

In[35]:= **char**[k_, x_, theta_, alpha_] =

$$\begin{aligned}
& -\frac{1}{4k} \left(\frac{1}{e^{i\pi x} + e^{3i\pi x}} \left(-2i \left(1 + e^{4i\pi x} - 2e^{2i\pi(k+x)} \right) k + e^{2i\pi x} \left(-1 + e^{2ik\pi} \right) \alpha \right) \csc[k\pi] - \right. \\
& \quad \left. \sec[\pi x] \left(4k \cos[k\pi] + \alpha \sin[k\pi] \right) \left(-1 + \sqrt{1 - \frac{16k^2 \cos[\pi x]^2}{(4k \cos[k\pi] + \alpha \sin[k\pi])^2}} \right) \right) \\
& \left(\left(\left(-e^{i(\pi-\theta)(k-x)} k - \frac{2e^{i(k(\pi-\theta)+(-3\pi+\theta)x}}{-1+e^{2ik\pi}} \left(-1 + e^{2i\pi(k+x)} \right) k - \left(e^{-i(k(\pi+\theta)+(\pi-\theta)x} \left(e^{2ik\pi} + \right. \right. \right. \right. \right. \\
& \quad \left. \left. \left. e^{2ik(2\pi+\theta)} - 2e^{2i(k(\pi+\theta)+\pi x)} \right) k \right) / \left(-1 + e^{2ik(\pi+\theta)} \right) + i e^{i(\pi-\theta)(k-x)} \alpha \right) \right. \\
& \quad \left(2 \left(1 + e^{2ik\theta} - 2e^{2i(k(\pi+\theta))} \right) \left(-1 + e^{2i\pi(k+x)} \right) k + i e^{2i\pi x} \left(-1 + e^{2ik\pi} \right) \left(-1 + \right. \right. \\
& \quad \left. \left. e^{2ik(\pi+\theta)} \right) \alpha \right) - \left(e^{-i(\pi-\theta)(k+x)} k - \frac{2e^{-i(k\pi-k\theta+3\pi x-\theta x)}{-1+e^{2ik\pi}} \left(-1 + e^{2i\pi(k+x)} \right) k - \right. \\
& \quad \left(e^{-i(k(\pi+\theta)+(\pi-\theta)x} \left(e^{2ik\theta} + e^{2ik(\pi+2\theta)} - 2e^{2i(k(\pi+\theta)+\pi x)} \right) k \right) / \\
& \quad \left. \left(-1 + e^{2ik(\pi+\theta)} \right) + i e^{-i(\pi-\theta)(k+x)} \alpha \right) \left(2 \left(-1 - e^{2ik\pi} + e^{4ik\pi} + e^{2ik(\pi+\theta)} + \right. \right. \\
& \quad \left. \left. e^{2i\pi x} - e^{2i(2k\pi+k\theta+\pi x)} \right) k + i e^{2i\pi x} \left(-1 + e^{2ik\pi} \right) \left(-1 + e^{2ik(\pi+\theta)} \right) \alpha \right) \right) \\
& \left(\frac{1}{e^{i\pi x} + e^{3i\pi x}} \left(-2i \left(1 + e^{4i\pi x} - 2e^{2i\pi(k+x)} \right) k + e^{2i\pi x} \left(-1 + e^{2ik\pi} \right) \alpha \right) \right. \\
& \quad \left. \csc[k\pi] - \sec[\pi x] \left(4k \cos[k\pi] + \alpha \sin[k\pi] \right) \left(-1 + \sqrt{1 - \frac{16k^2 \cos[\pi x]^2}{(4k \cos[k\pi] + \alpha \sin[k\pi])^2}} \right) \right) / \\
& \left(16 \left(-1 + e^{2ik\pi} \right) \left(1 + e^{-2i\pi x} \right) \left(e^{2ik\pi} - e^{2ik\theta} - e^{2i\pi x} + e^{2i(k(\pi+\theta)+\pi x)} \right) k^3 \right) - \\
& \left(i e^{-ik\pi} \left(- \left(-e^{i(\pi-\theta)(k-x)} k - \frac{2e^{i(k(\pi-\theta)+(-3\pi+\theta)x}}{-1+e^{2ik\pi}} \left(-1 + e^{2i\pi(k+x)} \right) k - \right. \right. \right. \right. \\
& \quad \left. \left(e^{-i(k(\pi+\theta)+(\pi-\theta)x} \left(e^{2ik\pi} + e^{2ik(2\pi+\theta)} - 2e^{2i(k(\pi+\theta)+\pi x)} \right) k \right) / \right. \\
& \quad \left. \left(-1 + e^{2ik(\pi+\theta)} \right) + i e^{i(\pi-\theta)(k-x)} \alpha \right) \left(2e^{2ik\pi} k + 2e^{2ik\theta} k - 2e^{2ik(\pi+\theta)} k - \right. \\
& \quad \left. 2e^{2ik(2\pi+\theta)} k + e^{2i(k(2\pi+\theta)+\pi x)} (2k - i\alpha) - e^{2i\pi x} (2k + i\alpha) + i e^{2i\pi(k+x)} \alpha + \right. \\
& \quad \left. i e^{2i(k(\pi+\theta)+\pi x)} \alpha \right) - \left(e^{-i(\pi-\theta)(k+x)} k - \frac{2e^{-i(k\pi-k\theta+3\pi x-\theta x)}{-1+e^{2ik\pi}} \left(-1 + e^{2i\pi(k+x)} \right) k - \right. \\
& \quad \left(e^{-i(k(\pi+\theta)+(\pi-\theta)x} \left(e^{2ik\theta} + e^{2ik(\pi+2\theta)} - 2e^{2i(k(\pi+\theta)+\pi x)} \right) k \right) / \\
& \quad \left. \left(-1 + e^{2ik(\pi+\theta)} \right) + i e^{-i(\pi-\theta)(k+x)} \alpha \right) \\
& \left(-4e^{2ik\pi} k + 2e^{4ik\pi} k + 2e^{2ik(2\pi+\theta)} k - e^{2i\pi(k+x)} (2k + i\alpha) - \right.
\end{aligned}$$

