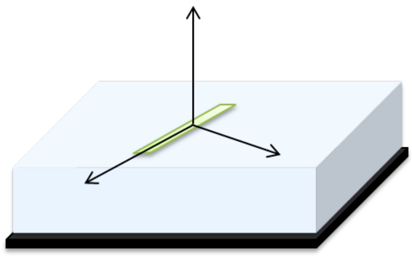
EE4620 - Spectral Domain Methods in Electromagnetics

Surface Wave Characterization

Question 1:

Write a Matlab routine that finds the propagation constant of the first two surface waves (TM0 and TE1) supported by a grounded slab.



To check the code, provide a plot showing the propagation constant, normalized to *k0*, of the TM0 and TE1 surface waves for a frequency range from 1 GHz to 20 GHz. Consider h=2 mm, εr=10 and εr=5.

Question 2:

Write a Matlab routine to calculate the field contribution, in cylindrical coordinates, associated to the TM0 surface wave excited by a half-wavelength dipole (l=15 mm, w=0.5 mm) on top of a grounded slab.

Provide the following plots (h=2 mm, εr=10, f=10 GHz):

- Real and imaginary part variation of the electric field as a function of the radial distance.
- Amplitude variation of the electric field components as a function of z.
- Amplitude variation of the electric field as a function of ϕ.

Question 3:

Write a Matlab routine to calculate the power radiated into the TM0 surface wave of a dipole antenna printed on top of a grounded slab.

Provide the following plots (h=2 mm, εr=10, f=1–20 GHz):

- The far field power and surface wave power radiated by an elementary dipole (J=1) normalized to the power radiated by the same current in free space.
- The TM0 surface wave efficiency for:
    - the elementary dipole,
    - a dipole with l=5.3 mm and w=0.5 mm (assume a PWS distribution along the dipole and uniform across it), and
    - a uniform current distribution with a dimension of l=w=25 mm.

Helpful notes:

- While iterating the Newton-Raphson method for finding the SW poles, remember to remove the known linear frequency dependence of k to improve the tracking. The following snippet of code should help:

```
k_guess_norm = #;  % 1st guess point
for fi=nF:-1:1
      k_guess      = k_guess_norm * k0(fi);
      …
      kSW(fi)      = …
      …
      k_guess_norm = kSW(fi)/k0(fi);
end;
```

- The spectrum of a PWS current along x and constant along y is:

$$C_{PWS}(k_x, k_y) \coloneqq 2k_{eq}\frac{\cos\left(\frac{k_x l}{2}\right) - \cos\left(\frac{k_{eq} l}{2}\right)}{\left(k_{eq}^2 - k_x^2\right)\sin\left(\frac{k_{eq} l}{2}\right)} \cdot \mathrm{sinc}\left(\frac{k_y w}{2}\right)$$

  where $\mathrm{k_{eq}} = \mathrm{k_0}\sqrt{\frac{\varepsilon_{r1}+\varepsilon_{r2}}{2}}$ when the current is placed between two dielectric media.
- We normally refer to the normalized sinc function. However, Matlab sinc function is not normalized and thus one needs to normalize its argument by π.