Personal Notes on

ECE357: Electromagnetic Wave

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Abstract

This note is documented for ECE357 Electromagnetic Wave

Contents

1 Transmission Lines

The basic definition for transmission line is that

- **Definition**: Transmission line is two conductors (material with abundance of free electrons) separated by a dielectric (material with bounded electrons). There are types like coaxial line, two wire line, parallel-plate line...
- **Dielectric Material:** For a dielectric material, it has the following properties
  - **Permitivity** ($\epsilon = \epsilon_r \epsilon_0$): The product of relative permitivity and permitivity of free space.
  - **Permeability** ($\mu = \mu_0 \mu_r$): The product of permeability of free space and relative permeability.

  A dielectric of width w, length l, and height h can provide a **capacitance** of

$$C_{dielectric} = \epsilon_0 \epsilon_r \frac{wl}{h} \tag{1}$$

  It is also an **inductor** with magnetic field pointing horizontally when two currents flowing on the top and bottom plates.

$$\hat{H} = -\hat{y} I/w, \quad \phi_m = (\mu \frac{I}{w}) lh \rightarrow L = \frac{\mu h}{w} l = \text{Inductance} \tag{2}$$

  There is also **leaky electric field** through the dielectric

$$E = -V/h \cdot \hat{x} \rightarrow J = \sigma E \rightarrow I = \int_S J \cdot dS = \sigma \frac{V}{h} (w \cdot l) \tag{3}$$

  with the conductance of I/V and per unit length conductance G/l
  It is also a **resistor** with resistance of

$$R = \frac{l}{\sigma w \delta} \tag{4}$$