19MAT202 OPTIMIZATION TECHNIQUES

Assignment

Application Problem of Optimization

Submitted by:

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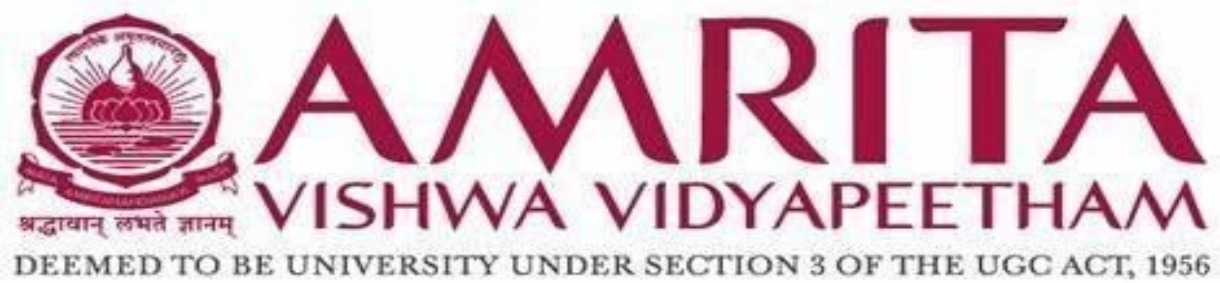
SECTION: CSE-B **-BL.EN.U4CSE22184**

Submitted to

Ms. Mamatha T.M.



AMRITA SCHOOL OF ENGINEERING

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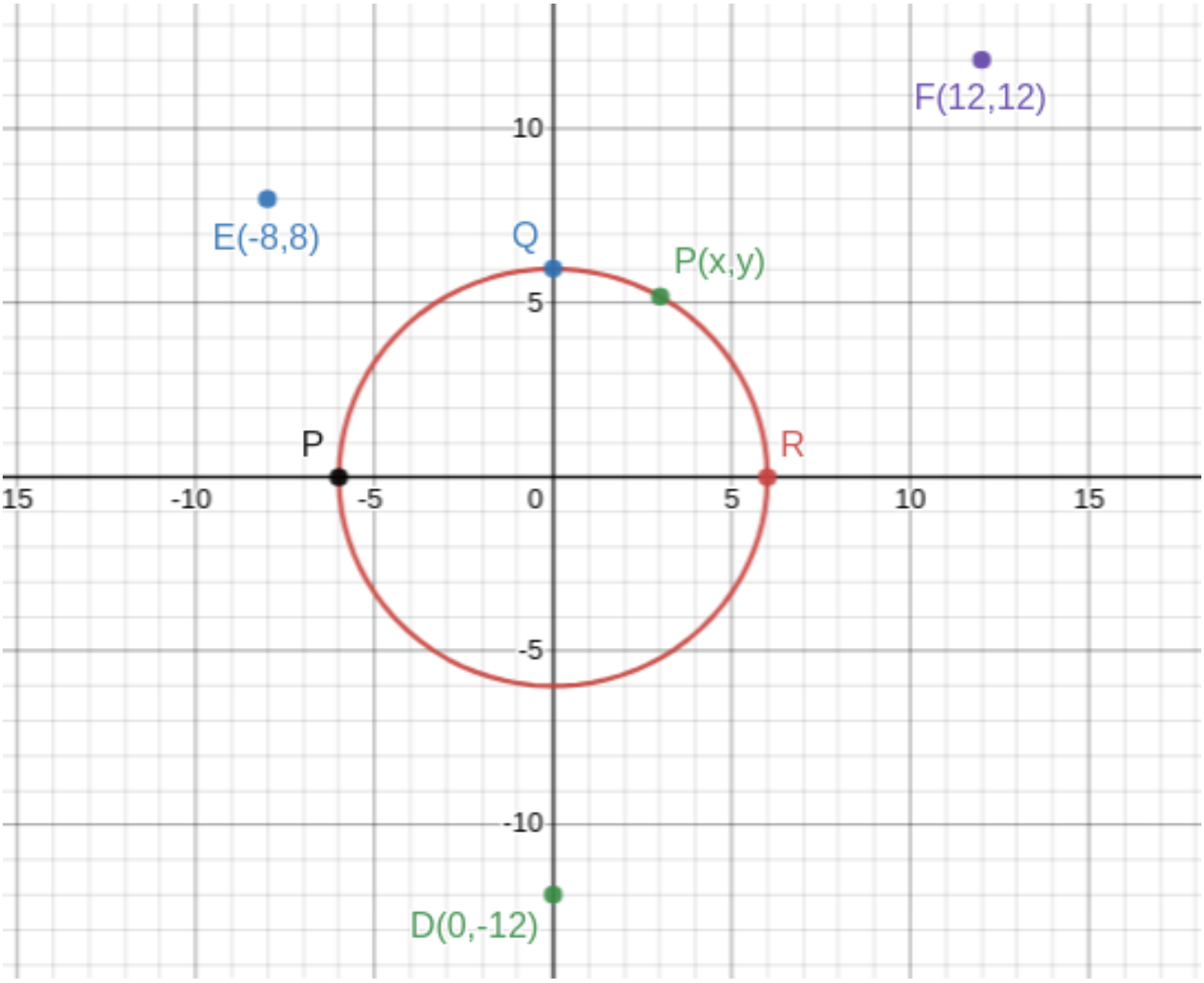
Problem Statement

