PHYSICS-II
MIDTERM ASSIGNMENT

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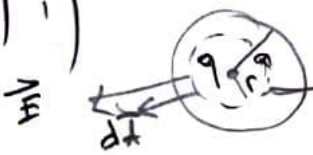
1) a) i)

$r < a$



Note: $\vec{E} \longrightarrow$, $d\vec{A} \longrightarrow$ } $\cos 0$ or $\cos 180$

$$\frac{q_{in}}{\Sigma_0} = \oint \vec{E} \cdot d\vec{A}$$

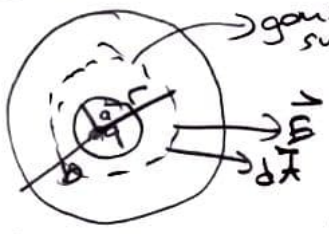
$$\frac{q_{in}}{\Sigma_0} = E \int dA \cos 0$$

$$\frac{q}{\Sigma_0} = E\, 4\pi r^2$$

$$\boxed{\frac{q}{4\Sigma_0 \pi r^2} = E}$$

ii)

$a < r < b$



$\vec{E} \longrightarrow$, $d\vec{A} \longrightarrow$ } $\cos 0$ or $\cos 180$

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\Sigma_0}$$

$$\frac{Q_{in}}{V_{in}} = \frac{Q}{V} = \rho$$

$$\frac{Q_{in}}{\frac{4}{3}\pi r^3 - \frac{4}{3}\pi a^3} = \frac{Q}{\frac{4}{3}\pi b^3 - \frac{4}{3}\pi a^3}$$

$$\boxed{Q_{in} = \frac{Q(r^3 - a^3)}{b^3 - a^3}}$$

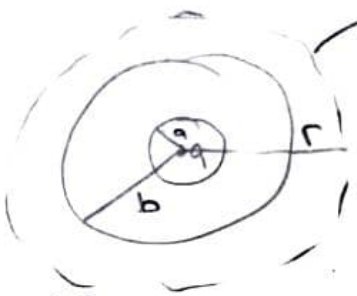
$$E \int dA \cos 0 = \frac{q + Q_{in}}{\Sigma_0}$$

$$E\, 4\pi r^2 = \frac{q + \frac{Q(r^3 - a^3)}{b^3 - a^3}}{\Sigma_0}$$

$$E = \frac{q(b^3 - a^3) + Q(r^3 - a^3)}{4\pi r^2 \Sigma_0 (b^3 - a^3)}$$

$$\boxed{E = \frac{q}{4\Sigma_0 \pi r^2} + \frac{Q(r^3 - a^3)}{4\pi \Sigma_0 r^2 (b^3 - a^3)}}$$

iii) $b < r$



$\vec{E}$ → cos 0 or cos 180

$d\vec{A}$ → cos 180

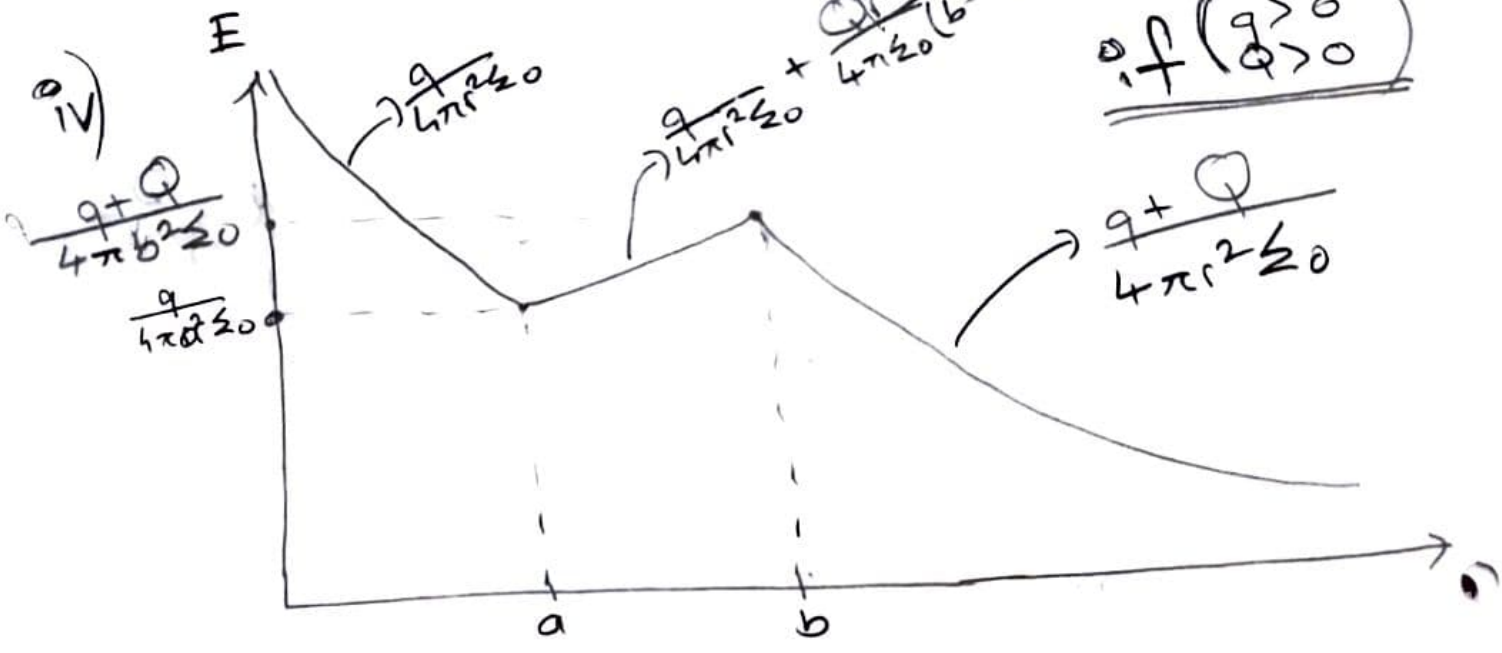
$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

