Laboratory Manual on

DESIGN AND ANALYSIS OF ALGORITHMS LABORATORY

[15CSL 47]

By

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1 A)Create a Java class called ***Student*** with the following details as variables within it.

(i) USN (ii) Name (iii) Branch (iv)Phone

Write a Java program to create *n Student* objects and print the USN, Name, Branch, and Phone of these objects with suitable headings.

B) Write a Java program to implement the Stack using arrays. Write Push(), Pop(), and Display() methods to demonstrate its working.

```
package student;

import java.util.Scanner;       /* @author PROF SAKEENA *

 class Stu {

      private String USN;

      private String Name;

      private String Branch;

      private String Phone;

   public String getUSN()

   {

      return USN;

   }

      public String getName()

   {

      return Name;

   }

   public String getBranch()    {
```

```
        return Branch;
    }
    public String getPhone()
    {
        return Phone;
    }
 public Stu(String usn,String name,String branch,String phone) {
     super();
    USN=usn;
    Name=name;
    Branch= branch;
    Phone=phone;
    }
    }
public class Student {
    public static void main(String[] args) {
        Scanner in =new Scanner(System.in);
        Scanner s =new Scanner(System.in);
        System.out.println("enter no of students");
        int n=in.nextInt();
        Stu[] st=new Stu[n];
```

```
        String usn,name,branch,phone;
      for(int i=0;i<n;i++)        {
            System.out.println("enter student details"+(i+1));
            System.out.print("enter student USN");
            usn=s.nextLine();
            System.out.print("enter student NAME");
            name=s.nextLine();
            System.out.print("enter student BRANCH");
            branch=s.nextLine();
            System.out.print("enter student PHONE");
            phone=s.nextLine();
            st[i]=new Stu(usn,name,branch,phone);
        }
        System.out.println("the student details");
        System.out.println("USN\tNAME\tBRANCH \tPHONE");
       for(int i=0;i<n;i++)
        {
System.out.println(st[i].getUSN()+"\t"+st[i].getName()+"\t"+st[i].getBranch()+"\t"+st[i].getPhon
e());
        }
    }
    }
```

/*1 B) Write a Java program to implement the Stack using arrays. Write Push(), Pop(), and Display() methods to demonstrate its working.*/

```
package stack;

import java.io.BufferedReader;

import java.io.IOException;

import java.io.InputStreamReader;

/*@author PROF SAKEENA */

public class Stack {

   private int top;

   private final int s[];

   Stack(int size)    {

                     top=-1;

                   s =new int[size];

                    }

   void pushItem(int item) {

      if(top==s.length-1){

         System.out.println("STACKFULL");

       }

      else

      {

         s[++top]=item;
```

```
        System.out.println("pushed item :-"+s[top]);
    }
  }
 int popitem()
  {
    if(top<0)
    {
        System.out.println("STACK UNDERFLOW");
        return 0;
    }
    else
    {
        System.out.println("popped item :- "+s[top]);
        return s[top--];
    }
    }
  public void display()
  {
    System.out.println("the stack is\n");
    for(int i=0;i<=top;i++)
    {
```

```
        System.out.println(s[i]);
      }
     }
  public static void main(String[] args) throws IOException     {
     boolean yes=true;        int choice;
     Stack stk= new Stack(4);
     BufferedReader n = new BufferedReader(new InputStreamReader(System.in));
do{
    System.out.println("press 1 for push,2 for pop,3 for display,4 for exit\nEnter your choice");
       choice=Integer.parseInt(n.readLine());
       switch (choice)
       {
          case 1:System.out.println("enter number to push:-");
                stk.pushItem(Integer.parseInt(n.readLine()));
                break;
          case 2:stk.popitem();
                break;
          case 3:stk.display();
                break;
          case 4:System.out.println("DONE");
                yes=false;
```

```
                break;
            default:System.out.println("invalid choice");
        }
    }
    while(yes == true);
  }
}
```