$$\begin{aligned}
& \left. \left(e^{2i(k(\pi+\theta)+\pi\vartheta)} (2k + i\alpha) + e^{2i\pi\vartheta} (4k + i\alpha) + i e^{2i(k(2\pi+\theta)+\pi\vartheta)} \alpha \right) \right. \\
& \left. \text{Sec}[\pi\vartheta] (\alpha + 4k \text{Csc}[k\pi] \text{Sin}[\pi\vartheta] \text{Sin}[\pi(k+\vartheta)]) \right) / \\
& \left(16 (-1 + e^{2ik\pi}) (1 + e^{-2i\pi\vartheta}) (e^{2ik\pi} - e^{2ik\theta} - e^{2i\pi\vartheta} + e^{2i(k(\pi+\theta)+\pi\vartheta)}) k^3 \right) - \\
& \frac{1}{4k} i e^{-ik\pi} \text{Sec}[\pi\vartheta] (\alpha + 4k \text{Csc}[k\pi] \text{Sin}[\pi\vartheta] \text{Sin}[\pi(k+\vartheta)]) \\
& \left(\left((-2 (1 + e^{2ik\theta} - 2 e^{2ik(\pi+\theta)}) (-1 + e^{2i\pi(k+\vartheta)}) k - \right. \right. \\
& i e^{2i\pi\vartheta} (-1 + e^{2ik\pi}) (-1 + e^{2ik(\pi+\theta)}) \alpha \left(e^{i(\pi-\theta)(k-\vartheta)} - \frac{1}{2(1 + e^{-2i\pi\vartheta}) k} \right. \\
& \left(e^{i(\pi-\theta)(k-\vartheta)} k + \frac{2 e^{i(k(\pi-\theta)+(-3\pi+\theta)\vartheta)} (-1 + e^{2i\pi(k+\vartheta)}) k}{-1 + e^{2ik\pi}} + \right. \\
& \left. (e^{-i(k(\pi+\theta)+(\pi-\theta)\vartheta)} (e^{2ik\pi} + e^{2ik(2\pi+\theta)} - 2 e^{2i(k(\pi+\theta)+\pi\vartheta)}) k) / \right. \\
& \left. (-1 + e^{2ik(\pi+\theta)}) - i e^{i(\pi-\theta)(k-\vartheta)} \alpha \right) \left. \right) + \\
& (2 (-1 - e^{2ik\pi} + e^{4ik\pi} + e^{2ik(\pi+\theta)} + e^{2i\pi\vartheta} - e^{2i(2k\pi+k\theta+\pi\vartheta)}) k + \\
& i e^{2i\pi\vartheta} (-1 + e^{2ik\pi}) (-1 + e^{2ik(\pi+\theta)}) \alpha \left(e^{-i(\pi-\theta)(k+\vartheta)} - \frac{1}{2(1 + e^{-2i\pi\vartheta}) k} \right. \\
& \left(-e^{-i(\pi-\theta)(k+\vartheta)} k + \frac{2 e^{-i(k\pi-k\theta+3\pi\vartheta-\theta\vartheta)} (-1 + e^{2i\pi(k+\vartheta)}) k}{-1 + e^{2ik\pi}} + \right. \\
& \left. (e^{-i(k(\pi+\theta)+(\pi-\theta)\vartheta)} (e^{2ik\theta} + e^{2ik(\pi+2\theta)} - 2 e^{2i(k(\pi+\theta)+\pi\vartheta)}) k) / \right. \\
& \left. (-1 + e^{2ik(\pi+\theta)}) - i e^{-i(\pi-\theta)(k+\vartheta)} \alpha \right) \left. \right) \left. \right) \\
& \left(\frac{1}{e^{i\pi\vartheta} + e^{3i\pi\vartheta}} (-2i (1 + e^{4i\pi\vartheta} - 2 e^{2i\pi(k+\vartheta)}) k + e^{2i\pi\vartheta} (-1 + e^{2ik\pi}) \alpha) \right. \\
& \text{Csc}[k\pi] - \text{Sec}[\pi\vartheta] (4k \text{Cos}[k\pi] + \alpha \text{Sin}[k\pi]) \\
& \left. \left(-1 + \sqrt{1 - \frac{16k^2 \text{Cos}[\pi\vartheta]^2}{(4k \text{Cos}[k\pi] + \alpha \text{Sin}[k\pi])^2}} \right) \right) / \\
& (8 (-1 + e^{2ik\pi}) (e^{2ik\pi} - e^{2ik\theta} - e^{2i\pi\vartheta} + e^{2i(k(\pi+\theta)+\pi\vartheta)}) k^2) - \\
& i e^{-ik\pi} \left((2 e^{2ik\pi} k + 2 e^{2ik\theta} k - 2 e^{2ik(\pi+\theta)} k - 2 e^{2ik(2\pi+\theta)} k + e^{2i(k(2\pi+\theta)+\pi\vartheta)} (2k - \right. \\
& i \alpha) - e^{2i\pi\vartheta} (2k + i\alpha) + i e^{2i\pi(k+\vartheta)} \alpha + i e^{2i(k(\pi+\theta)+\pi\vartheta)} \alpha) \left(e^{i(\pi-\theta)(k-\vartheta)} - \right.
\end{aligned}$$

