2.2.1

$$U(P) = \frac{\lambda}{2\pi\epsilon}\log\left(\frac{r_1}{r_2}\right) + U(0)$$

$$r_1^2 = (s+x)^2 + y^2$$

$$r_2^2 = (s-x)^2 + y^2$$

So that : $\frac{r_1}{r_2} = \left(\frac{(s+x)^2+y^2}{(s-x)^2+y^2}\right)^{\frac{1}{2}}$

$$U(P) = \frac{\lambda}{2\pi\epsilon}\log\left(\frac{(s+x)^2+y^2}{(s-x)^2+y^2}\right)\cdot\frac{1}{2} + U(0)$$

$$= \frac{\lambda}{4\pi\epsilon}\log\left(\frac{(s+x)^2+y^2}{(s-x)^2+y^2}\right) + U(0)$$

2.2.2:

Symmetry around the origin: the potential surface is symmetric with respect to the y-axis, reflecting the symmetrical placement of the two parallel wires around the origin. This symmetry corresponds to the equal but opposite charges on the wires.

Potential Wells corresponds to the Wire Positions: The two distinct "wells" or depressions in the potential surface correspond to the locations of the wires at $x = \pm h$. These wells represent the regions where the potential is most negative due to the proximity to the line charges.

Steep gradient between the wires: the steep gradient in the potential between the two wells indicates a strong electric field between the wires. This field is directed from the positively charged wire to the negatively charged wire, Consistent with the physical configuration shown in figure 3.

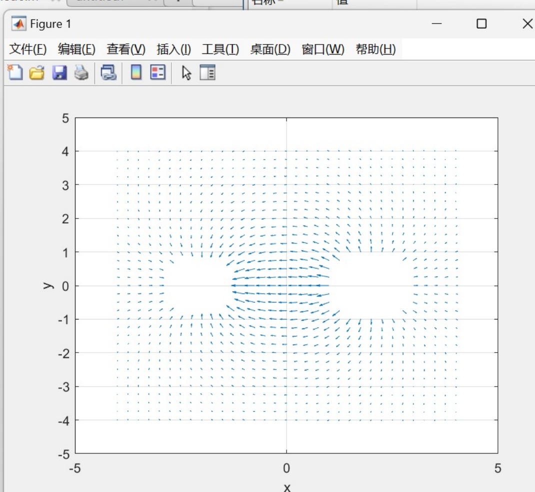
==Flattening of the potential far from the wires:== As you move away from the wires, the potential surface flattens, indicating that the influence of the electric field diminishes with distance from the wires. This corresponds to the weaker field far from the source of the charges.

==Zero potential at the origin:== The origin is set at zero potential, serving as the reference point. The point difference of 2 V between the wires is visualized by the height difference between the two potential wells, reflecting the energy required to move a charge between the two wires.

2.2.3

untitled.m | task7.m | task8.m | task8new.m | pre.m | pre2.m | untitled5.m | untitled6.m | untitled7 *

```
a = 1; h = 2;
k = h/a + sqrt((h/a)^2-1); s = (k^2-1)/k*a/2;
x = -4:.25:4; y = x;
[xx,yy] = meshgrid(x,y);
outofleftcirc = ((xx+h).^2 + yy.^2 - a*a)>=0;
outofrightcirc = ((xx-h).^2 + yy.^2 - a*a)>=0;
cc = outofleftcirc.*outofrightcirc;
den = ((s-xx).^2 + yy.^2).*((s+xx).^2 + yy.^2);
numxx = s*(s^2 - xx.^2 + yy.^2);
numyy = -2*s*xx.*yy;
Exx = -numxx./den.*cc;
Eyy = -numyy./den.*cc;
figure(1);
quiver(xx,yy,Exx,Eyy);
xlabel('x'); ylabel('y');
grid on;
```



2.2.4

1.Symmetry Around the Origin: The electric field is symmetric about the y-axis, similar to the potential in Figure 4. This symmetry arises because the two wires are identical and positioned symmetrically about the origin. This symmetry reflects the distribution of the electric potential, where both the field and potential exhibit symmetric behavior centered along the axis between the wires.

2. Field Lines Between the Wires: The field lines originate from the positively charged wire and terminate at the negatively charged wire. The density and direction of the field lines reflect the strength and direction of the electric field, which corresponds to the gradient of the potential shown in Figure 4. The field lines' behavior indicates that the electric field is strongest near the wires, where the potential gradient is steepest.

3.Strong Field Near the Wires: The electric field is strongest near the wires, where the potential changes most rapidly. This is represented by the steeper regions in Figure 4. where the potential wells are located. The high density of field lines near the wires further emphasizes this strong electric field, which is consistent with the steep potential gradients observed

4.Field Lines Curving Outward: The electric field lines curve outward as they move away4from the wires, indicating a decrease in field strength with distance. This relates to the flattening of the potential surface in Figure 4 as you move farther from the wires. The outward curvature of the field lines also illustrates the effect of the wire geometry and spacing on the field distribution.

5.Electric Field and Potential Gradient: The electric field represents the negative gradient of the potential U(P). This means that the electric field vectors in Figure 5 point in the direction where the potential decreases most rapidly. The steepness of the potential surface in Figure 4 corresponds directly to the strength of the electric field in Figure 5.

2.3.1

$$U(\vec{P}) = \frac{\lambda}{2\pi\epsilon}\log(K) + U(\vec{O})$$

Because of $K^+, K^- = \frac{h}{a} \pm \sqrt{(\frac{h}{a})^2 - 1}$

$$\therefore U(\vec{P}^+) = \frac{\lambda}{2\pi\epsilon}\log\left(\frac{h}{a} + \sqrt{(\frac{h}{a})^2 - 1}\right) + U(\vec{O})$$

$$U(\vec{P}^-) = \frac{\lambda}{2\pi\epsilon}\log\left(\frac{h}{a} - \sqrt{(\frac{h}{a})^2 - 1}\right) + U(\vec{O})$$

2.3.2

$$V = U(\vec{P^+}) - U(\vec{P^-})$$

$$= \frac{\lambda}{2\pi\epsilon}\left(\log\left(\frac{h}{a} + \sqrt{(\frac{h}{a})^2 - 1}\right) - \log\left(\frac{h}{a} - \sqrt{(\frac{h}{a})^2 - 1}\right)\right)$$

$$= \frac{\lambda}{2\pi\epsilon}\log\left(\frac{\frac{h}{a} + \sqrt{(\frac{h}{a})^2 - 1}}{\frac{h}{a} - \sqrt{(\frac{h}{a})^2 - 1}}\right)$$

$$= \frac{\lambda}{2\pi\epsilon}\log\left[\left(\frac{h}{a} + \sqrt{(\frac{h}{a})^2 - 1}\right)^2\right]$$

$$= \frac{\lambda}{\pi\epsilon}\log\left(\frac{h}{a} + \sqrt{(\frac{h}{a})^2 - 1}\right)$$

2.3.3

$\because C = \frac{Q}{V}$

Because of λ is the charge change per unit length

$$\therefore \hat{C} = \frac{\lambda}{V} = \frac{\lambda}{\frac{\lambda}{\pi\epsilon}\log\left(\frac{h}{a} + \sqrt{(\frac{h}{a})^2 - 1}\right)}$$

$$= \frac{\pi\epsilon}{\log\left(\frac{h}{a} + \sqrt{(\frac{h}{a})^2 - 1}\right)} \ F\ m^{-1}$$