2 A) Design a super class called ***Staff*** with details as StaffId, Name, Phone, Salary. Extend this class by writing three subclasses namely ***Teaching*** (domain, publications), ***Technical*** (skills), and ***Contract*** (period). Write a Java program to read and display at least 3 *staff* objects of all three categories.

```
package staff;   /* @author PROF SAKEENA  */

class Stf                          // class name Stf

   {

      private int StafId;                    // declaration of fields

      private String Name;

      private String Phone;

      private long Salary;

public Stf(int stafid,String name,String phone,long salary)

{

        StafId=stafid;

        Name=name;

        Phone=phone;

        Salary=salary;

}

public void Display()

{

   System.out.print(StafId+"\t"+Name+"\t"+Phone+"\t"+Salary);

}
```

```
}
class Teaching extends Stf                              //inheritance
{
        private String Domain;
        private int Publication;
 public Teaching(int stafid,String name,String phone,long salary,String domain,int publication)
 {
     super(stafid,name,phone,salary);
     Domain=domain;
     Publication=publication;
 }
public void Display()
{
    super.Display();
    System.out.print("\t"+Domain+"\t\t"+Publication+"\t\t"+"---"+"\t\t"+"---");
}
}
class Technical extends Stf
{
     private String Skills;
     public Technical(int stafid,String name,String phone,long salary,String skills){
```

```
    super(stafid,name,phone,salary);
    Skills=skills;
}
public void Display()
{
   super.Display();
   System.out.print("\t"+"---"+"\t\t---"+"\t\t"+Skills+"\t"+"---");
}
}
class Contract extends Stf
{
    private int Period;
    public Contract(int stafid,String name,String phone,long salary,int period){
     super(stafid,name,phone,salary);
     this.Period=period;
}
public void Display()
{
   super.Display();
   System.out.print("\t---"+"\t\t---"+"\t\t---"+"\t\t"+Period);
}
```

```
}
public class STAFF{
public static void main(String[] args)
{
   Stf stf[]=new Stf[3];
   stf[0]= new Teaching(1,"RAHIL","944955001",25000,"CSE",10);
   stf[1]= new Technical(2,"REEHA","944955002",10000,"system admin");
   stf[2]= new Contract(3 ,"RIFA","944955003",20000,3);
System.out.println("STAFFID\tNAME\tPHONE\t\tSALARY\tDOMAIN\t\tPUBLICATION\tSK
ILLS\t\tPERIOD");
   for(int i=0;i<3;i++)
   {
      stf[i].Display();
      System.out.println();
   }
}
}
```

STAFFID	NAME	PHONE	SALARY	DOMAIN	PUBLICATION	SKILLS	PERIOD
1	RAHIL	944955001	25000	CSE	10	---	---
2	REEHA	944955002	10000	---	---	system admin	---
3	RIFA	944955003	20000	---	---	---	3

2 B)Write a Java class called ***Customer*** to store their name and date_of_birth. The date_of_birth format should be dd/mm/yyyy. Write methods to read customer data as <name, dd/mm/yyyy> and display as <name, dd, mm, yyyy> using StringTokenizer class considering the delimiter character as "/".

```
package customer1;

import java.util.Scanner;

import java.util.StringTokenizer; /* @author PROF.SAKEENA */

public class Customer1 {

private String custName;

   private String dob;

   public Customer1(String custName,String dob)

   {

      this.custName=custName;

      this.dob=dob;

      }

   public static void main(String[] args) {

       Scanner scanner =new Scanner(System.in);

     System.out.println("Enter customername");

     String custName=scanner.nextLine();

     System.out.println("enter date(dd/mm/yyyy)");

     String dob=scanner.next();

     Customer1 customer=new Customer1(custName,dob);
```

```
        System.out.println("Customer name "+customer.custName);
        StringTokenizer date=new StringTokenizer (customer.dob,"/");
        System.out.print("customer DOB: " + date.nextToken()+ "," +  date.nextToken() + ","
+date.nextToken());
    }
}
```

Run:

Enter customer name

sakeena

enter date(dd/mm/yyyy)

22/3/2017

Customer name sakeena

customer DOB: 22,3,2017BUILD SUCCESSFUL (total time: 10 seconds)

3 A) Write a Java program to read two integers *a* and *b*. Compute *a*/*b* and print, when *b* is not zero. Raise an exception when *b* is equal to zero.

```
package divide;

import java.util.Scanner;   /*author PROF SAKEENA */

public class Divide {

public static void main(String[] args) {

   Scanner s=new Scanner(System.in);

   System.out.println("Enter the integers a and b");

   int a=s.nextInt();

   int b=s.nextInt();

         try   //try block

         {

         System.out.println("the result of  division of a by b is  "+(a/b));

         }

         catch(ArithmeticException e)  //catch block to catch any exceptions

         {

         System.out.println("division by zero error");

         }

  }

}
```

Enter the integers a and b

10 5

the result of division of a by b is 2

BUILD SUCCESSFUL (total time: 8 seconds)

