise data members
    Result(double a, double b, double c, double d, double e)
    {
        super(a, b, c, d, e);// Calling the constructor of FinalExam
        total_marks = 0.0;
    }

    // Function to compute total marks
    void compute()
    {
        total_marks = Math.round(0.2*(ut1+ut2+ut3+ut4)+0.8*ft);// Storing total
marks
    }

    // Function to display all marks

```

```

void disp()
{
    super.disp();// Calling display function of FinalExam
    System.out.println("Total Marks"+"\\t    "+total_marks);// Displaying
total marks
}

// Main method to create object and call functions accordingly
public static void main(String[] args)
{
    Scanner sc = new Scanner(System.in);
    // Taking input of the marks
    System.out.println("Enter marks of unit test 1");
    double a = sc.nextDouble();
    System.out.println("Enter marks of unit test 2");
    double b = sc.nextDouble();
    System.out.println("Enter marks of unit test 3");
    double c = sc.nextDouble();
    System.out.println("Enter marks of unit test 4");
    double d = sc.nextDouble();
    System.out.println("Enter marks of final term");
    double e = sc.nextDouble();
    // Creating object
    Result obj=new Result(a, b, c, d, e);
    // Calling functions accordingly
    obj.compute();
    obj.disp();
}
}

```


Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	Double	ut1	To store marks of UT 1
2	Double	ut2	To store marks of UT 2
3	Double	ut3	To store marks of UT 3
4	Double	ut4	To store marks of UT 4
5	-	ClassTest	parameterized constructor to assign value to data members
6	Void	disp()	function to display the marks

No.	DataType/ReturnType	Variable/Method	Description
1	Double	Ft	To store marks th final term
2	-	FinalExam	parameterized constructor to assign value to data members
3	Void	disp()	function to display the marks

No.	DataType/ReturnType	Variable/Method	Description
1	Double	total_marks	To store total marks
2	-	FinalExam	parameterized constructor to assign value to data members
3	Void	disp()	function to display the marks
4	Void	compute()	To calculate total marks
5	Void	main(String[])	To create object and call functions

Output)

```

Enter marks of unit test 1
50
Enter marks of unit test 2
50
Enter marks of unit test 3
50
Enter marks of unit test 4
50
Enter marks of final term
100
    Test           Marks Obtained
Unit Test 1       50.0
Unit Test 2       50.0
Unit Test 3       50.0
Unit Test 4       50.0
Final Term        100.0
Total Marks       120.0

```

Program 17

Question)

In a computer game, a vertical column and a pile of rings are displayed. The objective of the game is to pile up rings on the column till it is full. It can hold 10 rings at the most. Once the column is full, the rings have to be removed from the top till the column is empty and then the game is over. Define the class RingGame with the following details:

Class name : RingGame

Data members/instance variables :-

- ring[] : array to hold rings (integer)
- MAX : integer to hold maximum capacity of ring array
- TOP : integer to point to the upper most element

Member functions :-

- RingGame(int m) : constructor to initialize, MAX = m & TOP to -1.
- void jumpin(int) : adds a ring to the top of the column, if possible, otherwise displays a message "Column full. Start removing rings".
- void jumpout() : removes the ring from the top, if column is not empty otherwise, outputs a message, "Congratulations. The game is Over".

Specify the class RingGame giving the details of the constructor and functions void jump-in(int) and void jump-out(). Also define the main function to create an object and call methods accordingly to enable the task.

Algorithm)

- Start
- For jump in, first check if maximum capacity is reached, if yes print message
- Else add a ring to the stack and print the pile with the stack and set TOP to the position of new ring
- For jump out, first check if the stack is already empty, if yes print message
- Else remove the top most ring, set TOP to the position of previous ring, and print the pile and stack
- When game ends System.exit(0);
- End

Code)

```
import java.util.*;
```

```

class RingGame
{
    // Declaring class variables
    int MAX;// To store the Maximum number of rings possible
    int[] ring;// To store the ring stack
    int TOP;// To store the top most ring

    // Constructor to initialise data members
    RingGame(int m)
    {
        MAX = m;
        ring = new int[m];
        TOP = -1;
    }

    // Function to place a ring if possible
    void jumpin(int n)
    {
        if (TOP == MAX - 1)// If no more rings possible
        {
            System.out.println("Column full ! Start removing rings.");
        }
        else// If ring adding is possible
        {
            ring[++TOP] = n;// Adding ring
            System.out.println("Ring added successfully.");
            // Displaying the rings and the stack
            System.out.println("\nR I N G\tG A M E");
            System.out.println("Stack\tPile");
        }
    }
}

```

```

        for(int i = 0; i < MAX; i++)
        {
            if(i < MAX - (TOP + 1))
                System.out.print("\t");
            else
                System.out.print("+\t");
            if(i < TOP + 1)
                System.out.println(" ");
            else
                System.out.println("-");
        }
    }
}