A Renewable Energy Company plans to install a wind turbine on a circular plateau, denoted as Circle PQR, located between three towns D, E, and F. The towns have coordinates (0, -12), (-8, 8), and (12, 12), respectively, with the center of the plateau situated at the origin. The plateau has a radius of 6 kilometers. Determine the optimal location on the upper half of the circumference of the plateau (Circle PQR) for the wind turbine to minimize the total cable length required to connect all three towns. (All values are in kilometers.)

Solution:

Let the coordinates of tower be P(x, y). The following graph provides pictorial interpretation of above problem:



Formulation of Optimization Problem:

In order to reduce cable length, the sum of distance of each city from wind turbine has to be minimized.

Minimize: DP + EP + FP

$$f(x,y) = \sqrt{(x-0)^2+(y+12)^2} + \sqrt{(x+8)^2+(y-8)^2} + \sqrt{(x-12)^2+(y-12)^2}$$

Subject to:

$$x^2 + y^2 = 36$$
$$-6 \leq x \leq 6$$
$$y \geq 0$$

Classification of Optimization Problem:

- Multi-variable Optimization Problem
- Non-linear Optimization Problem
- Constrained Optimization Problem
- Deterministic Optimization Problem
- Continuous Optimization Problem
- Single Objective Problem

This two optimization function can be reduced in one variable.

Since, $x^2 + y^2 = 36 \quad \& \quad y \geq 0$

So, y can be expressed as: $y = \sqrt{36 - x^2}$

Now, y can be replaced with its corresponding value in terms of x in above optimization function making it single variable function.

Selection of Suitable Method:

Since, Minimum of function at x has to be evaluated within range [-6,6]. So, Interval based method would be suitable for this problem.