Enter the integers a and b

10 0

division by zero error

3B) Write a Java program that implements a multi-thread application that hashtree threads. First thread generates a random integer for every 1 second; second thread computes the square of the number and prints; third thread will print the value of cube of the number.

```
package multithread;
import java.util.Scanner;
/*@author PROF SAKEENA*/

public class Multithread {
      public static int num;
      public static int state=0;

   public static void main(String[] args) {
       new Thread(new Runnable(){
          @Override
          public void run(){
            int i=0;
            System.out.println("Enter n");
            Scanner s=new Scanner(System.in);
            int n=s.nextInt();

       while(i<n)
       {
           num =(int) (Math.random() * 100);
           System.out.println("\nNumber :"+num);
          i++;
           state = 1;
           try
          {
          Thread.sleep(1000);
          }
          catch (InterruptedException e){
```

```
        System.err.println("error"+e);
        }
     }
    }
     }).start();

          new Thread(new Runnable(){
             @Override
             public void run(){
                while(true)
                {
                   while(state!= 1);
                   System.out.println("square :"+(num* num));
                   state=2;
                }
             }
          ).start();

          new Thread(new Runnable(){
             @Override
             public void run(){
                while(true)
                {
                   while(state!= 2);
                   System.out.println("cube  :"+(num* num*num));
                   state=0;
                }
             }
          }).start();
  }
```

```
}

run:
Enter n
5

Number :27
square :729
cube  :19683

Number :82
square :6724
cube  :551368

Number :6
square :36
cube  :216

Number :33
square :1089
cube  :35937

Number :60
square :3600
cube  :216000
BUILD STOPPED (total time: 11 seconds)
```

4) Sort a given set of ***n*** integer elements using **Quick Sort** method and compute its time complexity. Run the program for varied values of n > 5000 and record the time taken to sort.

Plot a graph of the time taken versus n on graph sheet. The elements can be read from a file or can be generated using the random number generator. Demonstrate using Java how the divide- and-conquer method works along with its time complexity analysis: worst case, average case and best case.

```
import java.util.Random;

import java.util.Scanner; /* @author PROF SAKEENA */

public class Quick {

private int[] numbers;

    private int size;

    public void sort(int[] values) {

        // check for empty or null array

       /* if (values ==null || values.length==0){

            return;

        }*/

        this.numbers = values;

        size = values.length;

        long startTime =System.currentTimeMillis();

        quicksort(0, size - 1);

      long stopTime =System.currentTimeMillis();

      long elapsedTime= stopTime-startTime;

      System.out.println("Time taken");

      System.out.println(elapsedTime);
```

```
    }
  private void quicksort(int low, int high) {
        int j;
        if(low<=high)
        {
           j=part(low,high);
           quicksort(low,j-1);
           quicksort(j+1,high);
        }
  }
private int part(int low,int high)
{
  int i,j,pivot;
  pivot=numbers[low];
  i=low+1;j=high;
  while(true)
  {
    while(i<high && pivot >numbers[i])
       i++;
    while(numbers[j]>pivot)
       j--;
```

```
        if (i<j)
        {
            int temp=numbers[i];
             numbers[i]=numbers[j];
            numbers[j]=temp;
        }
        else
        {
            int temp = numbers[low];
            numbers[low]=numbers[j];
            numbers[j]=temp;
            return j;
        }
      }
  }


  public static void main(String[] args) {
      Quick sorter = new Quick();
            int[] numbers;int size;
          Scanner scan =new Scanner(System.in);
          System.out.println("enter size of the array");
```

```
size =scan.nextInt();
numbers=new int[size];
System.out.println("the  elements of the array");
Random random = new Random();
for(int i=0;i<size;i++)
{
   numbers[i]=Math.abs(random.nextInt(100));


}
for(int i=0;i<size;i++)
{
   System.out.print("\t" + numbers[i]);


}
long startTime =System.currentTimeMillis();
   sorter.sort(numbers);
long stopTime =System.currentTimeMillis();
long elapsedTime= stopTime-startTime;
System.out.println();
for(int i:numbers){
        System.out.print(i);
```

```
                System.out.print(" ");
            }
        System.out.println();
        System.out.println("Time taken");
        System.out.println(elapsedTime);
        }
  }
```

```
enter size of the array
10
the  elements of the array
54      63      43      72      84      63      73      83      37      12
Time taken
0
12      37      43      54      63      63      72      73      83      84
Time taken
1
```