$$\begin{aligned}
& \frac{1}{2 \left(1 + e^{-2 i \pi \bar{\pi}}\right) k} \left(e^{i (\pi - \theta) (k - \bar{\pi})} k + \frac{2 e^{i (k (\pi - \theta) + (-3 \pi + \theta) \bar{\pi})} (-1 + e^{2 i \pi (k + \bar{\pi})}) k}{-1 + e^{2 i k \pi}} + \right. \\
& \left. \left(e^{-i (k (\pi + \theta) + (\pi - \theta) \bar{\pi})} \left(e^{2 i k \pi} + e^{2 i k (2 \pi + \theta)} - 2 e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right) k \right) / \right. \\
& \left. \left(-1 + e^{2 i k (\pi + \theta)} \right) - i e^{i (\pi - \theta) (k - \bar{\pi})} \alpha \right) \Bigg) + \\
& \left(-4 e^{2 i k \pi} k + 2 e^{4 i k \pi} k + 2 e^{2 i k (2 \pi + \theta)} k - e^{2 i \pi (k + \bar{\pi})} (2 k + i \alpha) - e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right. \\
& \left. (2 k + i \alpha) + e^{2 i \pi \bar{\pi}} (4 k + i \alpha) + i e^{2 i (k (2 \pi + \theta) + \pi \bar{\pi})} \alpha \right) \left(e^{-i (\pi - \theta) (k + \bar{\pi})} - \right. \\
& \frac{1}{2 \left(1 + e^{-2 i \pi \bar{\pi}}\right) k} \left(-e^{-i (\pi - \theta) (k + \bar{\pi})} k + \frac{2 e^{-i (k \pi - k \theta + 3 \pi \bar{\pi} - \theta \bar{\pi})} (-1 + e^{2 i \pi (k + \bar{\pi})}) k}{-1 + e^{2 i k \pi}} + \right. \\
& \left. \left(e^{-i (k (\pi + \theta) + (\pi - \theta) \bar{\pi})} \left(e^{2 i k \theta} + e^{2 i k (\pi + 2 \theta)} - 2 e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right) k \right) / \right. \\
& \left. \left(-1 + e^{2 i k (\pi + \theta)} \right) - i e^{-i (\pi - \theta) (k + \bar{\pi})} \alpha \right) \Bigg) \Bigg) \\
& \left. \text{Sec}[\pi \bar{\pi}] (\alpha + 4 k \text{Csc}[k \pi] \text{Sin}[\pi \bar{\pi}] \text{Sin}[\pi (k + \bar{\pi})]) \right) \Bigg) / \\
& \left(8 (-1 + e^{2 i k \pi}) \left(e^{2 i k \pi} - e^{2 i k \theta} - e^{2 i \pi \bar{\pi}} + e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right) k^2 \right) \Bigg) \\
\text{Out[35]} = & -\frac{1}{4 k} \left(\frac{1}{e^{i \pi \bar{\pi}} + e^{3 i \pi \bar{\pi}}} \left(-2 i \left(1 + e^{4 i \pi \bar{\pi}} - 2 e^{2 i \pi (k + \bar{\pi})} \right) k + e^{2 i \pi \bar{\pi}} (-1 + e^{2 i k \pi}) \alpha \right) \text{Csc}[k \pi] - \right. \\
& \text{Sec}[\pi \bar{\pi}] (4 k \text{Cos}[k \pi] + \alpha \text{Sin}[k \pi]) \left(-1 + \sqrt{1 - \frac{16 k^2 \text{Cos}[\pi \bar{\pi}]^2}{(4 k \text{Cos}[k \pi] + \alpha \text{Sin}[k \pi])^2}} \right) \Bigg) \\
& \left(\left(\left(\left(-e^{i (\pi - \theta) (k - \bar{\pi})} k - \frac{2 e^{i (k (\pi - \theta) + (-3 \pi + \theta) \bar{\pi})} (-1 + e^{2 i \pi (k + \bar{\pi})}) k}{-1 + e^{2 i k \pi}} - \right. \right. \right. \\
& \left. \left(e^{-i (k (\pi + \theta) + (\pi - \theta) \bar{\pi})} \left(e^{2 i k \pi} + e^{2 i k (2 \pi + \theta)} - 2 e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right) k \right) / \right. \\
& \left. \left(-1 + e^{2 i k (\pi + \theta)} \right) + i e^{i (\pi - \theta) (k - \bar{\pi})} \alpha \right) \left(2 \left(1 + e^{2 i k \theta} - 2 e^{2 i k (\pi + \theta)} \right) \right. \\
& \left. \left(-1 + e^{2 i \pi (k + \bar{\pi})} \right) k + i e^{2 i \pi \bar{\pi}} (-1 + e^{2 i k \pi}) (-1 + e^{2 i k (\pi + \theta)}) \alpha \right) - \right. \\
& \left(e^{-i (\pi - \theta) (k + \bar{\pi})} k - \frac{2 e^{-i (k \pi - k \theta + 3 \pi \bar{\pi} - \theta \bar{\pi})} (-1 + e^{2 i \pi (k + \bar{\pi})}) k}{-1 + e^{2 i k \pi}} - \left(e^{-i (k (\pi + \theta) + (\pi - \theta) \bar{\pi})} \right. \right. \\
& \left. \left(e^{2 i k \theta} + e^{2 i k (\pi + 2 \theta)} - 2 e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right) k \right) / \left(-1 + e^{2 i k (\pi + \theta)} \right) + \\
& \left. i e^{-i (\pi - \theta) (k + \bar{\pi})} \alpha \right) \left(2 \left(-1 - e^{2 i k \pi} + e^{4 i k \pi} + e^{2 i k (\pi + \theta)} + e^{2 i \pi \bar{\pi}} - \right. \right. \\
& \left. \left. e^{2 i (2 k \pi + k \theta + \pi \bar{\pi})} \right) k + i e^{2 i \pi \bar{\pi}} (-1 + e^{2 i k \pi}) (-1 + e^{2 i k (\pi + \theta)}) \alpha \right) \Bigg)
\end{aligned}$$