// Function to remove a ring
void jumpout()
{
    if (TOP == -1)// If no more rings left
    {
        System.out.println("Congratulations ! the game is over .");
        System.exit(0);
    }
    else
    {
        ring[TOP] = ring[TOP--]; // Last element removed
        System.out.println("Ring removed successfully");
        // Displaying the rings and the stack
        System.out.println("\nR I N G\tG A M E");
        System.out.println("Stack\tPile");
    }
}

```

```

        for(int i = 0; i < MAX; i++)
        {
            if(i < MAX - (TOP + 1))
                System.out.print("\t");
            else
                System.out.print("+\t");
            if(i < TOP + 1)
                System.out.println(" ");
            else
                System.out.println("-");
        }
    }
}

```

// Main method to create object and call the functions accordingly

```

public static void main (String[] args)
{
    RingGame obj = new RingGame(10); // Creating object
    System.out.println("\nR I N G\tG A M E");
    System.out.println("Stack\tPile");
    for(int i = 0; i < obj.MAX; i++)
    {
        System.out.println("\t-");
    }
    Scanner sc=new Scanner(System.in);
    // Calling functions accordingly
    for(int i = 1; i > 0; i++)
    {
        System.out.println("\nEnter :-\n\t1. Add Ring\n\t2. Remove ring");
    }
}

```

```

        System.out.print("Enter your choice : ");
        int c = sc.nextInt();
        if(c == 1)
            obj.jumpin(i);//To add rings.
        else if(c == 2)
            obj.jumpout();//To remove rings.
        else
            System.out.println("Wrong choice!");
    }
}
}

```

Variable Description Table)

No.	DataType/Return Type	Variable/Method	Description
1	int	MAX	To store the maximum number of rings
2	int[]	ring	To store the ring stack
3	int	TOP	To store the topmost ring
4	-	RingGame(int)	Constructor to initialise values
5	void	jumpin(int)	To add a ring to the stack
6	void	jumpout()	To remove a ring from the stack
7	void	main(String[])	To create object and call functions

Output)

The max was set to 3 for feasible output

```

R I N G G A M E
Stack  Pile
|      -
|      -
|      -

Enter :-
      1. Add Ring
      2. Remove ring
Enter your choice : 1
Ring added successfully.

R I N G G A M E
Stack  Pile
|      -
+      -

Enter :-
      1. Add Ring
      2. Remove ring
Enter your choice : 1
Ring added successfully.

R I N G G A M E
Stack  Pile
|      -
+      -
+      -

```

```

Enter :-
      1. Add Ring
      2. Remove ring
Enter your choice : 1
Ring added successfully.

R I N G G A M E
Stack  Pile
+
+
+

Enter :-
      1. Add Ring
      2. Remove ring
Enter your choice : 1
Column full ! Start removing rings.

Enter :-
      1. Add Ring
      2. Remove ring
Enter your choice : 1
Column full ! Start removing rings.

Enter :-
      1. Add Ring
      2. Remove ring
Enter your choice : 2
Ring removed successfully

R I N G G A M E
Stack  Pile
|      -
+      -
+      -

```

```

Enter :-
      1. Add Ring
      2. Remove ring
Enter your choice : 2
Ring removed successfully

R I N G G A M E
Stack  Pile
|      -
|      -
+      -

Enter :-
      1. Add Ring
      2. Remove ring
Enter your choice : 2
Ring removed successfully

R I N G G A M E
Stack  Pile
|      -
|      -
|      -

Enter :-
      1. Add Ring
      2. Remove ring
Enter your choice : 2
Congratulations ! the game is over .

```

Program 18

Question)

Declare a class named CircularQueue with following declaration:-

Class Name – CircularQueue

Data members:-

- double Q[] - an array to hold floating points.
- int N - the size of the array (max size 10)
- int front, rear - two pointers of the queue

Member methods:-

- CircularQueue (int n) - constructor to initialize size = n and front & rear with 0 and the array elements with default value.
- void enqueue(double nm) - to push one number to the array, if the queue is full display the message "OVERFLOW"
- double delqueue() - to extract one number from the array. If the queue is empty, display the message "UNDERFLOW"
- void display() - to display content of the array

Specify the above class with all the member methods. Write the main function to create an object and call the functions accordingly.

Algorithm)

- Start
- For enqueue, first check if the queue is full, if yes print message
- Else place the element at rear and then shift rear to (rear + 1) % N
- For delqueue, first check if the queue is empty, if yes print message
- Else remove the front element and change the front to (front + 1) % N
- For display, run loop from front to rear and print the elements of the queue
- Do this while the user doesn't want to end, when user ends then exit
- End

Code)

```
import java.util.*;
```

```
class CircularQueue
```

```
{
```

```
    // Declaring class variables
```



```
double Q[]; // Array to be used as a Queue
int N; // Size of the queue
int front, rear; // Pointer to front and rear
```