5) Sort a given set of n integer elements using Merge Sort method and compute its time complexity. Run the program for varied values of n > 5000, and record the time taken to sort. Plot a graph of the time taken versus n on graph sheet. The elements can be read from a file or can be generated using the random number generator. Demonstrate using Java how the divide- and-conquer method works along with its time complexity analysis: worst case, average case and best case.

```
package merge;
import java.util.Scanner;
import java.util.Random;
/* @author PROF SAKEENA */
public class Merge {
   private int[] numbers;
   private int[] c;
      private int number;
      public void sort(int[] values) {              // check for empty or null array
            if (values ==null || values.length==0){
                  return;
                  }
            this.numbers = values;
            number = values.length;
            this.c = new int[number];
            mergesort(0, number - 1);
             }
      private void mergesort(int low, int high) {
           // int i = low, j = high;
            // Get the pivot element from the middle of the list
            if (low<high)
```

```
        {
            int mid = (low + (high))/2;
                // Recursion
            mergesort(low, mid);
            mergesort(mid+1, high);
            mergearray( low,  mid,  high);
        }
    }
    private void mergearray(int low,int mid,int high)     {
          int i=low; int j=mid+1; int k =low;
         while(i<=mid && j<=high)
          {
            if( numbers[i] < numbers[j])
               c[k++]= numbers[i++];
            else
               c[k++]=numbers[j++];
          }
            while(i<=mid)
               c[k++]=numbers[i++];
            while (j<=high)
               c[k++]=numbers[j++];
            for(i=low;i<=high;i++)
               numbers[i]= c[i];

          }
```

```
public static void main(String[] args) {
    Merge sorter = new Merge();
        int[] numbers; int number;      int[] c;
      Scanner scan =new Scanner(System.in);
      System.out.println("enter size of the array");
      number =scan.nextInt();
      numbers=new int[number];
      System.out.println("The elements of the array");
      Random random = new Random();
      for(int i=0;i<number;i++)
            numbers[i]=Math.abs(random.nextInt(5000));
      for(int i=0;i<number;i++)
           System.out.print( "\t" + numbers[i]);          System.out.println();
      long startTime =System.currentTimeMillis();
        sorter.sort(numbers);
      long stopTime =System.currentTimeMillis();
      long elapsedTime= stopTime-startTime;
          for(int i:numbers){
            System.out.print(i);       System.out.print(" ");
        }
      System.out.println();
      System.out.println("Time taken");
      System.out.println(elapsedTime);
}
}
```

6 A) Implement in Java, the **0/1 Knapsack** problem using (a) Dynamic Programming method

```
package knapsack;
import java.util.Scanner;       /* @author PROF. SAKEENA */

public class Knapsack {
   static int max(int a,int b)
    {
        return (a>b)?a:b;
    }
   public static void main(String[] args) {
    int n,i,j,cap;
    int[] p =new int[20];
    int[] w= new int [20];
    int[][] v =new int[10][10];
    System.out.println("enter no of items\n");
    Scanner s=new Scanner(System.in);
    n =s.nextInt();
      for(i=1;i<=n;i++)
      {
          System.out.println("\n enter weights and profit of each object");
          w[i]=s.nextInt();
          p[i]= s.nextInt();

      }
      System.out.println("\ncapacity of knapsack");
      cap=s.nextInt();

    for(i=0;i<=n;i++)
          v[i][0]=0;
     for(i=1;i<=n;i++) // to find the maximum values of item to be placed
      for(j=1;j<=cap;j++)
```

```
        {
         if(w[i] > j)
            v[i][j]=v[i-1][j];
         else
        v[i][j] = max(v[i-1][j],v[i-1][j-w[i]]+p[i]);
         }
    System.out.println("\n the table is\n");

    for(i=0;i<=n;i++)
    {
       for(j=0;j<=cap;j++)
       {
       System.out.print(v[i][j]+" ");
       }
       System.out.println("\n");
    }
    System.out.println("the maximum profit is\n"+v[n][cap]);
    System.out.println("optimal subset {");              // to find the items placed in the knapsack
    j=cap;
    for(i=n; i>=1; i--)
       if( v[i][j] != v[i-1][j])   // if values not of v[i][j] and  v[i-1][j] are not same then pick that
item i
       {
          System.out.println("item\t"+i);
            j=j-w[i];                  // reduce the capacity of the knapsack after picking item i

       }
    System.out.println("\t }");

    }
}
```

```
run:
enter no of items
4
 enter weights and profit of each object
2 12
 enter weights and profit of each object
1 10
 enter weights and profit of each object
3 20
 enter weights and profit of each object
2 15
capacity of knapsack
5
 the table is

0 0 0 0 0 0

0 0 12 12 12 12

0 10 12 22 22 22

0 10 12 22 30 32

0 10 15 25 30 37
the maximum profit is
37
optimal subset {
item     4
item     2
item     1
          }
```