$$E \int dA \cos 0 = \frac{q+Q}{\varepsilon_0}$$

$$E\, 4\pi r^2 = \frac{q+Q}{\varepsilon_0}$$

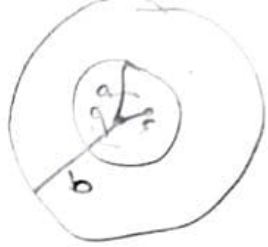
$$\boxed{E = \frac{q+Q}{4\pi r^2 \varepsilon_0}}$$

iv)



if $q > 0$, $Q > 0$

1) b) a) $r < a$



$$\Delta V = -\int_{\infty}^{r} \vec{E}.d\vec{r}$$

$$\Delta V = -\int_{\infty}^{r} \frac{q}{4\pi\varepsilon_0 r^2}\cos 0^{\circ}$$

$$V_r - V_{\infty} = -\frac{q}{4\pi\varepsilon_0}\left[-\frac{1}{r}\right]_{\infty}^{r} = -\frac{q}{4\pi\varepsilon_0}\left(-\frac{1}{r}\right) = \frac{q}{4\pi\varepsilon_0 r}$$

a, a) $a < r < b$

$$\Delta V = -\int_{b}^{r} \vec{E}.d\vec{r}$$

$$V_r - V_b = -\int_{b}^{r} \frac{1}{4\pi\varepsilon_0}\left(\frac{Q(r^3-a^3)}{(b^3-a^3)r^2} + \frac{q}{r^2}\right)$$

$$V_r - V_b = -\frac{1}{4\pi\varepsilon_0}\left(\int_{b}^{r}\frac{Qr}{b^3-a^3} - \int_{b}^{r}\frac{Qa^3}{(b^3-a^3)r^2} + \int_{b}^{r}\frac{q}{r^2}\right)$$

$$V_r - V_b = -\frac{1}{4\pi\varepsilon_0}\left(\left[\frac{Qr^2}{2(b^3-a^3)}\right]_b^r - \left[-\frac{Qa^3}{(b^3-a^3)r}\right]_b^r + \left[-\frac{q}{r}\right]_b^r\right)$$

$$V_r - V_b = -\frac{1}{4\pi\varepsilon_0}\left(\frac{Qr^2 - Qb^2}{2(b^3-a^3)} - \left[-\frac{Qa^3}{(b^3-a^3)r} + \frac{Qa^3}{(b^3-a^3)b}\right] + \left(-\frac{q}{r} + \frac{q}{b}\right)\right)$$

(2b) (2r)

$$V_r - V_b = -\frac{1}{4\pi\varepsilon_0}\left(\frac{Qr^3b - Qrb^3 + Q2a^3b - Qa^32r}{2rb(b^3-a^3)} - \frac{q}{r} + \frac{q}{b}\right) + \frac{Q+q}{4\pi\varepsilon_0 r}$$

$\frac{Q+q}{4\pi\varepsilon_0 r}$

$$\boxed{V_r = -\frac{1}{4\pi\varepsilon_0}\left(\frac{Qr^3b - Qrb^3 + Q2a^3b - Qa^32r}{2rb(b^3-a^3)} - \frac{2q}{r} + \frac{q}{b} - \frac{Q}{r}\right)}$$

iii) $r > b$

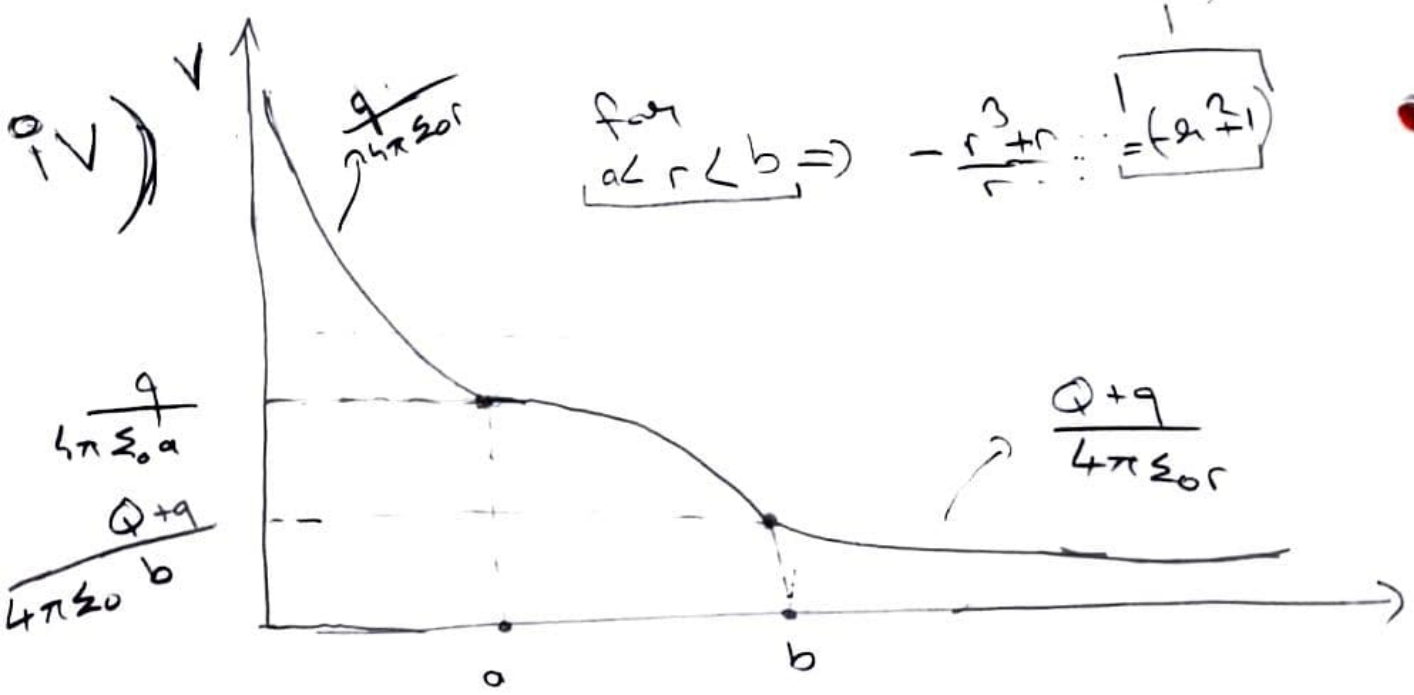
$$\Delta V = -\int_{\infty}^{r} \vec{E} \cdot d\vec{r}$$

