# EI3302: Home assignment 3

## Scattering against a slab of an Ω-medium

The paper [1] (available at the Canvas page) considers a so-called Ω medium, named after the shape of the metallic inclusions, which is an example of a bianisotropic medium.

### Task (a)

Use the general theory of propagation in multilayered structures to reproduce the results shown in [1], Figure 4.

### Notes and hints

- In [1], the time-convention is $\mathrm{e}^{+\mathrm{j}\omega t}$ while the general theory is using $\mathrm{e}^{-\mathrm{i}\omega t}$.
- In [1], the dyadics $\boldsymbol{\varepsilon}$ and $\boldsymbol{\mu}$ are not expressed normalised wrt to their vacuum values.
- In [1], the eigenmodes in vacuum are not power normalised, but instead wrt to the electric field, which modifies the levels on cross-polarised scattering parameters.
- When dealing with the Ω-slab, do not bother deriving eigenvalus and eigenvalues analytically (cf. [1], Section 3), but instead utilise the general theory and let Matlab diagonalise the $\mathbf{W}$-matrix numerically - the ordering of the pairs of eigenvalues/-vectors, in the $\mathbf{D}$ and $\mathbf{T}^{-1}$-matrices respectively, does not matter.
- Regarding Figures 4(c) and 4(d) in [1], there is a mistake (by the first author) which you see once you have the correct results.

### Task (b)

With reference to [1], Figure 1, re-orient the principal axes of the Ω-elements along the coordinate axes in the $xyz$-system, and repeat the analysis.

- Brage, Freysteinn and Oskar: straight rods in the $y$-direction and loop-normal $\pm\hat{\boldsymbol{x}}$.
- Balwan, Harald and Pilar: straight rods in the $z$-direction and loop-normal $\pm\hat{\boldsymbol{y}}$.

### Notes and hints

- The cross-coupling tensors $\boldsymbol{\xi}$ and $\boldsymbol{\zeta}$ must be modified, wrt the new orientations.
- When presenting your results, you need not chose the same parameter values as in [1], and need not show just the S-parameters shown therein (Figure 4).

# References

[1] Norgren M. and He S., "Electromagnetic reflection and transmission for a dielectric-Ω interface and an Ω slab", *International Journal of Infrared and Millimeter Waves*, 15(9), 1537-1554, 1994.