6 B)Implement in Java, the **0/1 Knapsack** problem using Greedy method.

```
package greedyknapsack;  /* @author PROF. SAKEENA */
import java.util.Scanner;
public class Greedyknapsack{
   static void knapsack (int n,float weight[],float profit[],float capacity)
   {
      float x[]= new float [20],tp=0;
      int i,j,u;
      c= (int) capacity;
      for (i=0;i<n;i++)
         x[i]= (float) 0.0;
      for(i=0;i<n;i++)
            {
            if(weight[i] >c )
               break;
            else
            {
               x[i]=(float) 1.0;
               tp = tp + profit[i];
               c=(int)(c-weight[i]);
            }
            }
      if(i<n)
         x[i]= c/weight[i];
      tp=tp+(x[i] * profit[i]);
      System.out.println("the result vector");
      for (i=0;i<n;i++)
         System.out.println( + x[i]);
      System.out.println("the total profit is");
     System.out.println( + tp);
```

```
}
public static void main(String[] args)
{
   float weight[]= new float[20];
   float profit[]= new float[20];
   float capacity;
   int num,i,j;
   float ratio[] = new float[20],temp;
   System.out.println("\nenter the no of objects");
   Scanner s = new Scanner(System.in);
   num =s.nextInt();
   System.out.println("\n enter weights and profit of each object");
   for(i=0;i<num;i++)
   {
      weight[i]=s.nextInt();
      profit[i]= s.nextInt();
   }
   System.out.println("\ncapacity of knapsack");
   capacity=s.nextInt();
   for(i=0;i<num;i++)
   {
      ratio[i]= profit[i]/weight[i];
   }
    for(i=0;i<num;i++)
   {
      for(j=i+1;j<num;j++)

   {
     if (ratio[i]< ratio[j])
     {
        temp= ratio[j];
```

```
            ratio[j]=ratio[i];
            ratio[i]=temp;
            temp= weight[j];
            weight[j]=weight[i];
            weight[i]=temp;
            temp= profit[j];
            profit[j]=profit[i];
            profit[i]=temp;
          }
        }
        }
        knapsack(num,weight,profit,capacity);
         }
}
```

```
enter the no of objects
4
 enter weights and profit of each object
2 12
1 10
3 20
2 15
capacity of knapsack
5
the result vector
1.0
1.0
0.6666667
0.0
the total profit is
38.333336
```

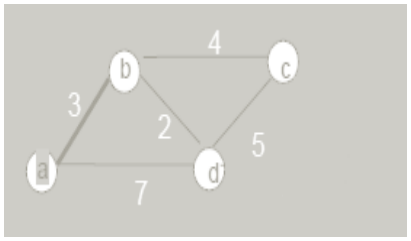
7) From a given vertex in a weighted connected graph, find shortest paths to other vertices using **Dijkstra's algorithm**. Write the program in Java.

```
import java.util.*;
public class Dijkstra
{
        public  int distance[] = new int[10];
        public  int cost[][] = new int[10][10];

public void calc(int n,int s)
        {
        int flag[] = new int[n+1];
         int i,minpos=1,k,c,minimum;

        for(i=1; i<=n; i++)
        {
        flag[i]=0;
         this.distance[i] = this.cost[s][i];
         }
         c = 2;
         while(c<=n)
          {
                minimum=99;
               for(k=1; k<=n; k++)
               {
                if(this.distance[k] < minimum && flag[k]!=1)
                        {
                       minimum = this.distance[i];
                        minpos = k;
                       }
               }
```

```
        flag[minpos] = 1;
        c++;
         for(k=1;k<=n;k++)
                {
         if(this.distance[minpos]+this.cost[minpos][k] <  this.distance[k] && flag[k]!=1 )
         this.distance[k]=this.distance[minpos]+this.cost[minpos][k];
                }
        }
}
public static void main(String args[])
 {
  int nodes,source,i,j;
  Scanner in = new Scanner(System.in);
  System.out.println("Enter the Number of Nodes \n");
  nodes = in.nextInt();
  Dijkstra d = new Dijkstra();
  System.out.println("Enter the Cost Matrix Weights: \n");
       for(i=1;i<=nodes;i++)
         for(j=1;j<=nodes;j++)
           {
          d.cost[i][j]=in.nextInt();
          if(d.cost[i][j]==0)
            d.cost[i][j]=999;
          }
  System.out.println("Enter the Source Vertex :\n");
  source=in.nextInt()
  d.calc(nodes,source);
  System.out.println("The Shortest Path from Source \t"+source+"\t to all other vertices are : \n");
       for(i=1;i<=nodes;i++)
         if(i!=source)
 System.out.println("source :"+source+"\t destination :"+i+"\t MinCost is :"+d.distance[i]+"\t");
```

```
 }
}
```

Enter the Number of Nodes :4



Enter the Cost Matrix Weights:

0 3 999 7

3 0 4 2

999 4 0 5

7 2 5 0

Enter the Source Vertex :