$$\begin{aligned}
& \left(\frac{1}{e^{i\pi\bar{\pi}} + e^{3i\pi\bar{\pi}}} \left(-2i \left(1 + e^{4i\pi\bar{\pi}} - 2e^{2i\pi(k+\bar{\pi})} \right) k + e^{2i\pi\bar{\pi}} \left(-1 + e^{2ik\pi} \right) \alpha \right) \right. \\
& \quad \left. \text{Csc}[k\pi] - \text{Sec}[\pi\bar{\pi}] \left(4k \text{Cos}[k\pi] + \alpha \text{Sin}[k\pi] \right) \right. \\
& \quad \left. \left(-1 + \sqrt{1 - \frac{16k^2 \text{Cos}[\pi\bar{\pi}]^2}{(4k \text{Cos}[k\pi] + \alpha \text{Sin}[k\pi])^2}} \right) \right) \Bigg/ \\
& \quad \left(16 \left(-1 + e^{2ik\pi} \right) \left(1 + e^{-2i\pi\bar{\pi}} \right) \left(e^{2ik\pi} - e^{2ik\theta} - e^{2i\pi\bar{\pi}} + e^{2i(k(\pi+\theta)+\pi\bar{\pi})} \right) k^3 \right) - \\
& \quad \left(i e^{-ik\pi} \left(\left(e^{i(\pi-\theta)(k-\bar{\pi})} k + \frac{2e^{i(k(\pi-\theta)+(-3\pi+\theta)\bar{\pi})} \left(-1 + e^{2i\pi(k+\bar{\pi})} \right) k}{-1 + e^{2ik\pi}} + \right. \right. \right. \\
& \quad \left. \left(e^{-i(k(\pi+\theta)+(\pi-\theta)\bar{\pi})} \left(e^{2ik\pi} + e^{2ik(2\pi+\theta)} - 2e^{2i(k(\pi+\theta)+\pi\bar{\pi})} \right) k \right) / \right. \\
& \quad \left. \left. \left(-1 + e^{2ik(\pi+\theta)} \right) - i e^{i(\pi-\theta)(k-\bar{\pi})} \alpha \right) \right. \\
& \quad \left(2e^{2ik\pi} k + 2e^{2ik\theta} k - 2e^{2ik(\pi+\theta)} k - 2e^{2ik(2\pi+\theta)} k + e^{2i(k(2\pi+\theta)+\pi\bar{\pi})} \right. \\
& \quad \left. \left(2k - i\alpha \right) - e^{2i\pi\bar{\pi}} \left(2k + i\alpha \right) + i e^{2i\pi(k+\bar{\pi})} \alpha + i e^{2i(k(\pi+\theta)+\pi\bar{\pi})} \alpha \right) - \\
& \quad \left(e^{-i(\pi-\theta)(k+\bar{\pi})} k - \frac{2e^{-i(k\pi-k\theta+3\pi\bar{\pi}-\theta\bar{\pi})} \left(-1 + e^{2i\pi(k+\bar{\pi})} \right) k}{-1 + e^{2ik\pi}} - \right. \\
& \quad \left. \left(e^{-i(k(\pi+\theta)+(\pi-\theta)\bar{\pi})} \left(e^{2ik\theta} + e^{2ik(\pi+2\theta)} - 2e^{2i(k(\pi+\theta)+\pi\bar{\pi})} \right) k \right) / \right. \\
