Highlights from ECE 235: Solid-state Physics

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Contents

1 EM wave

1.1 waves

- Traverse wave: oscillation $\perp$ propagation
- Longitudinal wave: oscillation $\parallel$ propagation
- $v = \lambda f$

1.2 EM wave function

$$\begin{cases} E_x = E_0 \sin(kz - \omega t) \\ B_y = B_0 \sin(kz - \omega t) \end{cases} \quad [1$$

where $k = \frac{2\pi}{\lambda}$ (wave number) , $\quad \omega = 2\pi f = kc$ (dispersion relationship), B_0 : magnetic field amplitude, E_0 : electric field amplitude

1.3 EM Energy flux

Energy flux the energy transferred per unit area per unit time in the direction of wave propagation of an EM wave is defined by the Poynting vecter

$$\vec{S} \equiv \frac{\vec{E} \times \vec{B}}{\mu_0}. \quad [2$$

Where $\mu_0 = 1.25663706126e\text{-}6(N \cdot A^{\text{-}2})$ is the vacuum permeability.

- Intensity of EM wave is the magnitude of the Poynting vector:

$$I = \langle S \rangle = \frac{E_0^2}{377\Omega} \quad [3$$

  where Ω is ohm. Very unorthodoxy I know, but hey we are in Engineering Hall.

- Specially, when EM wave is emitted from a point light source with power P ,

$$I = \frac{P}{4\pi r^2} = \frac{E_0^2}{377\Omega} \quad [4$$

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2 Photoelectric effect

- Energy of a photon

$$E_p = hf = \Phi + E_k \quad [5$$

where Φ is the work function of the material, E_k is the kinetic energy of the emitted electron at the surface of the material. $h = 6.26e\text{-}34$ is the Planck constant.

- Motion for Photoelectric effect:

$$E_{k,m} + (\text{-}e)V_m = E_{k,d} + (\text{-}e)V_d \quad [6$$

- stopping potential

$$V_{\text{stop}} = \frac{E_{k,m}}{e} = \frac{hf - \Phi}{e}, \quad [7$$

  the minimum potential required to stop the emitted electron.

- Threshold frequency $f_{\text{tr}} = \frac{\Phi}{h}$