$$= -\int_{\infty}^{r} \frac{Q+q}{4\pi\varepsilon_0 r^2} dr \cos 0^\circ$$

$$V_r - V_\infty = \frac{-(Q+q)}{4\pi\varepsilon_0}\left[-\frac{1}{r}\right]_{\infty}^{r} = \left(\frac{-(Q+q)}{4\pi\varepsilon_0}\right)\left(-\frac{1}{r}\right)$$

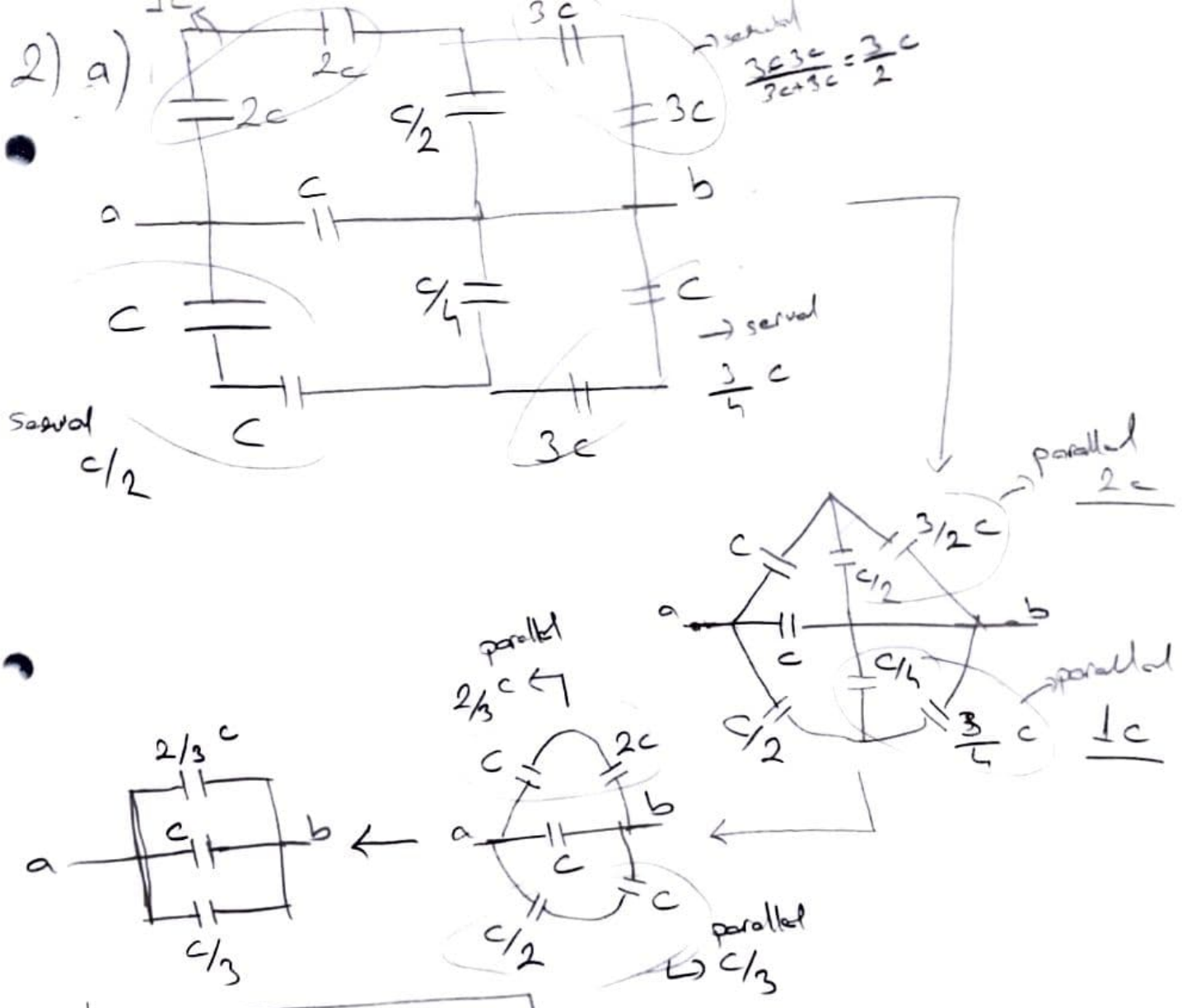
$$V(r) = \frac{Q+q}{4\pi\varepsilon_0 r}$$

for function

iv) 

for $a < r < b \Rightarrow -\frac{r^3+r}{r} = -(r^2+1)$

2) a)



