4.2. Special Electromagnetic Regimes

4.2.1. Time-Harmonic Regime: TD → FD

- <u>Ass.:</u> – Linear material laws
  – time-harmonic excitation with the frequency ω [Hz] : $F = \mathrm{Re}(\hat{F}(x) e^{i\omega t})$
- <u>Ansatz:</u> $U = H, B, E, D, J, \varrho = \mathrm{Re}(\hat{u}(x) e^{i\omega t})$

  Then: $\frac{\partial U}{\partial t} = i\omega \mathcal{U}$, $\frac{\partial^2 U}{\partial t^2} = -\omega^2 \mathcal{U}$
- <u>Time-Harmonic Maxwell Equation:</u> $\hat{u}(x) \mapsto u(x)$

  $(\hat{1})_A$ $\quad \mathrm{curl}\, H(x) - (i\omega\varepsilon + \sigma) E(x) = J_i(x)$ $\quad (v=0, P=0)$

  $(\hat{1})_{mG}$ $\quad \mathrm{div}\, \mu H(x) = 0$ $\quad (M=0)$

  $(\hat{1})_F$ $\quad \mathrm{curl}\, E(x) + i\omega\mu H(x) = 0$

  $(\hat{1})_{eG}$ $\quad \mathrm{div}\, \varepsilon E(x) = \varrho(x)$

- <u>Continuity Equation:</u>

  $(\hat{1})_{cont}$ $\quad i\omega \varrho(x) + \mathrm{div}\, J(x) = 0$

$A^* \mapsto A$

- <u>Vector potential:</u> $E = -i\omega A$, $B = \mathrm{curl}\, A$

  $(\hat{6})$ $\quad \boxed{\mathrm{curl}\, \mu^{-1} \mathrm{curl}\, A - (\omega^2\varepsilon - i\omega\sigma) A = J_i}$

  BC: $A \times n = 0$ (PEC), $\mu^{-1} \mathrm{curl}\, A \times n = -j_{\Gamma_i}$ (PMC, ISC),

  $\mu^{-1} \mathrm{cur} A \times n + \varkappa i\omega A \times n = 0$ (IBC)
- <u>E-field based:</u> $(\hat{7}) = -i\omega\,(\hat{6})$

  $(\hat{7})$ $\quad \boxed{\mathrm{curl}\, \mu^{-1} \mathrm{curl}\, E - (\omega^2\varepsilon - i\omega\sigma) E = -i\omega J_i}$