& \quad \left. \left(-1 + e^{2ik(\pi+\theta)} \right) + i e^{-i(\pi-\theta)(k+\bar{\pi})} \alpha \right) \\
& \quad \left(-4e^{2ik\pi} k + 2e^{4ik\pi} k + 2e^{2ik(2\pi+\theta)} k - e^{2i\pi(k+\bar{\pi})} \left(2k + i\alpha \right) - \right. \\
& \quad \left. e^{2i(k(\pi+\theta)+\pi\bar{\pi})} \left(2k + i\alpha \right) + e^{2i\pi\bar{\pi}} \left(4k + i\alpha \right) + i e^{2i(k(2\pi+\theta)+\pi\bar{\pi})} \alpha \right) \Bigg) \\
& \quad \left. \text{Sec}[\pi\bar{\pi}] \left(\alpha + 4k \text{Csc}[k\pi] \text{Sin}[\pi\bar{\pi}] \text{Sin}[\pi(k+\bar{\pi})] \right) \right) \Bigg/ \\
& \quad \left(16 \left(-1 + e^{2ik\pi} \right) \left(1 + e^{-2i\pi\bar{\pi}} \right) \left(e^{2ik\pi} - e^{2ik\theta} - e^{2i\pi\bar{\pi}} + e^{2i(k(\pi+\theta)+\pi\bar{\pi})} \right) k^3 \right) \Bigg) - \\
& \quad \frac{1}{4k} i e^{-ik\pi} \text{Sec}[\pi\bar{\pi}] \left(\alpha + \right. \\
& \quad 4 \\
& \quad k \\
& \quad \text{Csc}[\\
& \quad k\pi] \text{Sin}[\\
& \quad \pi\bar{\pi}] \text{Sin}[\\
& \quad \pi(k+\bar{\pi})] \Bigg) \\
& \quad \left(\left(\left(-2 \left(1 + e^{2ik\theta} - 2e^{2ik(\pi+\theta)} \right) \left(-1 + e^{2i\pi(k+\bar{\pi})} \right) k - i e^{2i\pi\bar{\pi}} \left(-1 + e^{2ik\pi} \right) \left(-1 + e^{2ik(\pi+\theta)} \right) \right. \right. \right. \\
& \quad \left. \left. \left. \alpha \right) \left(e^{i(\pi-\theta)(k-\bar{\pi})} - \left(e^{i(\pi-\theta)(k-\bar{\pi})} k + \frac{2e^{i(k(\pi-\theta)+(-3\pi+\theta)\bar{\pi})} \left(-1 + e^{2i\pi(k+\bar{\pi})} \right) k}{-1 + e^{2ik\pi}} + \right. \right. \right. \right. \\
& \quad \left. \left. \left. \left(e^{-i(k(\pi+\theta)+(\pi-\theta)\bar{\pi})} \left(e^{2ik\pi} + e^{2ik(2\pi+\theta)} - 2e^{2i(k(\pi+\theta)+\pi\bar{\pi})} \right) k \right) / \right. \right. \right.
\end{aligned}$$