```
// Constructor to initialize data members
```

```
CircularQueue(int n)
```

```
{
    N = n;
    front = rear = 0;
    Q = new double[N];
    for(int i = 0; i < N; i++)
        Q[i] = 0.0;
}
```

```
// Function to enqueue if possible else print error message
```

```
void enqueue(double nm)
```

```
{
    // Checking if enqueue is possible
    if(((rear + 1) % N) == front)
    {
        System.out.println("OVERFLOW");
        return;
    }
    Q[rear] = nm;
    rear = (rear + 1) % N; // Rear here points to the next empty cell after
each entry
}
```

```
// Function to delqueue if possible else print error message
```

```
double delqueue()
```

```

{
    // Checking if delqueue is possible
    if(front == rear)//front and rear at same index position
    {
        System.out.println("UNDERFLOW");
        return -123456789.321;
    }
    double n = Q[front];
    front = (front + 1) % N;// Front here points to the next filled cell after
deleting an entry
    return n;// Returning the deleted entry
}

// Function to display the queue
void display()
{
    // Checking if the queue is empty
    if(rear == front)
    {
        System.out.println("Queue is Empty");
        return;
    }
    // If not empty printing the queue
    for(int i = front; i != rear; i = (i + 1) % N)
        System.out.print(Q[i]+" ");
    System.out.println();
}

// Main method to create object and call functions accordingly
public static void main(String[] args)

```

```

{
    // Scanner initialisation
    Scanner sc=new Scanner(System.in);
    int n = 0;// Temporarily store user input for size of array
    while(true)
    {
        // Using try-catch to get desired input
        try
        {
            System.out.print("Enter the size of the queue : ");
            n = sc.nextInt();
            // Size less than or equal to 0 is not allowed
            if(n <= 0)
                System.out.println("Please enter a number greater
than 0");
            else if(n >= 10)
                System.out.println("Please enter a number less than
11");
            else
                break;
        }
        catch(Exception e)
        {
            System.out.println("Please enter a size in integers");
        }
    }
    // Creating object
    CircularQueue cq=new CircularQueue(n+1);
    // Menu-driven logic for performing tasks on the queue

```

```

        String menu = "Choose: \n\t1. Enqueue\n\t2. Delqueue\n\t3.
Display\n\t4. End";
        while(true)
        {
            // Using try-catch to get desired input
            try
            {
                System.out.print(menu + "\nEnter choice : ");
                // Taking commands
                int choice = sc.nextInt();
                switch(choice)
                {
                    // Performing commands
                    case 1:// Enqueue
                        while(true)
                        {
                            System.out.print("\nEnter a number to enqueue :
");

                            // Using try-catch to get desired input
                            try
                            {
                                double d = sc.nextDouble();
                                cq.enqueue(d);
                                break;
                            }
                            catch(Exception e)
                            {
                                System.out.println("Please enter a decimal
number only");
                            }
                        }
                    }
                }
            }
        }
    }
}

```

```

    }
    break;
    case 2:// Delqueue
    double d = cq.delqueue();
    // Printing if delqueue-ing took place
    if(d!=-123456789.321)
        System.out.println(d);
    break;
    case 3:// Display
    cq.display();// Displaying
    break;
    case 4:// Exit
    System.exit(0);// Exiting
    default:
    System.out.println("Please enter a correct choice");
    }
}
catch(Exception e)
{
    System.out.println("The choice should be an integer");
}
}
}
}
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	double[]	Q[]	To store the circular queue
2	int	N	To store the maximum number of elements in the queue

3	int	front	To store the front pointer
4	int	rear	To store the rear pointer
5	-	CircularQueue(int)	Constructor to initialise values
6	void	enqueue(double)	To add element to the queue if possible
7	double	delqueue()	To remove element from the queue if possible
8	void	display()	To display the queue
9	void	main(String[])	To create object and call functions

Output)

```

Enter the size of the queue : 3
Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice : 1

Enter a number to enqueue : 12.34
Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice : 1

Enter a number to enqueue : 23.45
Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice : 1

Enter a number to enqueue : 34.56
Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice : 1

Enter a number to enqueue : 45.67
OVERFLOW

```

```

Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice : 3
12.34 23.45 34.56
Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice :
2
12.34
Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice : 2
23.45
Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice : 2
34.56

```

```

Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice : 2
UNDERFLOW
Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice : 3
Queue is Empty
Choose:
    1. Enqueue
    2. Delqueue
    3. Display
    4. End
Enter choice : 4

```

Program 19

Question)

Write a program to simulate conversion of numbers from Decimal number system to Binary/Octal/Hexadecimal equivalent and vice-versa as per the user's choice. The program should display the menu accordingly and ask the user for proper input. The program should have proper exception handling mechanism and validation checking.