1

The Shortest Path from Source Vertex 1 to all other vertices are :

source :1 destination :2 MinCost is :3

source :1 destination :3 MinCost is :7

source :1 destination :4 MinCost is :5

8) Find Minimum Cost Spanning Tree of a given connected undirected graph using **Kruskal's algorithm**

```
package kruskals;
import java.util.*; /*author PROF. SAKEENA */

public class Kruskals {

public  int parent[] = new int[15];
public  int cost[][] = new int[10][10];
public int mincost;

public void calc(int n)
   {
      int flag[] = new int[n+1];
      int i,j,min=999,num_edges=1,a=1,b=1,minpos_i=1,minpos_j=1;
      parent[minpos_i]= 0;parent[minpos_j]= 0;

   while(num_edges < n)
      {

         for(i=1 , min=999; i<=n; i++)
          for(j=1 ; j<=n; j++)
           if(this.cost[i][j] < min)

              {
                 min = this. cost[i][j];
                 a = minpos_i = i;
                 b = minpos_j = j;
              }
```

```
        while(parent[minpos_i]!=0)
           minpos_i=parent[minpos_i];

        while(parent[minpos_j]!=0)
           minpos_j=parent[minpos_j];

if(minpos_i!= minpos_j)
         {
        System.out.println("\t from Vertex \t"+a+"\t  to Vertex \t"+b+"-mincost:"+min+" \n");
        this.mincost=this.mincost+min;
          num_edges=num_edges+1;
        this.parent[minpos_j]=minpos_i;
         }
         this.cost[a][b]=this.cost[b][a]=999;
       }
  System.out .println("MINIMUM COST SPANNING TREE (MCST)="+mincost);
     }
   public static void main(String[] args) {
    int nodes,i,j;
     Scanner in = new Scanner(System.in);
     System.out.println("Enter the Number of Nodes \n");
     nodes =  in.nextInt ();
     Kruskals k  =  new Kruskals();
     System.out.println ("Enter the Cost Matrix Weights : \n");
     for(i=1; i<=nodes; i++)
      for(j=1; j<=nodes; j++)
      {
        k.cost[i][j] = in.nextInt();
        if(k.cost[i][j] == 0)
          k.cost[i][j] = 999;
      }
```

```
        k.calc(nodes);

        }
}
run:
Enter the Number of Nodes

6
Enter the Cost Matrix Weights :

0 3 0 0 6 5
3 0 1 0 0 4
0 1 0 6 0 4
0 0 6 0 8 5
6 0 0 8 0 2
5 4 4 5 2 0
        from Vertex   2        to Vertex     3-mincost:1

        from Vertex   5        to Vertex     6-mincost:2

        from Vertex   1        to Vertex     2-mincost:3

        from Vertex   2        to Vertex     6-mincost:4

        from Vertex   4        to Vertex     6-mincost:5

MINIMUM COST SPANNING TREE (MCST)=15
```

9) Find Minimum Cost Spanning Tree of a given connected undirected graph using Prim's algorithm.

```
package prim.s;
import java.util.*; /*author PROF. SAKEENA */

public class PrimS {
        public  int isVisited[] = new int[15];
        public  int cost[][] = new int[10][10];
         public int mincost;

public void calc(int n)
   {
      int flag[] = new int[n+1];
      int i,j,min=999,num_edges=1,a=1,b=1,minpos_i=1,minpos_j=1;

   while(num_edges < n)
      {

         for(i=1 , min=999; i<=n; i++)
          for(j=1 ; j<=n; j++)
           if(this.cost[i][j] < min)
             if(this.isVisited[i] != 0)
              {
                  min = this. cost[i][j];
                  a = minpos_i = i;
                  b = minpos_j = j;
              }
 if(this. isVisited[minpos_i]== 0 || this.isVisited[minpos_j] == 0)
          {
  System.out.println"\t from Vertex \t"+a+"\t  to Vertex \t"+b+"-mincost:"+min+" \n");
```

```
                this.mincost=this.mincost+min;
          num_edges=num_edges+1;
           this.isVisited[b]=1;
            }
            this.cost[a][b]=this.cost[b][a]=999;
         }
System.out .println("MINIMUM COST SPANNING TREE (MCST) = "+mincost);
        }

 public static void main(String args[])
   {
      int nodes,i,j;
      Scanner in = new Scanner(System.in);
      System.out.println("Enter the Number of Nodes \n");
      nodes =  in.nextInt ();
      PrimS p  =  new PrimS();
      System.out.println ("Enter the Cost Matrix Weights : \n");
      for(i=1; i<=nodes; i++)
        for(j=1; j<=nodes; j++)
        {
          p.cost[i][j] = in.nextInt();
          if(p.cost[i][j] == 0)
            p.cost[i][j] = 999;
        }
      p.isVisited[1] = 1; // Initialization
      p.calc(nodes);

       }
}
```

```
run:
Enter the Number of Nodes

4
Enter the Cost Matrix Weights :

0     3   999   7
3     0    4    2
999   4    0    5
7     2    5    0

        from Vertex   1        to Vertex     2-mincost:3

        from Vertex   2        to Vertex     4-mincost:2

        from Vertex   2        to Vertex     3-mincost:4

MINIMUM COST SPANNING TREE (MCST) = 9
```

10)Write Java programs to

(a) Implement All-Pairs Shortest Paths problem using **Floyd's algorithm**.