Selected Method: **Golden Search Method**

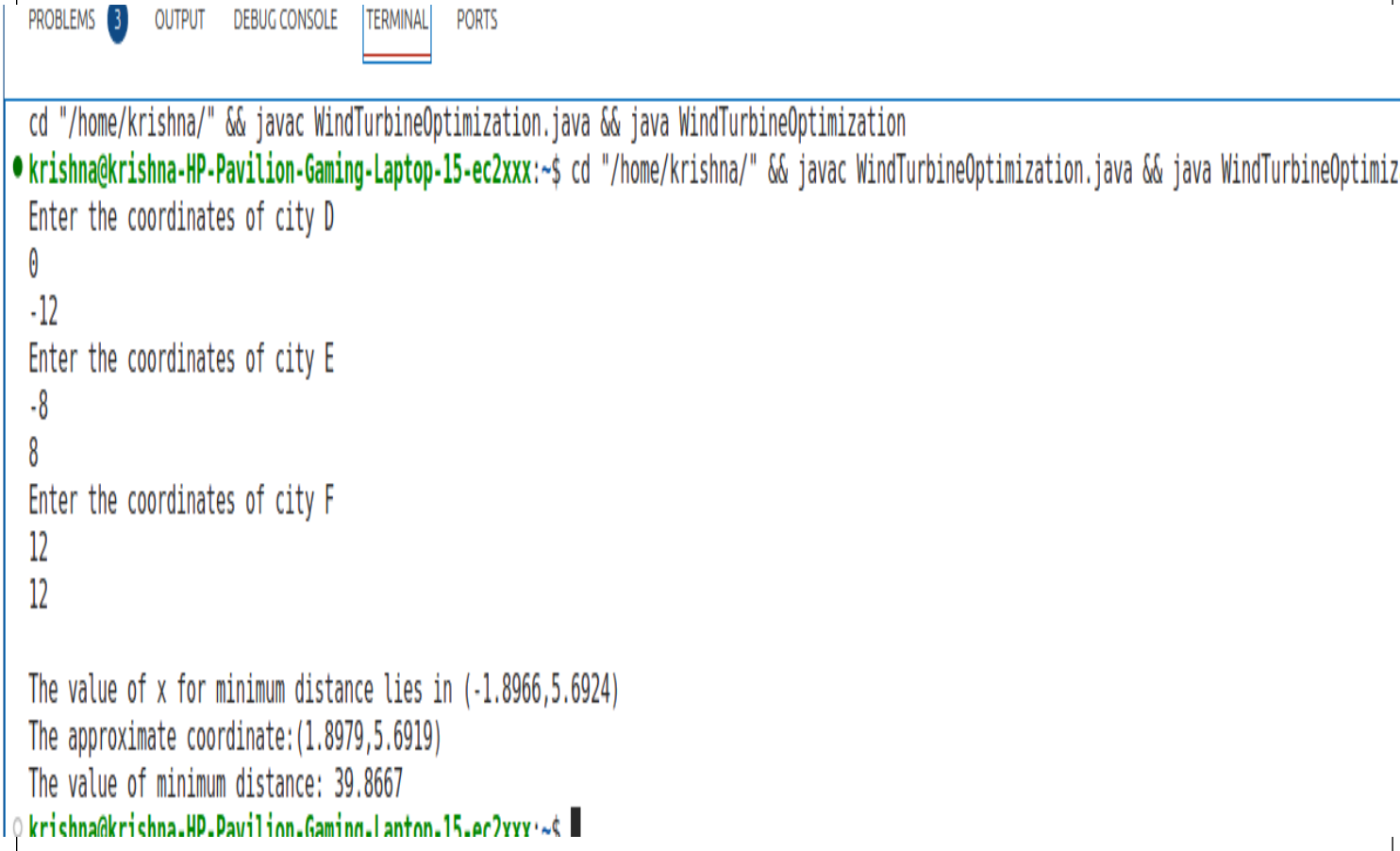
Code:

home > krishna > J WindTurbineOptimization.java > ...

```java
import java.util.Scanner;

public class WindTurbineOptimization {

    static double x1, y1, x2, y2, x3, y3;
    static double a = -6;
    static double b = 6;

    Run | Debug
    public static void main(String[] args) {
        Scanner scanner = new Scanner(System.in);

        System.out.println("Enter the coordinates of city D");
        x1 = scanner.nextDouble();
        y1 = scanner.nextDouble();

        System.out.println("Enter the coordinates of city E");
        x2 = scanner.nextDouble();
        y2 = scanner.nextDouble();

        System.out.println("Enter the coordinates of city F");
        x3 = scanner.nextDouble();
        y3 = scanner.nextDouble();

        // Initial Interval
        double aw = 0;
        double bw = 1;
        double g = 0.618;
        double epsilon = 0.0001;

        int n = (int) Math.ceil(Math.log(1 / (b - a)) / Math.log(g));

        for (int i = 0; i < n; i++) {
            double lw = bw - aw;
            double w1 = aw + g * lw;
            double w2 = bw - g * lw;

            double s = (w1 < w2) ? w1 : w2;
            b = (w1 > w2) ? w1 : w2;

            if (fw(s) > fw(b)) {
                aw = s;
            } else {
                bw = b;
            }
        }

        double x = a + aw * (b - a);
        double y = getY(x);
        System.out.println();
        System.out.println("The value of x for minimum distance lies in (" + round(x, places:4) + "," + round(y, places:4) + ")");
        double avgx = round((x + y) / 2, places:4);
        double avgy = round(getY(avgx), places:4);
        System.out.println("The approximate coordinate:(" + avgx + "," + avgy + ")");
        System.out.println("The value of minimum distance: " + round(f(avgx), places:4));
    }

```

```
56
57      static double getY(double x) {
58          return Math.sqrt(25 - x * x);
59      }
60
61      static double f(double x) {
62          double y = getY(x);
63          return Math.sqrt((x - x1) * (x - x1) + (y - y1) * (y - y1))
64                  + Math.sqrt((x - x2) * (x - x2) + (y - y2) * (y - y2))
65                  + Math.sqrt((x - x3) * (x - x3) + (y - y3) * (y - y3));
66      }
67
68      static double fw(double w) {
69          return f(a + w * (b - a));
70      }
71
72      static double round(double value, int places) {
73          double scale = Math.pow(10, places);
74          return Math.round(value * scale) / scale;
75      }
76  }
77
```

