1 Formulas

Maxwell's Equations

$$\nabla.D = \rho$$

$$\nabla.B = 0$$

$$\nabla \times E = -\frac{\delta B}{\delta t}$$

$$\nabla \times H = J_C + \frac{\delta D}{\delta t}$$

Electric Field

$$E = \frac{Q}{4\pi\epsilon r^2}$$

, where $\epsilon = \epsilon_0\epsilon_r$, $\epsilon_0 = 8.85 \times 10^{-12} Fm^{-1}$

$$E = -grad(V)$$

Electric Flux

$$\Psi = \iint \epsilon E ds = \iint D ds$$

Electric Flux Density

$$D = \frac{\Psi}{A}$$

Capacitor

- $C = \frac{\epsilon A}{d}$
- $E = \frac{1}{2}CV^2$

Magnetic Flux

$$\Phi = \iint \mu H ds = \iint B ds$$

Magnetic Flux Density

$$B = \frac{\Phi}{A} = \mu H$$

Resistivity

$$\rho = \frac{RA}{l}$$

Drift Velocity

$$U_d = \mu_m E$$

Transmission Line

- **Shunt Admittance**: $Y = G + j\omega C$
- **Series Impedance**: $Z = R + j\omega L$
- **Propagation Constant**: $\sqrt{ZY}$
- **Attenuation Constant**:$Re\sqrt{ZY}$

- **Phase Constant**:$Im\sqrt{ZY}$
- **Characteristic Impedance**:$Z_{line} = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{R+j\omega L}{G+j\omega C}}$
- **VSWR**: $VSWR = \frac{1+\Gamma_v}{1-\Gamma_v}$
- **Reflection coefficient for V**:$\Gamma_v = \frac{Z_L - Z_0}{Z_L + Z_0}$
- **Reflection coefficient for I**:$\Gamma_i = -\frac{Z_L - Z_0}{Z_L + Z_0} = -\Gamma_v$
- **Reflected Voltage**: $V_r = V_i \times \Gamma_v$
- **Reflected Current**: $I_r = I_i \times \Gamma_i$

2 Definitions

- **Gauss's Law**: Total electric flux over a volumn is equal to the charge enclosed by that volumn.
- **Electric Field**: E at at a point in a Electric field is the force act on the unit charge at this point.
- **Absolute Potential**: The work move a unit charge from infinity to a radial distance r1.
- **Electric Flux**: Electric Flux through a surface is the integral of normal component of electric field multiplied by ϵ.
- **Electric Flux Density**: Electric flux divided by A.
- **Permittivity**:Permittivity of vacuum multiplied by relative permittivity.
- **Drift Velocity**: Mobility multiplied by E.
- **Magnatic Flux Density**: B equals to Magnetic flux Φ divided by area A.
- **Relative Permeability**: Ratio of effective permeability to absolute permeability.
- **Transmission Line**: Guide electromagnetic energy or info from one point to another.
- **Application of Transmission Lines**: Telephone, coaxial cables, micro strip tracks on a PCB .....
- **AC Circuit Theory**: $l << \lambda$

3 Tao Lu

3.1 Know D, find ρ

1. $\iint Dds = \rho$
2. Determine if the ρ from last step is what we want.

3. If isn't, for example, we want the ρ of a line, but we have ρ in a volumn, then find the ρ we want.

3.2 Magnetic Flux Between Strips

1. $H = \frac{I}{W}$, where W is the width of the strip.
2. $\Phi = \mu H A$

3.3 Find EMF

1. Find EMF caused by change of B, $EMF = \frac{d\Phi}{dt} = \frac{AdB}{dt}$
2. Find EMF caused by $\int (v \times B) dL$
3. Add them together.

3.4 Wave Equation From Gauss's Law

1. We know $\nabla \times E = -\frac{dB}{dt}$
2. Calculate curl for both side. $\nabla \times \nabla \times E = \nabla \times \nabla \times -\frac{dB}{dt}$
3. Substitute $\nabla \times B = \mu_0 \epsilon_0 \frac{dE}{dt}$ into the equation obtained before
4. $\nabla \times \nabla \times E = \nabla(\nabla . E) - \nabla^2 E$, where $\nabla . E$ is 0 in vacuum
5. $\nabla^2 E = \mu_0 \epsilon_0 \frac{dE}{dt}$