$$C_{eq} = \frac{2}{3}c + c + \frac{c}{3} = 2c = \underline{\underline{2nF}}$$

b) $Q = C\,\Delta V$

$Q = 2nF \cdot 100V$

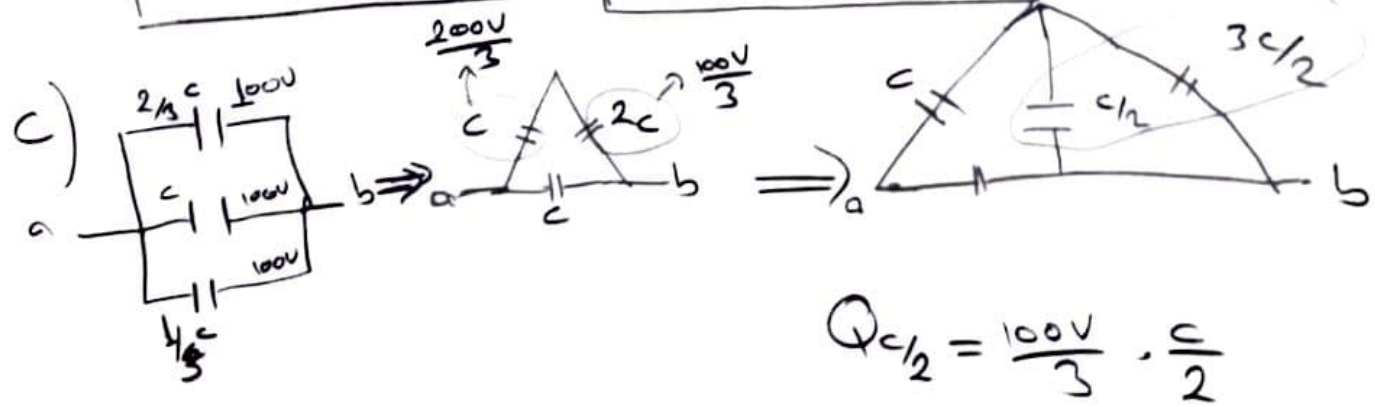
$$Q_{Total} = 200nFV$$

$$U_T = \frac{1}{2} C_T \Delta V^2$$

$$U_T = \frac{1}{2}\, 2nF\,(100)^2$$

$$U_T = 10000nJ$$

c)



$$Q_{c/2} = \frac{100V}{3} \cdot \frac{c}{2}$$

$$Q_{c/2} = \frac{50Vc}{3}$$

3) Programlama kısmı için Java programlama dilinde OOP yapısında altında oluşturulan ***IElectric inteface'i, Charge ve MyPoint*** nesneleri kullanılmıştır. Charge sınıfında içerisinde tek bir yükün belirtilen herhangi bir noktadaki Elektrik potansiyeli, elektrik alan vektör büyüklüğü ve vektörün x-ekseni ile yaptığı açılar tespit edilebilmektedir. Aynı zamanda eFieldVectorAdd() metodu ile iki yükün belli bir noktada oluşturduğu elektrik alan vektörünün şiddeti ve açısı tespit edilebilmektedir. Tüm bunlarla birlikte yaptığım araştırmalar sonucu İngilizce yazılmış **opensourcephyscs library** isimli 500 sayfalık bir kitap okunmuş ve sonucunda ScalarFrame altında grafikler çizdirilmiştir.

```
term_20190808020 C:\Users\KOZAN\
idea
out
src
Midterm_20190808020.java
```

```java
import org.opensourcephysics.display.Dataset;
import org.opensourcephysics.frames.PlotFrame;
import org.opensourcephysics.frames.Scalar2DFrame;

import javax.swing.*;
```

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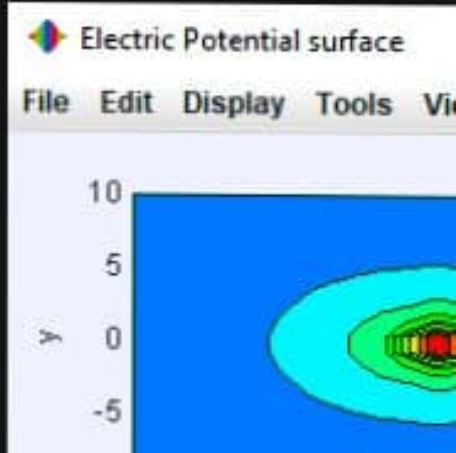
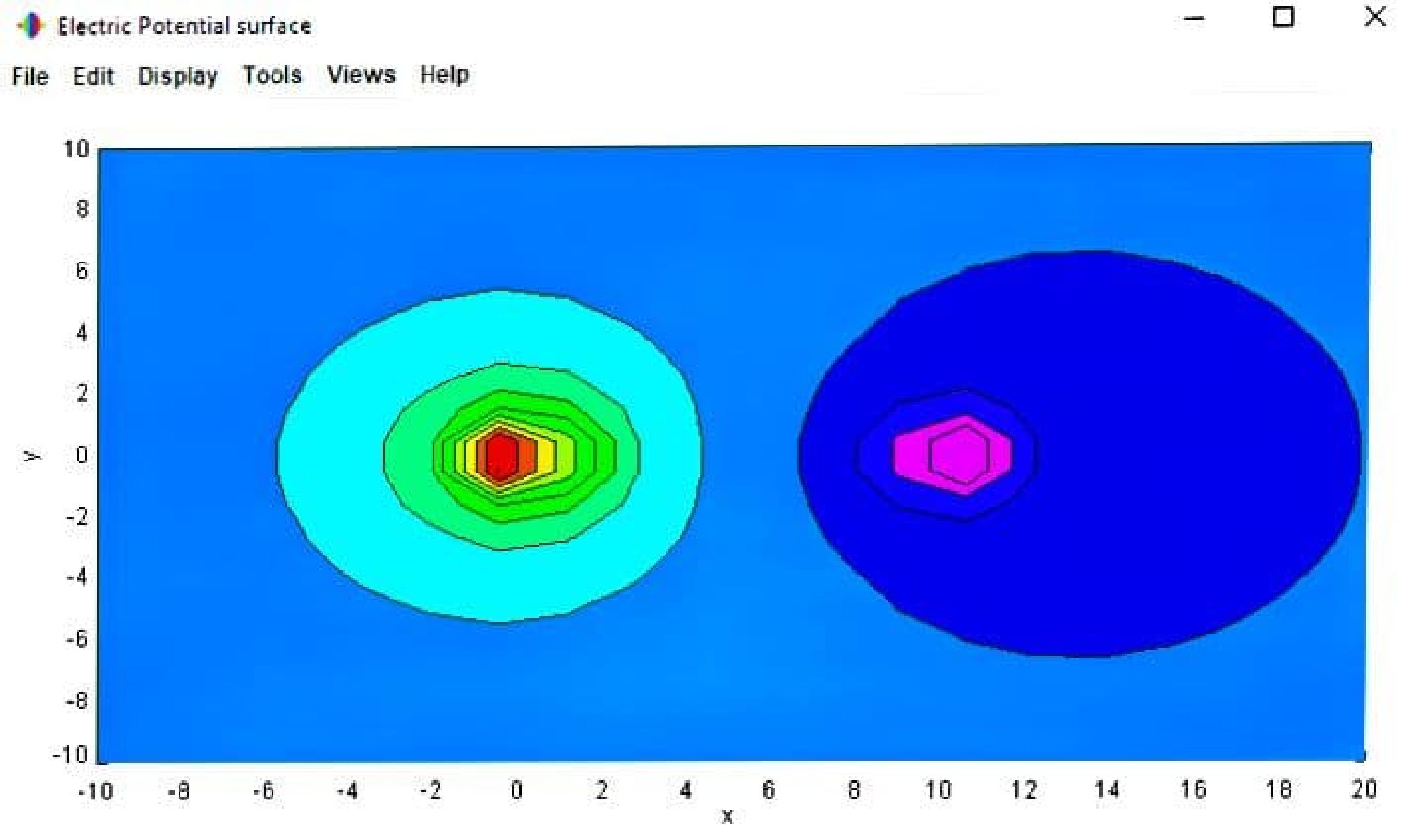
```
"C:\Program Files\Java\jdk-13.0.2\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Ed
3)  a)
  i)+2Q and -Q charge's electirc field vector magnitude is 1080,000 and angle is -0,000 at the the (5.0, 0.0)
  ii)+2Q and -Q charge's electirc field vector magnitude is 322,381 and angle is 28,366 at the the (5.0, 5.0)
  iii)+2Q and -Q charge's electirc field vector magnitude is 322,381 and angle is -28,366 at the the (5.0, -5.0)
3)  b)
  i) 5, 0 noktasında +2q ve -q nun oluşturduğu elektrik potansiyeli: 180,0 Volt tur.
  ii) 5, 5 noktasında +2q ve -q nun oluşturduğu elektrik potansiyeli: 127,3 Volt tur.
  iii) 5, -5 noktasında +2q ve -q nun oluşturduğu elektrik potansiyeli: 127,3 Volt tur.
```

