Advanced Computation:
Computational Electromagnetics

One-Dimensional Structures in Electromagnetics

- Multiple layers of homogeneous slabs.
- Slabs are of infinite extent in $x$ and $y$ directions.
- Very fast and efficient simulation.
Reducing 3D Problems to 1D

Simulating Thin Film Optical Filters in 1D

If we can ignore the edges of this device, thin film optical filters are just 1D stacks of different dielectrics.
3D → 1D Using Effective Medium Theory

- Effective medium theory allows inhomogeneous layers to be approximated as homogeneous.
- Serves as an excellent preliminary simulation before moving to 3D.

3D → 1D Using Circuit-Wave Equivalence

\[ n_i = \sqrt{\mu_{r,i} \varepsilon_{r,i}} \]

\[ Z_i = \eta_i = \frac{\mu_i}{\sqrt{\varepsilon_i}} \]
Simulating Optical Waveguide Circuits in 1D

Start with a 3D device.

Analyze the cross sections to calculate the effective refractive index of the guided mode in each unique segment.
Simulating Optical Waveguide Circuits in 1D

Start with a 3D device.

Analyze the cross sections to calculate the effective refractive index of the guided mode in each unique segment.

Build a 1D model using the effective refractive indices.