Ve230
RC for Final exam

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1. **Three A4 double-sided cheating sheets**
2. **4 Questions**
3. **CH7 & CH8**

Faraday' s law

Fundamental postulate for electromagnetic induction:

$$\boxed{\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}.}$$

$$\boxed{\mathscr{V} = -\frac{d\Phi}{dt} \qquad (\mathrm{V}).}$$

The induced emf will cause a current to flow in the closed loop in such a direction as to oppose the change in the linking magnetic flux. (Lenz's law)

transformer emf

$$\boxed{\mathscr{V}' = \oint_C (\mathbf{u} \times \mathbf{B}) \cdot d\boldsymbol{\ell} \qquad (\mathrm{V}).}$$

Called flux cutting emf or motional emf

For **u**//**B** (no flux is cut), emf $\mathscr{V}'$=0

motional emf

Eg.7-4

Maxwell's Equation

TABLE 7–2
Maxwell's Equations

Differential Form	Integral Form	Significance
$\nabla \times \mathbf{E} = -\dfrac{\partial \mathbf{B}}{\partial t}$	$\oint_C \mathbf{E} \cdot d\boldsymbol{\ell} = -\dfrac{d\Phi}{dt}$	Faraday's law
$\nabla \times \mathbf{H} = \mathbf{J} + \dfrac{\partial \mathbf{D}}{\partial t}$	$\oint_C \mathbf{H} \cdot d\boldsymbol{\ell} = I + \int_S \dfrac{\partial \mathbf{D}}{\partial t} \cdot d\mathbf{s}$	Ampère's circuital law
$\nabla \cdot \mathbf{D} = \rho$	$\oint_S \mathbf{D} \cdot d\mathbf{s} = Q$	Gauss's law
$\nabla \cdot \mathbf{B} = 0$	$\oint_S \mathbf{B} \cdot d\mathbf{s} = 0$	No isolated magnetic charge

Boundary Condition

TABLE 7–3
Boundary Conditions between Two Lossless Media

$E_{1t} = E_{2t} \rightarrow \dfrac{D_{1t}}{D_{2t}} = \dfrac{\epsilon_1}{\epsilon_2}$
$H_{1t} = H_{2t} \rightarrow \dfrac{B_{1t}}{B_{2t}} = \dfrac{\mu_1}{\mu_2}$
$D_{1n} = D_{2n} \rightarrow \epsilon_1 E_{1n} = \epsilon_2 E_{2n}$
$B_{1n} = B_{2n} \rightarrow \mu_1 H_{1n} = \mu_2 H_{2n}$

TABLE 7–4
Boundary Conditions between a Dielectric (Medium 1) and a Perfect Conductor (Medium 2) (Time-Varying Case)

On the Side of Medium 1	On the Side of Medium 2
$E_{1t} = 0$	$E_{2t} = 0$
$\mathbf{a}_{n2} \times \mathbf{H}_1 = \mathbf{J}_s$	$H_{2t} = 0$
$\mathbf{a}_{n2} \cdot \mathbf{D}_1 = \rho_s$	$D_{2n} = 0$
$B_{1n} = 0$	$B_{2n} = 0$

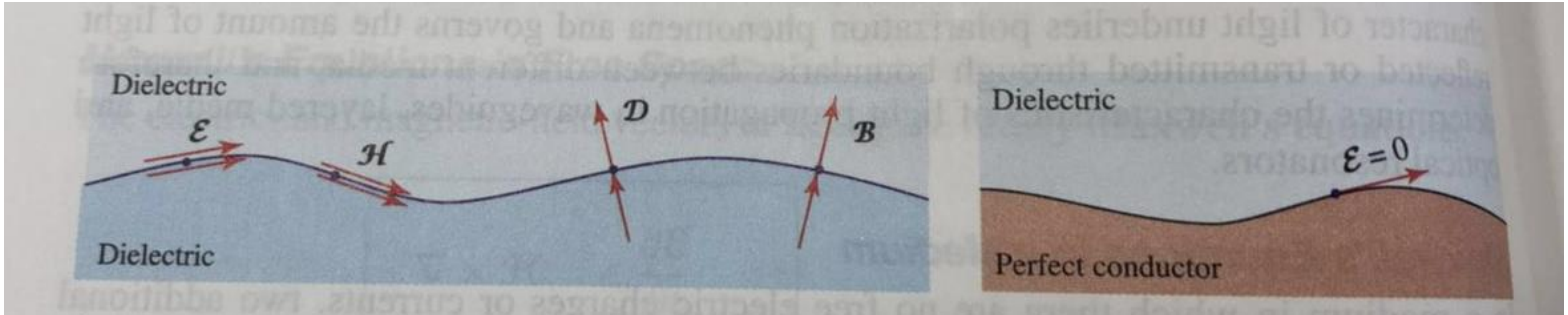

Figure 5.1-1 Boundary conditions at: (*a*) the interface between two dielectric media; (*b*) the interface between a perfect conductor and a dielectric material.

Time-Harmonic Electromagnetics

$$\mathbf{E}(x, y, z, t) = \mathscr{Re}[\mathbf{E}(x, y, z)e^{j\omega t}],$$

$\partial \mathbf{E}(x, y, z, t)/\partial t \Rightarrow j\omega \mathbf{E}(x, y, z)$

$\int \mathbf{E}(x, y, z, t)\, dt \Rightarrow \mathbf{E}(x, y, z)/j\omega,$

$\boxed{\partial/\partial t \rightarrow j\omega}$

$$k = \omega\sqrt{\mu\epsilon} = \frac{\omega}{u} = 2\pi/\lambda$$

(the wavenumber)

$$\rightarrow \boxed{\begin{aligned} \nabla \times \mathbf{E} &= -j\omega\mu\mathbf{H}, \\ \nabla \times \mathbf{H} &= \mathbf{J} + j\omega\epsilon\mathbf{E}, \\ \nabla \cdot \mathbf{E} &= \rho/\epsilon, \\ \nabla \cdot \mathbf{H} &= 0. \end{aligned}}$$

Maxwell equation

Losses

- **Lossy media:** $\varepsilon_c = \varepsilon' - j\varepsilon''$

$$k_c = \omega\sqrt{\mu\epsilon_c} = \omega\sqrt{\mu(\epsilon' - j\epsilon'')}$$

The real wavenumber k should be changed to a complex wavenumber k_c in a lossy dielectric media

- **Loss tangent:** a measure of power loss

$$\tan\delta_c = \frac{\epsilon''}{\epsilon'} \cong \frac{\sigma}{\omega\epsilon}.$$

δ_c : loss angle