Algorithm)

- Start
- Take required input, and check them
- For converting from decimal to a base say b, break the number to integer and fractional parts
- Then for integer part, to the final number concatenate integer part % b if it is a single digit else concatenate the hex equivalent of the mod then divide the integer part by b... continue till integer part becomes 0
- For fractional part, to the final number concatenate the integer part of fractional part * b, if it is single digit else concatenate hex equivalent character of the integer part of the product. Set fractional part to fractional part of the product, continue till fractional part is 0 or the limit of 10 decimal places is reached
- For converting a different base to decimal, break the number into fractional part and integer part
- Reverse the integer part then run loop on the integer part multiply each digit with the base to the power of position then add it to the final number
- Loop over the fractional part and multiply each digit to the negative power of the base to the position and add the result to the final number
- When a hex character is encountered use the equivalent numeric value for them
- Display the conversion results
- End

Code)

```
import java.util.*;
```

```
class NumConvert
```

```
{
```

```
    // Declaring class variables
```

```
int orgBase/* To store original number base */, convtBase/* To store
converted number base */;
```

```
String orgNum/* To store original number */, convtNum/* To store converted
number */;
```

```
char sign;// To store the sign of the number
```

```
// Default constructor to initialise class variables to default values
```

```
NumConvert()
```

```
{
```

```
    orgBase = convtBase = 0;
```

```
    orgNum = convtNum = "";
```

```
    sign = '\0';
```

```
}
```

```
// Function to take input of an integer with explicit error handling recursively
```

```
private int get_int(String s)
```

```
{
```

```
    Scanner sc=new Scanner(System.in);
```

```
    System.out.print(s);
```

```
    try
```

```
    {
```

```
        int i = sc.nextInt();
```

```
        return i;
```

```
    }
```

```
    catch(Exception e) // Catching error when user enters something other
than integer
```

```
    {
```

```
        System.out.println("Please enter an integer only");
```

```
        return get_int(s);
```

```
    }
```



```
}
```

```
// To verify the original number
```

```
private boolean verifyNumber()
```

```
{
```

```
    int countDecimal = 0;
```

```
    if(orgNum.length()==0)// If the user didn't enter any number
```

```
        return false;
```

```
    // Checking if there is a sign present, if yes then storing it in sign and  
    editing the original number
```

```
    if(orgNum.charAt(0)=='-')
```

```
    {
```

```
        sign = '-';
```

```
        orgNum = orgNum.substring(1, orgNum.length());
```

```
    }
```

```
    if(orgNum.charAt(0)=='+')
```

```
    {
```

```
        sign = '\0';
```

```
        orgNum = orgNum.substring(1, orgNum.length());
```

```
    }
```

```
    // Checking the number digit by digit
```

```
    for(int i = 0; i < orgNum.length(); i++)
```

```
    {
```

```
        char c = orgNum.charAt(i);
```

```
        if(c=='.')
```

```
            countDecimal++;// Counting the number of '.' in the number
```

```
        // If the number is not of the specified base
```

```
        else if(c >= '0' && c <= '9')
```

```

        {
            if(Character.getNumericValue(c) >= orgBase)
                return false;
        }
        else
        {
            if(orgBase != 16)
                return false;
            else if(!(c >= 'A' && c <= 'F'))
                return false;
        }
    }
    if(countDecimal>1)
        return false;// If number of '.' is more than 1
    // If no error was triggered
    return true;
}

```

// Function to take input

```
private void input()
```

```
{
```

```
    int choice = 0;// To temporarily store user choice
```

```
    While:
```

```
    while(true)
```

```
    {
```

```
        System.out.println("Choose the base of your number :-\n\t1. Binary\n\t2. Octal\n\t3. Decimal\n\t4. Hexa-Decimal");
```

```
        choice = get_int("Enter choice : ");// Getting input of choice of original base
```

```
        switch(choice)// Placing the value
```

```

        {
            case 1:orgBase = 2;break While;
            case 2:orgBase = 8;break While;
            case 3:orgBase = 10;break While;
            case 4:orgBase = 16;break While;
        }
        System.out.println("Please enter correct choice");
    }
    orgNum = "";
    System.out.println();
    while(true)
    {
        // Taking input of original number
        Scanner sc=new Scanner(System.in);
        System.out.print("Enter a number of base " + orgBase + ": ");
        orgNum = sc.nextLine();
        if(verifyNumber()==true)// Verifying the number
            break;
        System.out.println("Please enter a number of base " + orgBase);
    }
    System.out.println();
    While:
    while(true)
    {
        // Taking input of the base to convert the original number to
        System.out.println("Choose the base in which to convert your
number :-\n\t1. Binary\n\t2. Octal\n\t3. Decimal\n\t4. Hexa-Decimal");
        choice = get_int("Enter choice : ");
        switch(choice)// Placing the value
        {