$$\begin{aligned}
& \left(-1 + e^{2 i k (\pi + \theta)} \right) - i e^{i (\pi - \theta) (k - \bar{\pi})} \alpha \Bigg) / \left(2 \left(1 + e^{-2 i \pi \bar{\pi}} \right) k \right) \Bigg) + \\
& \left(2 \left(-1 - e^{2 i k \pi} + e^{4 i k \pi} + e^{2 i k (\pi + \theta)} + e^{2 i \pi \bar{\pi}} - e^{2 i (2 k \pi + k \theta + \pi \bar{\pi})} \right) k + \right. \\
& \quad \left. i e^{2 i \pi \bar{\pi}} \left(-1 + e^{2 i k \pi} \right) \left(-1 + e^{2 i k (\pi + \theta)} \right) \alpha \right) \\
& \left(e^{-i (\pi - \theta) (k + \bar{\pi})} - \left(-e^{-i (\pi - \theta) (k + \bar{\pi})} k + \frac{2 e^{-i (k \pi - k \theta + 3 \pi \bar{\pi} - \theta \bar{\pi})} \left(-1 + e^{2 i \pi (k + \bar{\pi})} \right) k}{-1 + e^{2 i k \pi}} + \right. \right. \\
& \quad \left. \left(e^{-i (k (\pi + \theta) + (\pi - \theta) \bar{\pi})} \left(e^{2 i k \theta} + e^{2 i k (\pi + 2 \theta)} - 2 e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right) k \right) / \right. \\
& \quad \left. \left. \left(-1 + e^{2 i k (\pi + \theta)} \right) - i e^{-i (\pi - \theta) (k + \bar{\pi})} \alpha \right) \Bigg) / \left(2 \left(1 + e^{-2 i \pi \bar{\pi}} \right) k \right) \Bigg) \Bigg) \\
& \left(\frac{1}{e^{i \pi \bar{\pi}} + e^{3 i \pi \bar{\pi}}} \left(-2 i \left(1 + e^{4 i \pi \bar{\pi}} - 2 e^{2 i \pi (k + \bar{\pi})} \right) k + e^{2 i \pi \bar{\pi}} \left(-1 + e^{2 i k \pi} \right) \alpha \right) \text{Csc}[k \pi] - \right. \\
& \quad \left. \text{Sec}[\pi \bar{\pi}] \left(4 k \text{Cos}[k \pi] + \alpha \text{Sin}[k \pi] \right) \right. \\
& \quad \left. \left(-1 + \sqrt{1 - \frac{16 k^2 \text{Cos}[\pi \bar{\pi}]^2}{(4 k \text{Cos}[k \pi] + \alpha \text{Sin}[k \pi])^2}} \right) \right) \Bigg) / \\
& \left(8 \left(-1 + e^{2 i k \pi} \right) \left(e^{2 i k \pi} - e^{2 i k \theta} - e^{2 i \pi \bar{\pi}} + e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right) k^2 \right) - \\
& \left(i e^{-i k \pi} \left(\left(2 e^{2 i k \pi} k + 2 e^{2 i k \theta} k - 2 e^{2 i k (\pi + \theta)} k - 2 e^{2 i k (2 \pi + \theta)} k + e^{2 i (k (2 \pi + \theta) + \pi \bar{\pi})} \right. \right. \right. \\
