4.2 Mutual impedance

Developing Matlab

Following relations can be derived for computing mutual impedance Z_{12} of two dipoles. Real part of the mutual impedance R_{12} is given by:

$$R_{12} = 15\{(K_1 \sin q + L_1 \cos q) + [K_2 \sin(q+2p) + L_2 \cos(q+2p)] + [K_3 \sin(q-2p) + L_3 \cos(q-2p)]\}. \quad (4.2D.1)$$

Imaginary part of the mutual impedance X_{12} can be expressed as:

$$X_{12} = 15\{(M_1 \sin q + N_1 \cos q) + [M_2 \sin(q+2p) + N_2 \cos(q+2p)] + [M_3 \sin(q-2p) + N_3 \cos(q-2p)]\}, \quad (4.2D.2)$$

where

$$\left.\begin{aligned}
K_1 &= 2[2f_2(\delta, q) - f_2(\delta, q+p) - f_2(\delta, q-p)] \\
L_1 &= 2[2f_3(\delta, q) - f_3(\delta, q+p) - f_3(\delta, q-p)] \\
K_2 &= f_2(\delta, q) - 2f_2(\delta, q+p) + f_2(\delta, q+2p) \\
L_2 &= f_3(\delta, q) - 2f_3(\delta, q+p) + f_3(\delta, q+2p) \\
K_3 &= f_2(\delta, q) - 2f_2(\delta, q-p) + f_2(\delta, q-2p) \\
L_3 &= f_3(\delta, q) - 2f_3(\delta, q-p) + f_3(\delta, q-2p) \\
M_1 &= 2[2f_4(\delta, q) - f_4(\delta, q+p) - f_4(\delta, q-p)] \\
N_1 &= -2[2f_1(\delta, q) - f_1(\delta, q+p) - f_1(\delta, q-p)] \\
M_2 &= f_4(\delta, q) - 2f_4(\delta, q+p) + f_4(\delta, q+2p) \\
N_2 &= -f_1(\delta, q) + 2f_1(\delta, q+p) - f_4(\delta, q+2p) \\
M_3 &= f_4(\delta, q) - 2f_4(\delta, q-p) + f_4(\delta, q-2p) \\
N_3 &= -f_1(\delta, q) + 2f_1(\delta, q-p) - f_3(\delta, q-2p)
\end{aligned}\right\}. \quad (4.2D.3)$$

In these relations, variables given by the user p, q, δ are present:

$$p = kl \quad q = kh \quad \delta = kd. \quad (4.2D.4)$$

Finally, we have to define the following functions:

$$\left.\begin{aligned}
f_1(\delta, u) &= \sin\left(\sqrt{u^2+\delta^2}+u\right) + \sin\left(\sqrt{u^2+\delta^2}-u\right) \\
f_2(\delta, u) &= \sin\left(\sqrt{u^2+\delta^2}+u\right) - \sin\left(\sqrt{u^2+\delta^2}-u\right) \\
f_3(\delta, u) &= \cos\left(\sqrt{u^2+\delta^2}+u\right) + \cos\left(\sqrt{u^2+\delta^2}-u\right) \\
f_4(\delta, u) &= \cos\left(\sqrt{u^2+\delta^2}+u\right) - \cos\left(\sqrt{u^2+\delta^2}-u\right)
\end{aligned}\right\}. \quad (4.2D.5)$$

Here, u is a parameter, which changes according to the variable, which is used in our relations.

The above-given relations are programmed. We do not present here the transcription into the Matlab syntax due to the worse readability. In the program one of the parameters kl, kh or kd vary.