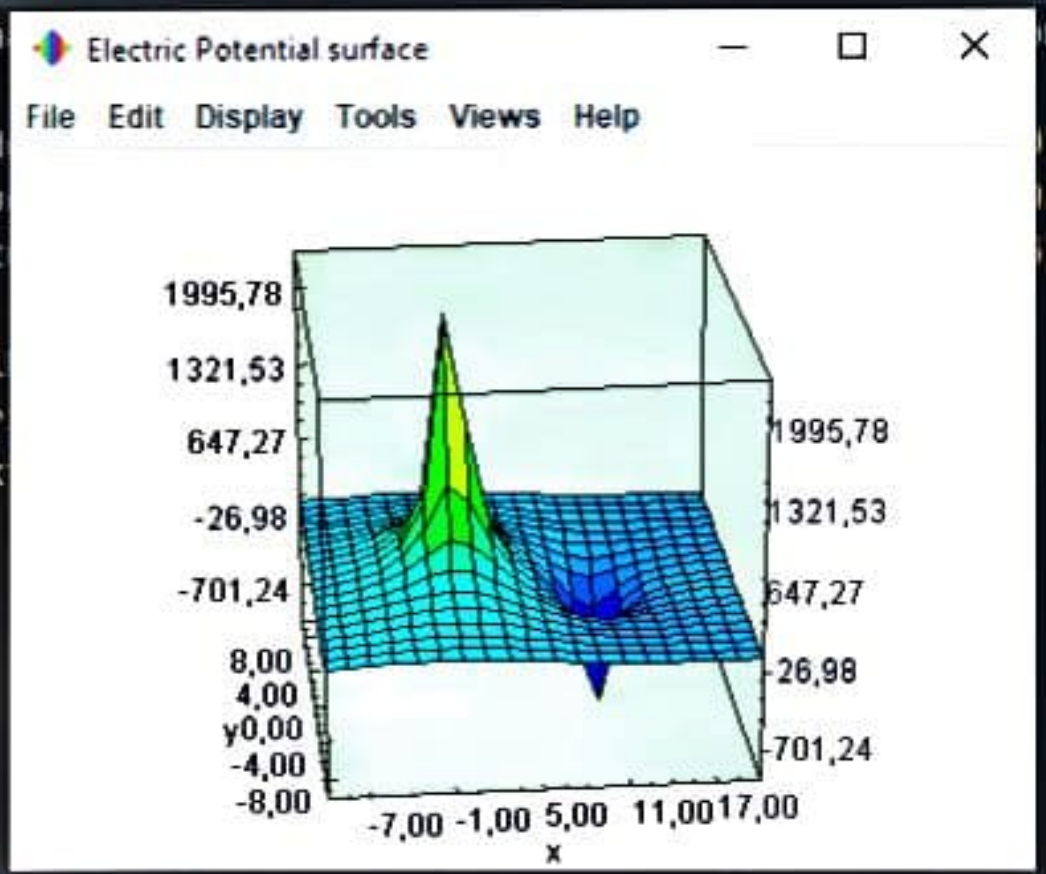


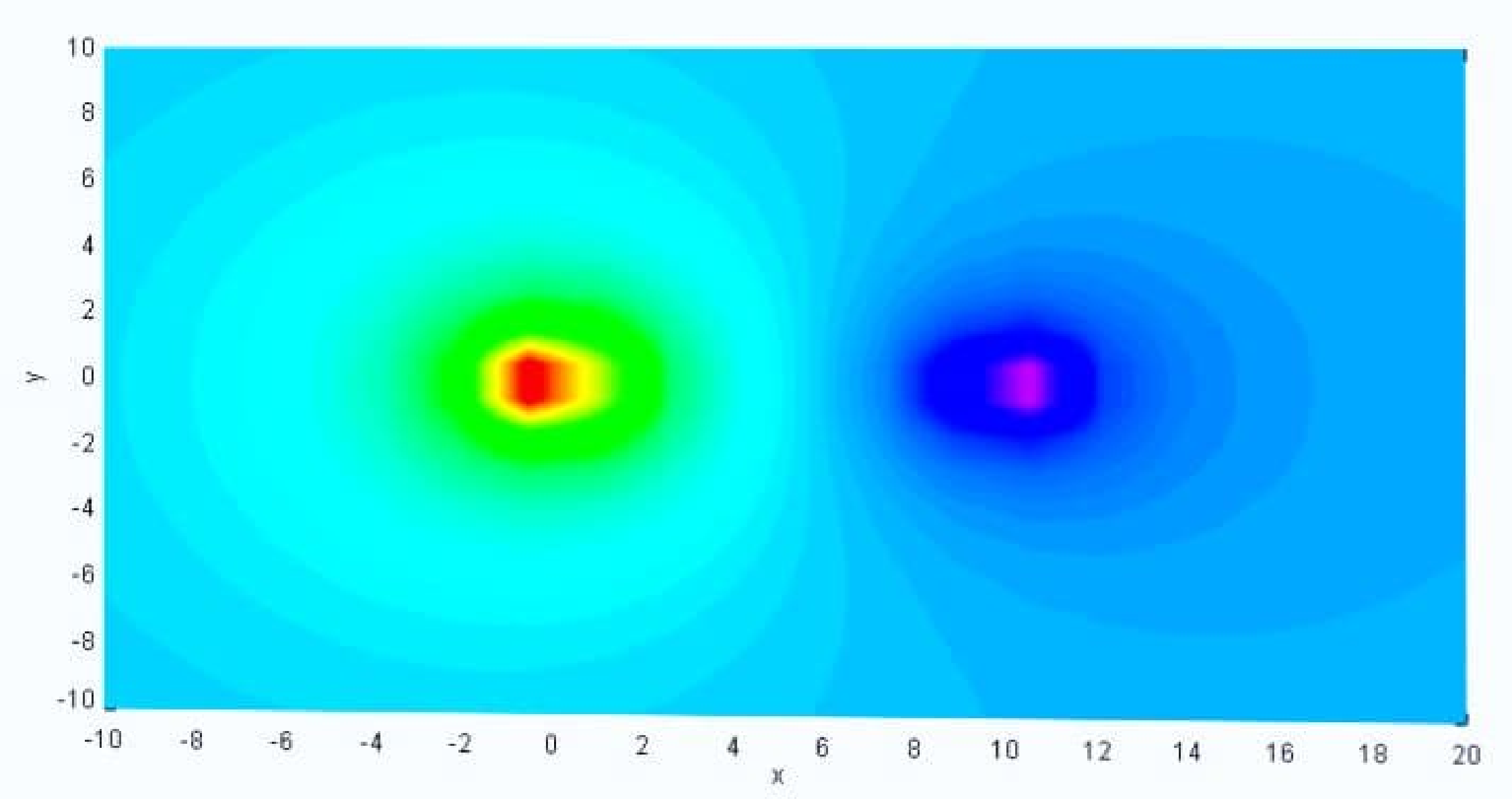

Electric Potential surface
File Edit Display Tools Views Help
10
8
6
4
2
0
-2
-4
-6
-8
-10
y
-10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20
x

Midterm_20190808020

```
"C:\Program Files\Java\jdk-13.0.2\bin\java.exe" "-java
3)  a)
  i)+2Q and -Q charge's electirc field vector magnitud
  ii)+2Q and -Q charge's electirc field vector magnitu
