Transformed variable approach to filter approximation
(for Cameron's 1999 example)

$dB := 1$

Filter degree: $n := 4$

Number of finite transmission zeros: $n_{ftz} := 2$

Normalised frequencies of transmission zeros: $\omega tz_1 := 1.3217$ $\omega tz_2 := 1.8082$

Transmission zeros at $\omega=\infty$ (z=1): $m_3 := 1$ $m_4 := 1$

Passband return loss: $RL_{min} := 22dB$

Transform all finite transmission zeroes from ω-domain to z-domain

$i := 1 .. n_{ftz}$

$$m_i := \sqrt{\frac{\omega tz_i - 1}{\omega tz_i + 1}}$$

$$m^T = \begin{pmatrix} 0.37224 & 0.53647 & 1 & 1 \end{pmatrix}$$

Create E + zF in product form:

$$E\_zF(z) := \prod_{i=1}^{n} \left(m_i + z\right)^2$$

Find coefficients of E + zF polynomial:

$$EzF := E\_zF(z)\ \text{coeffs}, z \rightarrow \begin{pmatrix} 0.03987822052043533116 \\ 0.52244294016054040335 \\ 2.9161331069950443855 \\ 9.055086390252307845 \\ 17.112135576054359001 \\ 20.168017985120709692 \\ 14.494819365432546936 \\ 5.8174189534688277131 \\ 1 \end{pmatrix}$$

The even part of E+zF is E and the odd part is zF. On Im(z) axis (passband), the roots of E interlace with those of zF. Creating E and zF polynomial coefficients:

$i := 1, 3 .. 2n + 1$ $\qquad E_i := EzF_i$ $\qquad E^T = (0.03988 \;\; 0 \;\; 2.91613 \;\; 0 \;\; 17.11214 \;\; 0 \;\; 14.49482 \;\; 0 \;\; 1)$

$i := 2, 4 .. 2 \cdot n$ $\qquad zF_i := EzF_i$ $\qquad zF^T = (0 \;\; 0.52244 \;\; 0 \;\; 9.05509 \;\; 0 \;\; 20.16802 \;\; 0 \;\; 5.81742)$

Define the polynomials E and zF as functions in ω yielding the characteristic function to obtain the filter response functions

$$z(\omega) := \sqrt{\frac{\omega - 1}{\omega + 1}} \qquad Ez(\omega) := \sum_{i=1}^{2n+1} \left(E_i \cdot z(\omega)^{i-1}\right) \qquad zFz(\omega) := \sum_{i=1}^{2n-1} \left(zF_{i+1} \cdot z(\omega)^{i}\right)$$

$$Ksq(\omega) := \frac{1}{\left(10^{\frac{RL_{min}}{10}} - 1\right)} \cdot \frac{1}{\left[1 - \left(\frac{zFz(\omega)}{Ez(\omega)}\right)^2\right]} \qquad S21dB(\omega) := -10 \cdot \log(1 + Ksq(\omega)) \qquad S11dB(\omega) := 10 \cdot \log\left(1 - \frac{1}{1 + Ksq(\omega)}\right)$$

$\omega := -3, -2.99 .. 4$