```

```

        case 1:convtBase = 2;break While;
        case 2:convtBase = 8;break While;
        case 3:convtBase = 10;break While;
        case 4:convtBase = 16;break While;
    }
    System.out.println("Please enter correct choice");
}
}

// Function that returns the value of a Hex character
private int getHexCharValue(char a)
{
    char[] arr = new char[6];// Creating an array
    for(char i = 'A', j = '0'; i <= 'F' && j < '6'; i++, j++)
        arr[Character.getNumericValue(j)] = i;// Filling the array
    for(int i = 0; i < 6; i++)
        if(arr[i]==a)
            return i+10;// Returning the required value
    return 0;
}

// Function to generate Hex character from a value
private char getHexValueChar(int a)
{
    return (char)('A'+(a-10));// Returning the required Hex character
}

// Function to get a to the power p
private int power(int a, int p)

```

```

{
    if(p==0)// Base case
        return 1;// Anything to the power 0 is 1
    return a*power(a, p-1);// Returning a to the power p in recursive way
}

```

// Function to get a to the power -p

```
private double reversePower(int a, int p)
```

```

{
    return (double)1.0/power(a, p);// Returning a to the power -p
}

```

// Function to get the integer part from a double number

```
private int getIntPart(double a)
```

```

{
    return (int) Math.floor(a);// Returning the integer part
}

```

// Function to change a number n of base base to decimal

```
private double fromOtherToDecimal(int base, String n)
```

```

{
    double convtd = 0.0;// Temporarily store converted number
    String intPart = n/* To store integer part */, fractPart = "";// To store the
fraction part
    for(int i = 0; i < n.length(); i++)
    {
        // Separating the integer part and fractional part
        if(n.charAt(i)=='.')
        {
            intPart = n.substring(0, i);

```

```

        fractPart = n.substring(i, n.length());
        break;
    }
}

```

```

// Reversing the integer part
String temp = "";
for(int i = 0; i < intPart.length(); i++)
{
    temp = intPart.charAt(i) + temp;
}
intPart = temp;

```

```

// Converting the integer part to decimal
for(int i = 0; i < intPart.length(); i++)
{
    char c = intPart.charAt(i); // Getting a character at position i
    int p = power(base, i); // Raising the base to the power of the
position
    if(Character.isDigit(c))
        convtd += Character.getNumericValue(c)*p; // If it is a digit
then multiplying it with base to the power position
    else
        convtd += getHexCharValue(c)*p; // If it is an alphabet then
multiplying the Hex character value to the base powered to position
}

```

```

// Converting the fractional part
for(int i = 0; i < fractPart.length(); i++)
{

```

```

        if(i==0)
            continue;// Skipping the '.'
        char c = fractPart.charAt(i);// Getting a character at position i
        double p = reversePower(base, i);// Raising the base to the power
of the position
        if(Character.isDigit(c))
            convtd += Character.getNumericValue(c)*p;// If it is a digit
then multiplying it with base to the power position
        else
            convtd += getHexCharValue(c)*p;// If it is an alphabet then
multiplying the Hex character value to the base powered to position
    }
    return convtd;// Returning the decimal number
}

```

// Function to convert a Decimal Number n to base base

private String fromDecimalToOther(int base, double n)

```

{
    String convtd = "";// Temporary storage of the converted number
    if(n==0.0)
        return "0";// If the number is 0 returning 0
    // Separating the integer and fractional parts
    int intPart = getIntPart(n);
    double fractPart = n - intPart;

    // Converting the integer part
    while(intPart > 0)
    {
        int mod = intPart % base;// Storing the mod of intPart to base
        if(mod <= 9)

```

```

        convtd = Integer.toString(mod) + convtd;// If mod is a single
digit concatenating it to converted in reverse
    else
        convtd = getHexValueChar(mod) + convtd;// If mod is double
digit concatenating the corresponding Hex character to converted in reverse
        intPart = intPart / base;// Dividing Integer part by base
    }

    // Converting the fractional part
    if(fractPart > 0)
        convtd = convtd + '.';// If the fractional part exists then adding a
decimal point
        int lim = 10;// Set the limit of the number of decimal places
        while(fractPart > 0 && lim > 0)
        {
            int prod = getIntPart(fractPart * base);// Storing the integer part of
the product of the fractional part to base
            if(prod <= 9)
                convtd = convtd + Integer.toString(prod);// Concatenating the
result to the converted if it is single digit
            else
                convtd = convtd + getHexValueChar(prod);// Concatenating
the corresponding hex character to the converted if it is double digit
            fractPart = fractPart*base - prod;// updating the fractional part to
the fractional part of the previous fractional part times base
            lim--;// Decreasing the limit by 1
        }
        return convtd;// Returning the converted number
    }

// Function to convert the original number of original base to converted base
private void convert()

```



```

{
    // Converting the number
    if(orgBase==10)
        convtNum = fromDecimalToOther(convtBase,
Double.valueOf(orgNum));
    else if(convtBase==10)
        convtNum = Double.toString(fromOtherToDecimal(orgBase,
orgNum));
    else
        convtNum = fromDecimalToOther(convtBase,
fromOtherToDecimal(orgBase, orgNum));

    // Adding the sign if required
    if(sign == '-')
        convtNum = sign + convtNum;
}

// Function to display the original number and converted number
private void display()
{
    System.out.print("\n(" + (sign=='\0'?"":sign) + "" + orgNum + ")base" +
orgBase);
    convert();
    System.out.println(" = (" + convtNum + ")base" + convtBase);
}

// Function that calls input and display
void operate()
{
    input();
    display();
}