  iii)+2Q and -Q charge's electirc field vector magnit
3)  b)
  i) 5, 0 noktasında +2q ve -q nun oluşturduğu elektri
  ii) 5, 5 noktasında +2q ve -q nun oluşturduğu elektr
  iii) 5, -5 noktasında +2q ve -q nun oluşturduğu elek
3)  c)   iii)
Potential Value Zero point is: (8, -4)

Potential Value Zero point is: (8, 4)
```




10
8
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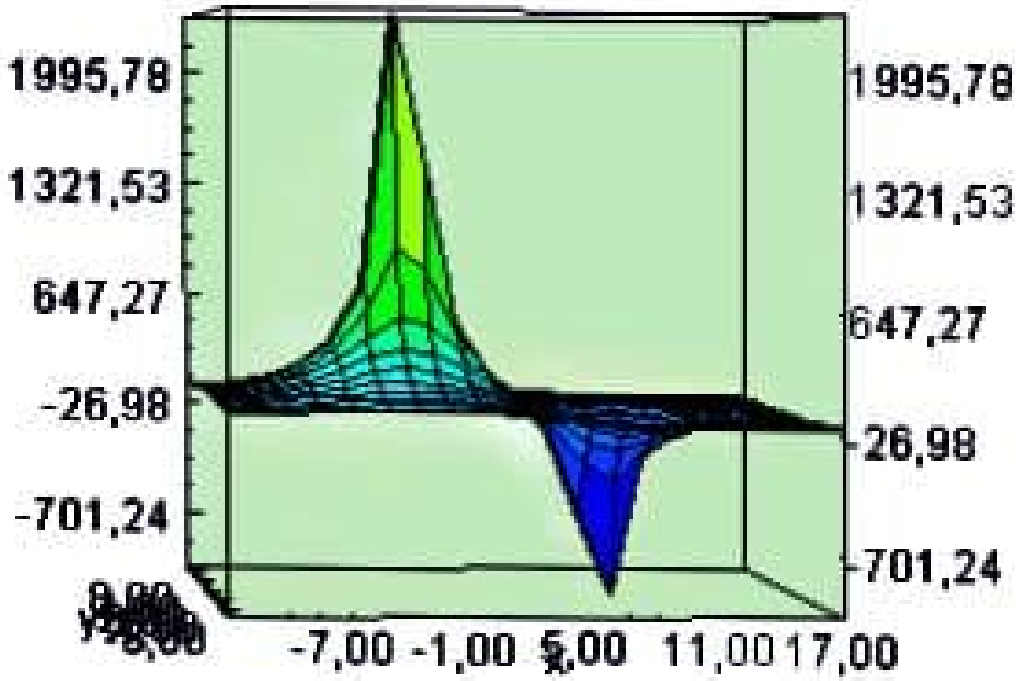
12
14
16
18
20
x