& \quad \left. \left(2 k - i \alpha \right) - e^{2 i \pi \bar{\pi}} \left(2 k + i \alpha \right) + i e^{2 i \pi (k + \bar{\pi})} \alpha + i e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \alpha \right) \\
& \quad \left(e^{i (\pi - \theta) (k - \bar{\pi})} - \left(e^{i (\pi - \theta) (k - \bar{\pi})} k + \frac{2 e^{i (k (\pi - \theta) + (-3 \pi + \theta) \bar{\pi})} \left(-1 + e^{2 i \pi (k + \bar{\pi})} \right) k}{-1 + e^{2 i k \pi}} + \right. \right. \\
& \quad \left. \left(e^{-i (k (\pi + \theta) + (\pi - \theta) \bar{\pi})} \left(e^{2 i k \pi} + e^{2 i k (2 \pi + \theta)} - 2 e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right) k \right) / \right. \\
& \quad \left. \left. \left(-1 + e^{2 i k (\pi + \theta)} \right) - i e^{i (\pi - \theta) (k - \bar{\pi})} \alpha \right) \Bigg) / \left(2 \left(1 + e^{-2 i \pi \bar{\pi}} \right) k \right) \Bigg) + \\
& \left(-4 e^{2 i k \pi} k + 2 e^{4 i k \pi} k + 2 e^{2 i k (2 \pi + \theta)} k - e^{2 i \pi (k + \bar{\pi})} \left(2 k + i \alpha \right) - \right. \\
& \quad \left. e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \left(2 k + i \alpha \right) + e^{2 i \pi \bar{\pi}} \left(4 k + i \alpha \right) + i e^{2 i (k (2 \pi + \theta) + \pi \bar{\pi})} \alpha \right) \\
& \quad \left(e^{-i (\pi - \theta) (k + \bar{\pi})} - \left(-e^{-i (\pi - \theta) (k + \bar{\pi})} k + \frac{2 e^{-i (k \pi - k \theta + 3 \pi \bar{\pi} - \theta \bar{\pi})} \left(-1 + e^{2 i \pi (k + \bar{\pi})} \right) k}{-1 + e^{2 i k \pi}} + \right. \right. \\
& \quad \left. \left(e^{-i (k (\pi + \theta) + (\pi - \theta) \bar{\pi})} \left(e^{2 i k \theta} + e^{2 i k (\pi + 2 \theta)} - 2 e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right) k \right) / \right. \\
& \quad \left. \left. \left(-1 + e^{2 i k (\pi + \theta)} \right) - i e^{-i (\pi - \theta) (k + \bar{\pi})} \alpha \right) \Bigg) / \left(2 \left(1 + e^{-2 i \pi \bar{\pi}} \right) k \right) \Bigg) \Bigg) \\
& \text{Sec}[\pi \bar{\pi}] \left(\alpha + 4 k \text{Csc}[k \pi] \text{Sin}[\pi \bar{\pi}] \text{Sin}[\pi (k + \bar{\pi})] \right) \Bigg) / \\
& \left(8 \left(-1 + e^{2 i k \pi} \right) \left(e^{2 i k \pi} - e^{2 i k \theta} - e^{2 i \pi \bar{\pi}} + e^{2 i (k (\pi + \theta) + \pi \bar{\pi})} \right) k^2 \right) \Bigg)
\end{aligned}$$