```

```

    }

    // Main method to create object and call functions
    public static void main(String[] args)
    {
        // Creating object
        NumConvert ncv=new NumConvert();

        // Calling appropriate function
        ncv.operate();
    }
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	int	orgBase	To store the base of original number
2	int	convtBase	To store the base to which we need to convert
3	String	orgNum	To store the number to be converted
4	String	convtNum	To store the converted number
5	char	sign	To store the sign of the number
6	-	NumConvert()	Default constructor to initialise values

7	int	get_int(String)	To get input of an integer
8	boolean	verifyNumber()	To verify the user entered number
9	void	input()	To take input from user
10	int	getHexCharValue(char)	To get the value of a Hex character
11	char	getHexValueChar(int)	To get the corresponding hex character of a value
12	int	power(int, int)	To raise an integer to the power of an integer
13	double	reversePower(int, int)	To raise an integer to the negative power of an integer
14	int	getIntPart(double)	To get the integer part of a decimal number
15	double	fromOtherToDecimal(int, String)	To convert any number to decimal equivalent
16	String	fromDecimalToOther(int, double)	To convert decimal to other base
17	void	convert()	To convert the given base to the other given base
18	void	display()	To display the numbers
19	void	operate()	To call input and display
20	void	main(String[])	To create object and call the functions

Output)

```
Choose the base of your number :-
    1. Binary
    2. Octal
    3. Decimal
    4. Hexa-Decimal
Enter choice : 2

Enter a number of base 8: 4785
Please enter a number of base 8
Enter a number of base 8: 14567.542

Choose the base in which to convert your number :-
    1. Binary
    2. Octal
    3. Decimal
    4. Hexa-Decimal
Enter choice : 4

(14567.542)base8 = (1977.B1)base16
```

Program 20

Question)

Write a program to simulate encryption and decryption of a given string. The program should be capable of converting a given string to a coded message and also be capable of decoding the same if given again. [Students can use any formula of their choice for encryption and decryption of the string]. The program should display the menu accordingly and ask the user for proper input.

Algorithm)

- Start
- Take necessary input
- For encrypting, create separate arrays for vowels consonants and other characters and also maintain an array to store where they were encountered in the input string, and check if the arrays are encryptable
- Generate a random key in the range 0 to 99 for all three categories
- For each category shift the elements to right by the (key % length of the array) in the respective array where the characters are stored and don't alter the position array
- After all the arrays are shifted, join all of the character arrays to form one single array, and join all the position arrays to form another array
- Sort both the arrays simultaneously using insertion sort so that the characters are placed where their category was present
- Join all characters in one string in the sequence in which they are present in the single array
- Now just attach the key to the encryption in the new formed string and encryption is done
- For decrypting first extract the key from the string, then follow the same process as encryption except the following changes
- Don't check if the arrays are encryptable, don't generate a new key, shift the characters to the left, and don't attach the key to the final string, rest of the process is same as the encryption
- Decryption is done
- Display the final string with appropriate message
- End

Code)

```
import java.util.*;
```

```
class Cypher
```

```

{
    // Declaring class variables

    int keyV/* Key for vowels */, keyC/* Key for Consonants */, keyO/* Key for
everything else */, l/* length of the string */;

    String s/* Original string */, f/* Final string */;

    char[] V_arr/* Array of vowels */, C_arr/* Array of consonants */, O_arr/*
Array of everything else */, letarr/* Array of everything combined */;

    int[] Vpos/* Array of position of vowels */, Cpos/* Array of position of
consonants */, Opos/* Array of position of everything else */, posarr/* Array of
position of everything combined */;


    // Default constructor to initialise data members
    Cypher()
    {
        keyV = keyC = keyO = l = 0;
        s = f = "";
        V_arr = new char[0];
        Vpos = new int[0];
        C_arr = new char[0];
        Cpos = new int[0];
        O_arr = new char[0];
        Opos = new int[0];
        letarr = new char[0];
        posarr = new int[0];
    }


    // Function to take input according to choice
    void input(int choice)
    {
        Scanner sc=new Scanner(System.in);
        switch(choice)

```

```

{
    case 1:// For encryption
    System.out.println("Enter a string to encrypt :");
    s = sc.nextLine();
    break;
    case 2:// For decryption
    System.out.println("Enter an encrypted string to decrypt :");
    s = sc.nextLine().trim();
    break;
}
l = s.length();// Storing length of string
}

```

// Function to add an element a to an array arr

char[] append(char[] arr, char a)