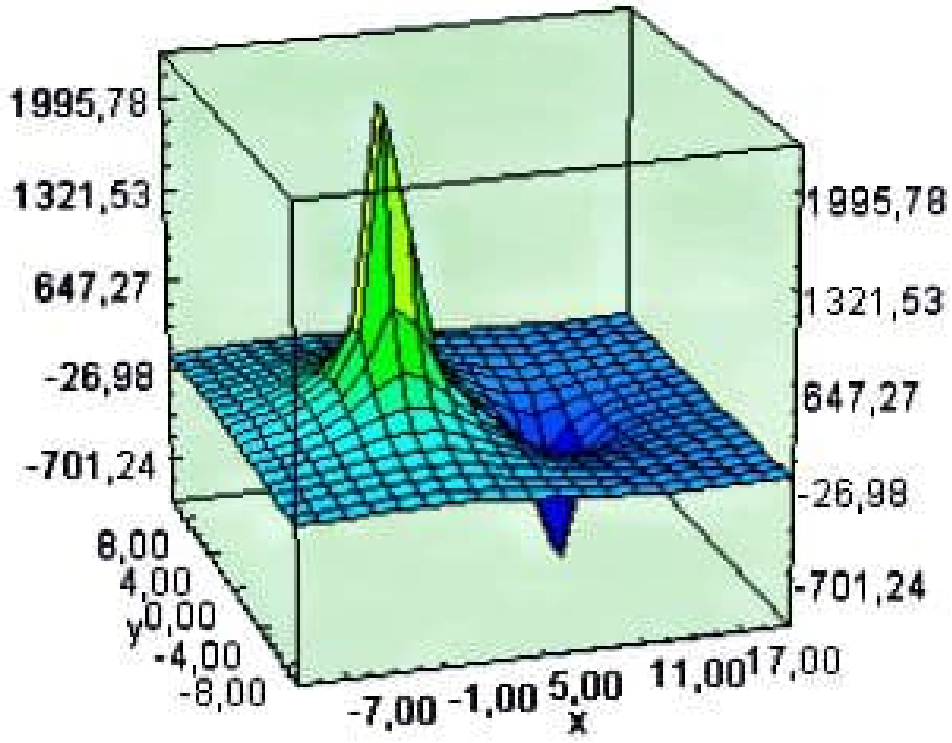
: Potential surface

Display Tools Views Help



Electric Potential surface

File Edit Display Tools Views Help



Potential Value is: 26,981 Volt at the (12, -10)
Potential Value is: 22,381 Volt at the (12, -9)
Potential Value is: 15,667 Volt at the (12, -8)
Potential Value is: 5,942 Volt at the (12, -7)
Potential Value is: -8,138 Volt at the (12, -6)
Potential Value is: -28,664 Volt at the (12, -5)
Potential Value is: -58,944 Volt at the (12, -4)
Potential Value is: -104,094 Volt at the (12, -3)
Potential Value is: -170,239 Volt at the (12, -2)
Potential Value is: -253,010 Volt at the (12, -1)
Potential Value is: -300,000 Volt at the (12, 0)
Potential Value is: -253,010 Volt at the (12, 1)
Potential Value is: -170,239 Volt at the (12, 2)
Potential Value is: -104,094 Volt at the (12, 3)
Potential Value is: -58,944 Volt at the (12, 4)
Potential Value is: -28,664 Volt at the (12, 5)
Potential Value is: -8,138 Volt at the (12, 6)
Potential Value is: 5,942 Volt at the (12, 7)
Potential Value is: 15,667 Volt at the (12, 8)
Potential Value is: 22,381 Volt at the (12, 9)
Potential Value is: 23,544 Volt at the (13, -10)
Potential Value is: 18,974 Volt at the (13, -9)
Potential Value is: 12,585 Volt at the (13, -8)
Potential Value is: 3,736 Volt at the (13, -7)
Potential Value is: -8,447 Volt at the (13, -6)

```
Potential Value is: 225,836 Volt at the (4, 3)
Potential Value is: 193,391 Volt at the (4, 4)
Potential Value is: 165,880 Volt at the (4, 5)
Potential Value is: 143,549 Volt at the (4, 6)
Potential Value is: 125,644 Volt at the (4, 7)
Potential Value is: 111,246 Volt at the (4, 8)
Potential Value is: 99,557 Volt at the (4, 9)
Potential Value is: 80,498 Volt at the (5, -10)
Potential Value is: 87,416 Volt at the (5, -9)
Potential Value is: 95,400 Volt at the (5, -8)
Potential Value is: 104,623 Volt at the (5, -7)
Potential Value is: 115,233 Volt at the (5, -6)
Potential Value is: 127,279 Volt at the (5, -5)
Potential Value is: 140,556 Volt at the (5, -4)
Potential Value is: 154,349 Volt at the (5, -3)
Potential Value is: 167,126 Volt at the (5, -2)
Potential Value is: 176,505 Volt at the (5, -1)
Potential Value is: 180,000 Volt at the (5, 0)
Potential Value is: 176,505 Volt at the (5, 1)
Potential Value is: 167,126 Volt at the (5, 2)
Potential Value is: 154,349 Volt at the (5, 3)
Potential Value is: 140,556 Volt at the (5, 4)
Potential Value is: 127,279 Volt at the (5, 5)
Potential Value is: 115,233 Volt at the (5, 6)
Potential Value is: 104,623 Volt at the (5, 7)
```

```
public static double Kq = 9;

public static void main(String[] args){
    Charge charge1 = new Charge( x: 0, y: 0, q: 2);
    Charge charge2 = new Charge( x: 10, y: 0, q: -1);

    System.out.println("3)  a)");
    System.out.print("  i)");
    MyPoint point1 = new MyPoint( x: 5, y: 0);
    charge1.eFieldVectorAdd(charge2, point1);

    System.out.print("  ii)");
    MyPoint point2 = new MyPoint( x: 5, y: 5);
    charge1.eFieldVectorAdd(charge2,point2);

    System.out.print("  iii)");
    MyPoint point3 = new MyPoint( x: 5, y: -5);
    charge1.eFieldVectorAdd(charge2,point3);

    double resultPot2charges1 = charge1.potentialAt( x: 5, y: 0) + charge2.potentialAt( x: 5, y: 0);
    double resultPot2charges2 = charge1.potentialAt( x: 5, y: 5) + charge2.potentialAt( x: 5, y: 5);
    double resultPot2charges3 = charge1.potentialAt( x: 5, y: -5) + charge2.potentialAt( x: 5, y: -5);

    System.out.println("3)  b)");
    System.out.printf("  i) 5, 0 noktasında +2q ve -q nun oluşturduğu " +
            "elektrik potansiyeli: %.1f Volt tur.\n", resultPot2charges1);
    System.out.printf("  ii) 5, 5 noktasında +2q ve -q nun oluşturduğu " +
            "elektrik potansiyeli: %.1f Volt tur.\n", resultPot2charges2);
    System.out.printf("  iii) 5, -5 noktasında +2q ve -q nun oluşturduğu " +
```

```
System.out.printf("  iii) 5, -5 noktasında +2q ve -q nun oluşturduğu " +