In[36]:= $\bar{\pi} = 0.2$

Out[36]= 0.2

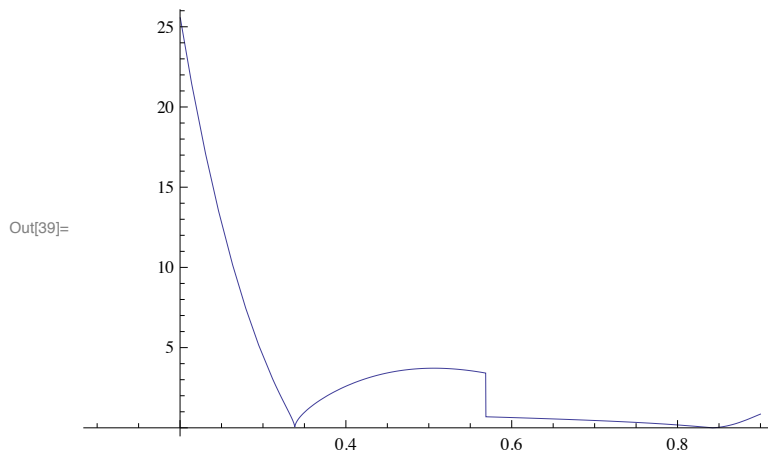
In[37]:= $\theta = 0.5$

Out[37]= 0.5

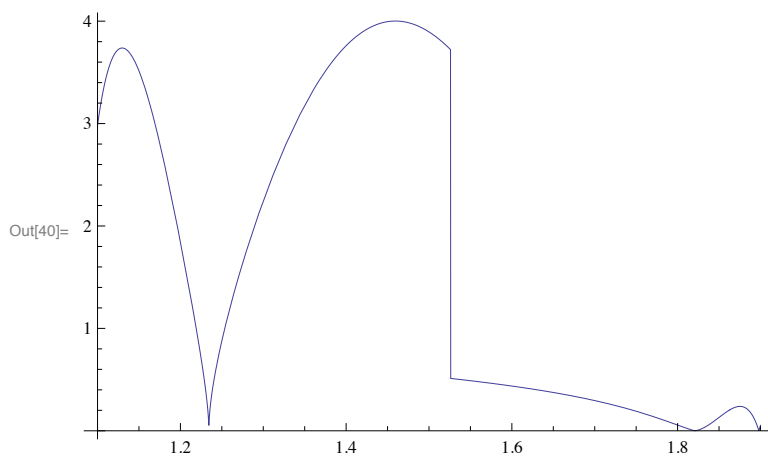
In[38]:= $\alpha = 0.5$

Out[38]= 0.5

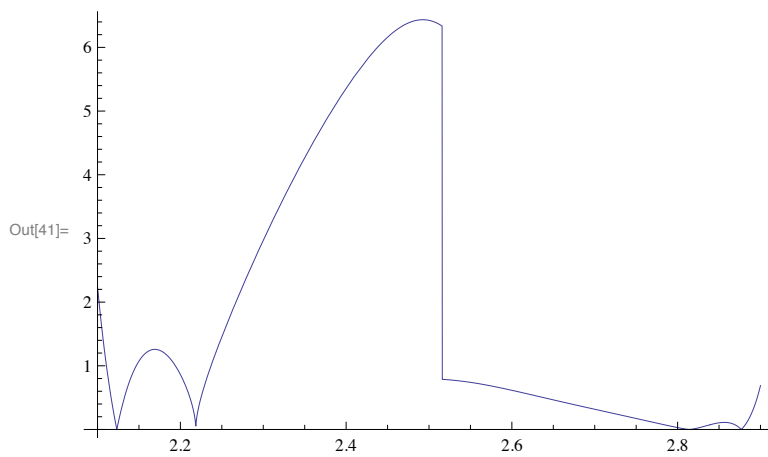
In[39]:= `Plot[Abs[char[x, Ξ , θ , α]], {x, 0.1, 0.9}]`



In[40]:= `Plot[Abs[char[x, Ξ , θ , α]], {x, 1.1, 1.9}]`



In[41]:= `Plot[Abs[char[x, Ξ , θ , α]], {x, 2.1, 2.9}]`



In[42]:= $\mathfrak{E} = 0.01$

Out[42]= 0.01

In[43]:= $\theta = 0.295$

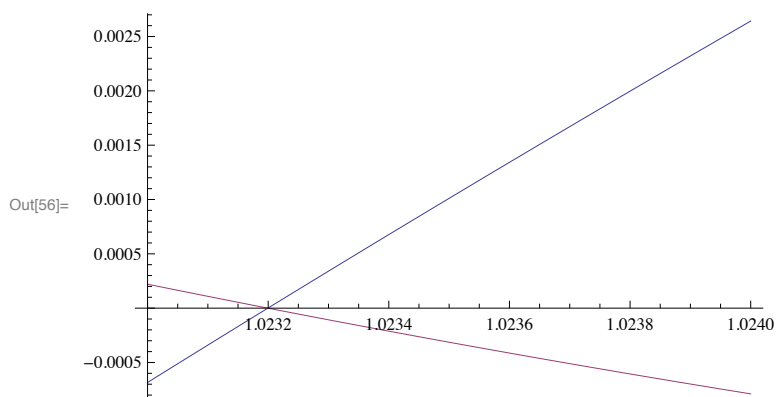
Out[43]= 0.295

In[44]:= $\alpha = 0.5$

Out[44]= 0.5

In[45]:= (* Далее будем строить вместе графики обеих частей нашей комплексной функции и смотреть за сближением их корней при изменении параметра *)

In[56]:= `Plot[{Re[char[x, \mathfrak{E} , θ , α]], Im[char[x, \mathfrak{E} , θ , α]]}, {x, 1.023, 1.024}]`



In[57]:= `Abs[char[1.0232, \mathfrak{E} , θ , α]]`

Out[57]= 1.75185×10^{-6}