```
{
```

char[] temp = new char[arr.length + 1];// Temporary array with size 1 more than arr

// Filling to array

for (int i = 0; i < arr.length; i++)

temp[i] = arr[i];

temp[arr.length] = a;

return temp;// Returning the array

```
}
```

// Function to an element a to an array arr

int[] append(int[] arr, int a)

```
{
```

int[] temp = new int[arr.length + 1];// Temporary array with size 1 more than arr

```

// Filling the array
for (int i = 0; i < arr.length; i++)
    temp[i] = arr[i];
temp[arr.length] = a;
return temp;// Returning the array
}

// Function to generate keys
void generateKey()
{
    int key = (int)(Math.random()*1000000)%1000000;
    keyV = key / 10000;
    keyC = (key / 100) % 100;
    keyO = key % 100;
}

// Function to extract keys
void extractKey()
{
    // Try-catch used to see if the keys are present unaltered
    try
    {
        String key[] = (s.substring(0, 4) + s.substring(l-4, l)).split("\\s+");
        keyV = Integer.valueOf(key[0]);
        keyC = Integer.valueOf(key[1]);
        keyO = Integer.valueOf(key[2]);
        s = s.substring(4, l-4);
        l = s.length();
    }
}

```



```

        catch(Exception e)
        {
            System.out.println("The encrypted string has been tampered or
the key is incomplete... try again after checking what you entered");
            System.exit(0);
        }
    }

// Function to check the array if it is encrypt able
boolean checkArray(char[] arr)
{
    for(int i = 0; i < arr.length - 1; i++)
        for(int j = i + 1; j < arr.length; j++)
            if(arr[j] != arr[i])
                return true;// If at least 1 element is different than the
others

    return false;// If all elements same or array is empty
}

// Function to shift position of all elements in an array arr to the right by a
number k
char[] increment(char[] arr, int k)
{
    int len = arr.length;// Length of the array
    char[] newarr = new char[len];// To store the new array
    // Filling the new array with elements having new positions
    for(int i = 0; i < len; i++)
        newarr[(i+k)%len] = arr[i];
    return newarr;// Returning the new array
}

```

// Function to shift position of all elements in an array arr to the left by a number k

```
char[] decrement(char[] arr, int k)
{
    int len = arr.length;// Length of the array
    char[] newarr = new char[len];// To store the new array
    // Filling the new array with elements having new positions
    for(int i = 0; i < len; i++)
        newarr[i] = arr[(i+k)%len];
    return newarr;// Returning the new array
}
```

// Function to fill the arrays with respective characters from the string

```
void fillArrs()
{
    for (int i = 0; i < l; i++)
    {
        char c = s.charAt(i);// Extracting characters
        char ch = Character.toUpperCase(c);// Changing them to upper
case for ease of computation
        // Filling arrays accordingly
        if(ch >= 'A' && ch <= 'Z')
        {
            if(ch=='A'||ch=='E'||ch=='I'||ch=='O'||ch=='U')
            {
                V_arr = append(V_arr, c);
                Vpos = append(Vpos, i);
            }
            else
```

```

        {
            C_arr = append(C_arr, c);
            Cpos = append(Cpos, i);
        }
    }
    else
    {
        O_arr = append(O_arr, c);
        Opos = append(Opos, i);
    }
}
}

```

// Function to join all arrays into a single array

void joinArrs()

```

{
    letarr = new char[V_arr.length + C_arr.length + O_arr.length];
    posarr = new int[letarr.length];
    for(int i = 0; i < letarr.length; i++)
    {
        if(i >= V_arr.length + C_arr.length)
        {
            letarr[i] = O_arr[i - V_arr.length - C_arr.length];
            posarr[i] = Opos[i - V_arr.length - C_arr.length];
        }
        else if(i >= V_arr.length)
        {
            letarr[i] = C_arr[i - V_arr.length];
            posarr[i] = Cpos[i - V_arr.length];
        }
    }
}

```

```

    }
    else
    {
        letarr[i] = V_arr[i];
        posarr[i] = Vpos[i];
    }
}

}

// Function to sort the arrays
void sortArrs()
{
    int len = posarr.length;// Storing the length
    // Insertion sort on both the arrays based on the position array at once
    for(int i = 1; i < len; i++)
    {
        int key = posarr[i];
        char keyc = letarr[i];
        int j = i - 1;
        while(j >= 0 && posarr[j] > key)
        {
            posarr[j + 1] = posarr[j];
            letarr[j + 1] = letarr[j];
            j--;
        }
        posarr[j + 1] = key;
        letarr[j + 1] = keyc;
    }
}

```

```

// Function to make a string from the array
void formStringFromArrs()
{
    f = "";
    for(int i = 0; i < letarr.length; i++)
        f = f + letarr[i];
}