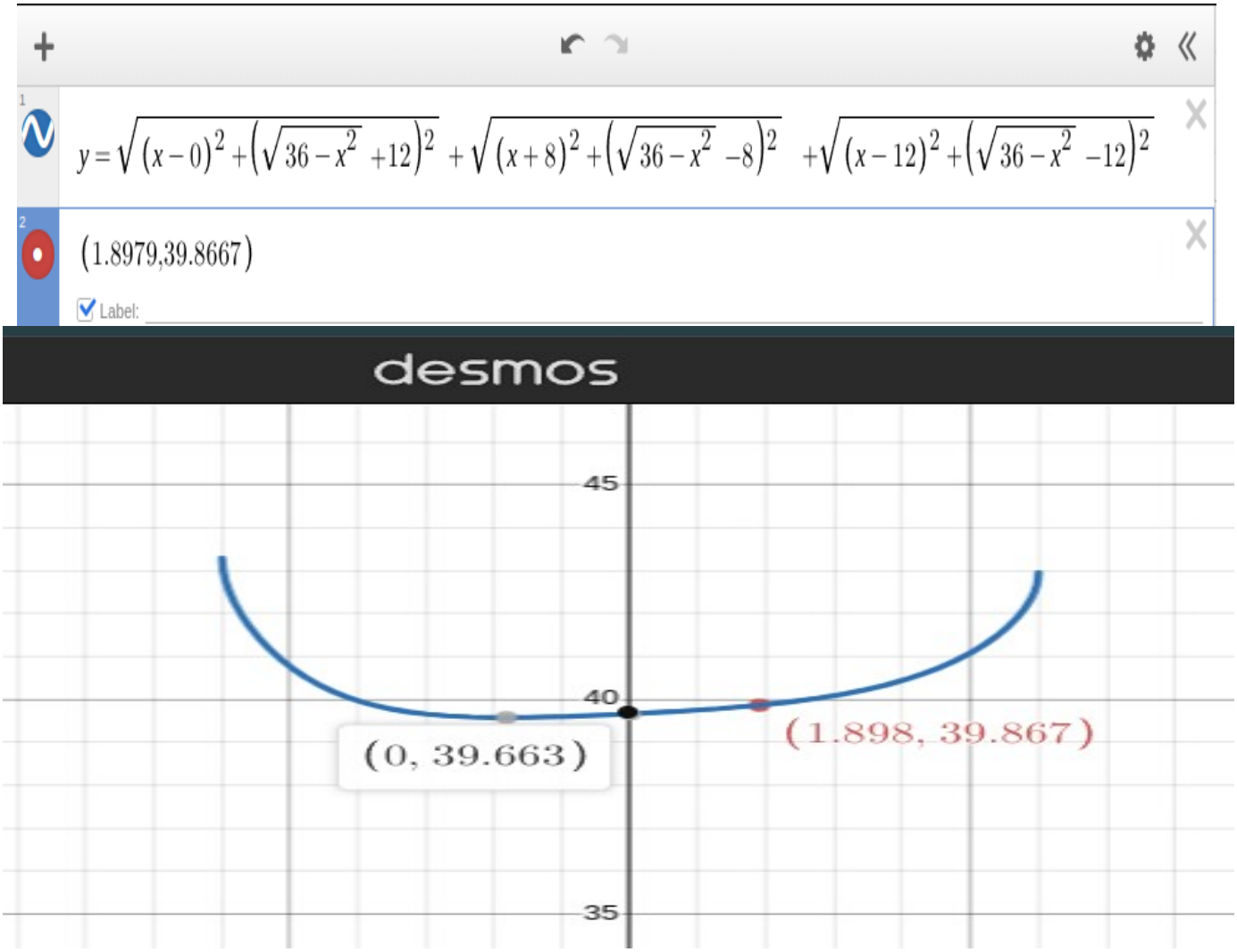
OUTPUT:



RESULT:

The coordinates for optimal location of telephone tower is found to be (1.8979, 5.6919) and the minimum value of sum of distances from all three cities is 39.8667 km.

VERIFICATION:



CONCLUSION:

The above curve is drawn by Desmos web App and the obtained minimum value of function is same as that obtained by the code.

Hence, The optimal location of wind turbine is determined.