(b) Implement **Travelling Sales Person problem** using Dynamic programming.

```
package floyd;

import java.util.*;/*@author Prof SAKEENA */

public class Floyd {

    public static void main(String[] args) {

        int wt[][]=new int[10][10];

        int n,i,j;

        System.out.print("\n create a graph using adjucency matrix");

        System.out.print("\n enter no of vertices");

       Scanner in= new Scanner(System.in);

        n=in.nextInt();

        System.out.print("enter elements     enter 999 as infinity value");

        for(i=1;i<=n; i++)

        {

           for(j=1;j<=n;j++)

           {

              System.out.print("\nwt["+i+"]["+j+"]");

              wt[i][j]=in.nextInt();

           }

        }
```

```
    System.out.print("\n\t Computing ALl pairs shortest path..\n");
    Floyd_shortest_path(wt,n);
  }
  public static void Floyd_shortest_path(int wt[][],int n)
  {
    int d[][]=new int[10][10];
    int i,j,k;
    for(i=1;i<=n;i++)
    {
      for(j=1;j<=n;j++)
      {
        d[i][j]= wt[i][j];
      }
    }
    for(k=1;k<=n;k++)
    {
      for(i=1;i<=n;i++)
          {
            for(j=1;j<=n;j++)
            {
              d[i][j] = min(d[i][j],(d[i][k]+d[k][j]));
```

```
                }
            }
    }
    for(k=0;k<=n;k++)
    {
       System.out.print("d("+k+")\n");
            for(i=1;i<=n;i++)
            {
               for(j=1;j<=n;j++)
               {
                  System.out.print("  "+d[i][j]);


               }
               System.out.print("\n");
            }
    }


    }
  public static int min(int a,int b)
  {
    if(a<b)
```

```
            return a;
        else
            return b;
    }
    }
```

```
create a graph using adjacency matrix
 enter no of vertices3
enter elements enter 999 as infinity value
create a graph using adjacency matrix
 enter no of vertices
3
enter elements
enter 999 as infinity value
0 8 5
2 0 999
999 1 0
 Computing ALL pairs shortest path..
d(0)
  0  6  5
  2  0  7
  3  1  0
```

d(1)

0 6 5

2 0 7

3 1 0

d(2)

0 6 5

2 0 7

3 1 0

d(3)

0 6 5

2 0 7

3 1 0

```
package tsp;
import java.util.*;
public class TSP{
   static int cost =0;
   public static void main(String[] args)
   {
      int a[][]=new int[10][10];
      int visited[]=new int[10];
      int i,j,n;
      System.out.print("\n eneter  no of cities");
      Scanner in= new Scanner(System.in);
      n= in.nextInt();
      //create(a,visited,n);
      System.out.println("enter cost matrix");
      for(i=0;i<n;i++)
      {
         for(j=0;j<n;j++)
         {
            a[i][j]=in.nextInt();
         }
         visited[i]=0;
```

```
    }
    System.out.println("The Path is");
    mincost(a,n,0,visited);
    display();
  }

  public static void mincost(int a[][],int n,int city,int visited[])
  {
    int i,cityno;
    visited[city]=1;
    System.out.print((city+1)+"->");
    cityno=least(a,visited,n,city);
    if(cityno==999)
    {
      cityno=0;
      System.out.print(""+(cityno+1));
      cost+=a[city][cityno];
      return;
    }

    mincost(a,n,cityno,visited)    ;
```

```
}
public static int least(int a[][],int visited[],int n,int c)
{
   int i,minnode=999,min=999,newmin=0;
   for(i=0;i<=n;i++)
   {
      if ( (a[c][i]!=0) && (visited[i]==0) )
        if(a[c][i]< min)
        {  min=a[i][0]+a[c][i];
           newmin = a[c][i];
           minnode=i;
        }
   }
   if (min!=999)
      cost+=newmin;
      return minnode;
}
public static void display()
{
   System.out.println("\n total cost of tour "+cost);
}
```

```
}

eneter  no of cities

4

enter cost matrix

0 10 15 20

5  0  9  10

6 13 0  12

8 8   9   0

The Path is

1->2->4->3->1

 total cost of tour 35
```

