E-field based Formulation:

$\mathrm{curl}\,\frac{1}{\mu}$ |

- $$\mathrm{curl}\, E \underset{(1)_F}{=} -\frac{\partial B}{\partial t} \underset{(2)_{BH}}{=} -\mu \frac{\partial H}{\partial t} - \mu_0 \frac{\partial M}{\partial t} \quad (\text{w.l.g. } \frac{\partial M}{\partial t} = 0)$$

$\frac{\mu_0}{\mu} \approx 1$ where $M \neq 0$

- $$\mathrm{curl}\,\frac{1}{\mu}\,\mathrm{curl}\, E = -\frac{\partial}{\partial t}\,\underbrace{\mathrm{curl}\, H}_{\overset{(1)_A}{=}} - \frac{\mu_0}{\mu}\frac{\partial}{\partial t}\,\mathrm{curl}\, M$$

$$= J + \frac{\partial D}{\partial t} \overset{(2)_{DE}}{\underset{(2)_{Ohm}}{=}} \sigma(E + \underset{\overset{\shortparallel}{0}}{v} \times B) + J_i + \varepsilon \frac{\partial E}{\partial t} + \underset{\overset{\shortparallel}{0}}{\frac{\partial P}{\partial t}}$$

- $$\mathrm{curl}\,\frac{1}{\mu}\,\mathrm{curl}\, E = -\sigma \frac{\partial E}{\partial t} - \varepsilon \frac{\partial^2 E}{\partial t^2} - \frac{\partial J_i}{\partial t}$$

$$(7) \quad \boxed{\varepsilon \frac{\partial^2 E}{\partial t^2} + \sigma \frac{\partial E}{\partial t} + \mathrm{curl}\,\frac{1}{\mu}\,\mathrm{curl}\, E = -\frac{\partial J_i}{\partial t}} \quad \text{in } Q_T$$

- $$(7) = -\frac{\partial}{\partial t}(6)$$

Recall: $E = -\frac{\partial A^*}{\partial t}$