// Function to encrypt the string
void encrypt()
{
    generateKey();
    fillArrs();
    if(!(checkArray(V_arr) || checkArray(C_arr) || checkArray(O_arr)))
    {
        System.out.println("Sorry the string cannot be encrypted through
this program");
        System.exit(0);
    }
    V_arr = increment(V_arr, keyV);
    C_arr = increment(C_arr, keyC);
    O_arr = increment(O_arr, keyO);
    joinArrs();
    sortArrs();
    formStringFromArrs();
    // Checking if the encrypted string is the same as the previous string
    if(f.equals(s))
    {
        encrypt();
    }
}

```

```

    }
    // Placing the key in the encrypted string
    else
        f = (keyV<10?"0"+Integer.toString(keyV):Integer.toString(keyV)) + "
" + Integer.toString(keyC/10)
        + f + (keyC%10) + " " +
(keyO<10?"0"+Integer.toString(keyO):Integer.toString(keyO));
    }

```

// Function to decrypt the string

void decrypt()

```

{
    extractKey();
    fillArrs();
    V_arr = decrement(V_arr, keyV);
    C_arr = decrement(C_arr, keyC);
    O_arr = decrement(O_arr, keyO);
    joinArrs();
    sortArrs();
    formStringFromArrs();
}

```

// Function to display the final string with message according to choice

void display(int choice)

```

{
    switch(choice)
    {
        case 1:// Encryption
            input(choice);
            encrypt();

```

```

        System.out.println("Encrypted String Is :-");
        break;
    case 2:// Decryption
        input(choice);
        decrypt();
        System.out.println("Decrypted String Is :-");
        break;
    default:// Wrong choice handling
        System.out.println("Wrong choice... Let's run through the input
again, shall we?");
        operate();
        System.exit(0);
    }
    System.out.println(f + ""); // Printing final string
}

// Function to take input of choice
int input()
{
    Scanner sc=new Scanner(System.in);
    System.out.println("Enter :\n\t1 For Encryption\n\t2 For Decryption");
    System.out.print("Enter choice : ");
    // Try-catch to get an integer only
    try
    {
        int c = sc.nextInt();
        return c;
    }
    catch(Exception e)
    {

```

```

        System.out.println("Enter an integer choice only");
        return input();
    }
}

// Function that calls the display function and the choice input function
void operate()
{
    int choice = input();
    display(choice);
}

// Main method to create object and call appropriate functions
public static void main(String[] args)
{
    // Creating object
    Cypher cyp=new Cypher();

    // Calling appropriate functions
    cyp.operate();
}
}

```

Variable Description Table)

No.	DataType/ReturnType	Variable/Method	Description
1	int	keyV	To store key for vowels
2	int	keyC	To store key for consonants
3	int	keyO	To store key for everything else
4	int	l	To store length of the string

5	String	s	To store the string from user
6	char[]	V_arr	To store the array of vowels
7	char[]	C_arr	To store the array of consonants
8	char[]	O_arr	To store the array of everything else
9	int[]	Vpos	To store the positions of vowels
10	int[]	Cpos	To store the positions of consonants
11	int[]	Opos	To store the positions of everything else
12	char[]	letarr	To store all the characters of the string
13	int[]	posarr	To store all the positions in the string
14	String	f	To store the final string
15	-	Cypher()	Default constructor to initialise data members
16	void	input(int)	To take input according to choice
17	char[]	append(char[], char)	To append an element to an array
18	int[]	append(int[], int)	To append an element to an array
19	void	generateKey()	To generate a random key
20	void	extractKey()	To extract the key from the string
21	boolean	checkArray(char[])	To check if an array is eligible to be encrypted
22	char[]	increment(char[], int)	To shift elements in an array to right
23	char[]	decrement(char[], int)	To shift elements in an array to left
24	void	fillArrs()	To fill all the arrays
25	void	joinArrs()	To join all the arrays

26	void	sortArrs()	To sort the joined arrays
27	void	formStringFromArrs()	To form a string from letarr
28	void	encrypt()	To encrypt a string
29	void	decrypt()	To decrypt a string
30	void	display(int)	To display according to choice
31	int	input()	To take input of choice
32	void	operate()	To call display and input of choice
33	void	main(String[])	To create object and call operate

Output)

```

Enter :
      1 For Encryption
      2 For Decryption
Enter choice : 1
Enter a string to encrypt :
Hello! I am Shaurrya Baheti. Who are you? And, What do you want?
Encrypted String Is :-
31 9hatWe o?uh!ryAandWo hotuda ywe onI.taa uHl ?lmaS ha,rei royB 4 54

```

```

Enter :
      1 For Encryption
      2 For Decryption
Enter choice : 2
Enter an encrypted string to decrypt :
31 9hatWe o?uh!ryAandWo hotuda ywe onI.taa uHl ?lmaS ha,rei royB 4 54
Decrypted String Is :-
Hello! I am Shaurrya Baheti. Who are you? And, What do you want?

```

Bibliography

The book that helped me in completing the project is Computer Science with JAVA:
A Textbook for Class XII by Sumita Arora.