11) Design and implement in Java to find a **subset** of a given set **S** = {S_1, S_2,.....,S_n} of ***n*** positive integers whose SUM is equal to a given positive integer ***d***. For example, if S ={1, 2, 5, 6, 8} and ***d***= 9, there are two solutions {1,2,6}and {1,8}. Display a suitable message, if the given problem instance doesn't have a solution.

```
package subset;/* @author prof sakeena */

public class Subset {

   static int count,d =9;

   static int a[]= new int[10];

   static int w[]= {1,2,5,6,8};

   public static void main(String[] args) {

      int sum = 0,i,n;

      n = 5;

   System.out.print("\n the set for sum is S= {");

   for(i=0; i<n-1; i++)

   System.out.print(w[i]+",");

   System.out.println(w[i]+"}");

   System.out.println("d=" +d);

   for(i=0; i<n; i++)

   sum += w[i];

   if (sum < d)

   {
```

```
    System.out.println("there is no solution");
    }
    System.out.println("The solution is  ");
    count=0;
    sumsubset(0,0,sum);
    }
public static void sumsubset(int sum,int index,int remainingsum)
{
    int i;
    a[index]=1;
    if (sum+w[index]== d)
    {
    System.out.println("\n solution ="+(++count));
    for(i=0;i<=index;i++)
    {
    if (a[i]== 1)
    System.out.print(" "+w[i]);
    }
    }
else if (sum + w[index] + w[index+1] <= d )
        sumsubset(sum + w[index],index+1,remainingsum-w[index] );
```

```
if( (sum  + remainingsum - w[index] >= d) && (sum+w[index+1]) <=d)
{
a[index] =0;
sumsubset(sum,(index+1),remainingsum- w[index]);
}
}
}
```

the set for sum is S= {1,2,5,6,8}

d=9

The solution is

solution =1

1 2 6

solution =2

1 8BUILD SUCCESSFUL (total time: 0 seconds)

12) Design and implement in java to find all **Hamiltonian Cycles** in a connected undirected Graph **G** of ***n*** vertices using backtracking principle.

```
package hamiltonian;/* @author PROF SAKEENA*/

import java.util.*;

public class Hamiltonian {

   static int MAX = 25;

   static int vertex[]=new int [MAX];

public static void main(String[] args) {

      int i,j,v1,v2,Edges,n;

      int G[][] =new int[MAX][MAX];

      System.out.println("\n Program for hamiltonian cycle");

      System.out.println("Enter number of vertices of graph");

      Scanner in = new Scanner(System.in);

      n= in.nextInt();

      for(i=1;i<=n;i++)

      {

         for(j=1;j<=n ;j++)

         {

            G[i][j] =0;

            vertex[i]=0;

         }

      }
```

```
System.out.println("enter the total no of edges");
Edges= in.nextInt();
for(i=1;i<=Edges;i++)
{
   System.out.println("enter the edge ");
        v1=in.nextInt();
        v2=in.nextInt();
        G[v1][v2]= 1;
        G[v2][v1]= 1;
}
vertex[1]=1;
System.out.println("Hamiltonian cycle");
H_cycle(G,n,2);
   }
public static void Nextvertex(int G[][],int n,int k)
{
   int j;
   while(true)
   {
      vertex[k]= (vertex[k] +1)%(n+1);
      if(vertex[k]==0)
```

```
            return;
          if(G[vertex[k-1]][vertex[k]]!=0)
          {
            for(j=1;j<=k-1;j++)//every adjacent vertex
            {
              if(vertex[j] == vertex[k])// not a distinct vertex
                break;
            }
            if(j==k)// obtain a distinct vertex
            {
              if ((k < n) || (k == n) && (G[vertex[n]][vertex[1]] !=0))
                return;//return a distinct vertex
            }
          }
        }
      }
  public static void H_cycle(int G[][],int n ,int k)
{
  int i;
  while(true)
  {
```

```
    Nextvertex(G,n,k);
    if (vertex[k]==0)
       return;
    if(k==n)
    {
       System.out.print("\n");
       for(i=1;i<=n;i++)
          System.out.print(vertex[i]+"->");
       System.out.print(""+vertex[1]);
    }
    else
       H_cycle(G,n,k+1);
     }
  }
```

Program for hamiltonian cycle Enter number of vertices of graph

6

enter the total no of edges

10

enter the edge

1 2

enter the edge

1 3

enter the edge

1 6

enter the edge

2 4

enter the edge

2 6

enter the edge

3 4

enter the edge

3 5

enter the edge

3 6

enter the edge

4 5

enter the edge

4 6

Hamiltonian cycle

1->2->4->5->3->6->1

1->2->6->4->5->3->1

1->3->5->4->2->6->1

1->3->5->4->6->2->1

1->6->2->4->5->3->1

1->6->3->5->4->2->1