In paper, The design constitutes parellel-biquid digital filter.
This page will represent how to set pole position.

First of all, the simple way to set poles is a pole and conjugate of this pole as below

$$p = Re^{\pm j\omega_0} = e^{\sigma_0 \pm j\omega_0}, \quad P_0 = \sigma_0 + j\omega_0$$

The next step is the peaking bandwidth based on poles. In this case, they suggest $\Delta\theta_k$ concepts.,

$$p = e^{\Delta\theta_k \pm j\theta_k}, \quad \begin{cases} k=0 & , \Delta\theta_0 = \theta_1 - \theta_0 \\ 0<k<N, & \Delta\theta_k = (\theta_{k+1} - \theta_{k-1})/2 \\ k=n & , \Delta\theta_n = \theta_n - \theta_{n-1}. \end{cases}$$

And they use The target frequency scale is the logarithmic frequency,

$$f_k = 10^{f_0 + nk}$$

By refering above equation, it can get Bandwidth , $2\sigma_0$ for Quality factor .

pf)

$$\theta_k = 2\pi \cdot \frac{f_k}{f_s}$$

$$0<k<N , \quad f_{k+1} - f_{k-1} = 10^{f_0+nk+n} - 10^{f_0+nk-n}$$

$$= 10^{f_0+nk}\left(10^{n} - 10^{-n}\right)$$

In this paper $n=0.1$, for getting 10 band bewteen 20-22050 Hz

$$f_{k+1} - f_{k-1} = 10^{f_0+nk}\left(10^{0.1} - 10^{-0.1}\right)$$

$$= 0.46 f_k$$

$$k=0, \quad f_1 - f_0 = 10^{f_0+n} - 10^{f_0} = 10^{f_0}\left(10^{n} - 1\right) \simeq 0.25 f_0$$

$$k=N, \quad f_N - f_{N-1} = 10^{f_0+Nn} - 10^{f_0+Nn-n} = 10^{f_0+Nn}\left(1 - 10^{-n}\right) \simeq 0.20 f_N$$

$$\Delta\theta_k = \alpha_k \theta_k , \quad \alpha_k = \begin{cases} 0.25 & , k=0 \\ 0.23 & , 0<k<N \\ 0.20 & , k=N \end{cases}$$

$$p, \bar{p} = e^{\Delta\theta_k} \cdot e^{\pm j\theta_k}$$

$$Q_k = \frac{\omega_k}{2\sigma_k} = \frac{2\pi f_k}{2\cdot\alpha_k\theta_k} = \frac{f_s}{2\alpha_k} = \begin{cases} f_s/0.5, & k=0 \\ f_s/0.46, & 0<k<N \\ f_s/0.4, & k=N \end{cases}$$