        "elektrik potansiyeli: %.1f Volt tur.\n", resultPot2charges3);

Scalar2DFrame frame = new Scalar2DFrame( xlabel: "x", ylabel: "y", frameTitle: "Electric Poten
double[][] data = new double[20][20];
frame.setAll(data, xmin: -10, xmax: 20, ymin: -10, ymax: 10);
double xs1 = charge2.getX(), ys1 = charge2.getY();
double xs = charge1.getX(), ys = charge1.getY();
for(int ix = 0; ix < 20; ix++){
    double x = frame.indexToX(ix);
    double dx = (xs - x);
    double dx1 = (xs1 - x);
    for(int iy = 0; iy < 20; iy++){
        double y = frame.indexToY(iy);
        double dy = (ys - y);
        double dy1 = (ys1 - y);
        double r2 = dx * dx + dy * dy;
        double r = Math.sqrt(r2);
        double r3 = dx1 * dx1 + dy1 * dy1;
        double r4 = Math.sqrt(r3);
        data[ix][iy] += charge1.potentialAt(dx,dy) + ((charge2.getQ()*kq)/r4)*100;

    }
```

```
103     }
104
105     class Charge extends MyPoint implements IElectric{
106         private double q;
107
108         public Charge(double x, double y, double q) {
109             super(x, y);
110             this.q = q;
111         }
112
113         public double getQ() { return q; }
116
117         public void setQ(double q) { this.q = q; }
120
121         public double distance(double x, double y){
122             double dx = x - this.getX();
123             double dy = y - this.getY();
124             return Math.sqrt((Math.pow(dx, 2) + Math.pow(dy, 2)));
125         }
126
127         @Override
128         public double potentialAt(double x, double y){
129             return ((kq * this.getQ()) / this.distance(x, y)) * 100;
130         }
131
```

```java
public double eFieldVectorMagnitude(MyPoint p){
    return ((this.getQ() * kq) / Math.pow(this.distance(p.getX(),p.getY()), 2)) * 1000;
}

public double eFieldVectorAngle(MyPoint p) throws NotFoundAngleException{
    double dy = p.getY() - getY();
    double dx = p.getX() - getX();
    if(dx != 0)
        return Math.toDegrees(Math.atan(dy/dx));
    else{
        if(dy > 0)
            return 90;
        else if(dy < 0)
            return 270;
        else
            throw new NotFoundAngleException(dx);
    }
}

public void eFieldVectorAdd(Charge c1, MyPoint p){
    double dx1 = Math.cos(this.eFieldVectorAngle(p)) * this.eFieldVectorMagnitude(p);
    double dx2 = Math.cos(c1.eFieldVectorAngle(p)) * c1.eFieldVectorMagnitude(p);
    double dy1 = Math.sin(this.eFieldVectorAngle(p)) * this.eFieldVectorMagnitude(p);
    double dy2 = Math.sin(c1.eFieldVectorAngle(p)) * c1.eFieldVectorMagnitude(p);
    double fieldVectorMagnitude = Math.sqrt(Math.pow((dx2-dx1),2) + Math.pow((dy2-dy1),2));
    double fieldVectorAngle = Math.toDegrees(Math.atan((dy2-dy1)/(dx2-dx1)));
    System.out.printf("+2Q and -Q charge's electirc field vector magnitude " +
            "is %.3f and angle is %.3f at the %s\n",fieldVectorMagnitude,fieldVectorAngle,p.toString());
}
```

```
}
}

interface IElectric{
    double kq = 9;

    double eFieldVectorMagnitude(MyPoint p);
    double potentialAt(double x, double y);
}

class NotFoundAngleException extends RuntimeException{
    private double angle;

    public NotFoundAngleException(double angle) { this.angle = angle; }

    public String toString(){
        return "This is not angle! it is a point. (0,0)";
    }
}
```

```java
class MyPoint{
    private double x;
    private double y;

    public MyPoint(double x, double y){
        this.x = x;
        this.y = y;
    }

    public double getX() { return x; }

    public void setX(double x) { this.x = x; }

    public double getY() { return y; }

    public void setY(double y) { this.y = y; }

    public double distance(double x, double y){
        double dx = x - this.x;
        double dy = y - this.y;
        return Math.sqrt((Math.pow(dx, 2) + Math.pow(dy, 2)));
    }

    public String toString(){
        return "the (" + this.getX() + ", " + this.getY() + ")";
    }
}
```