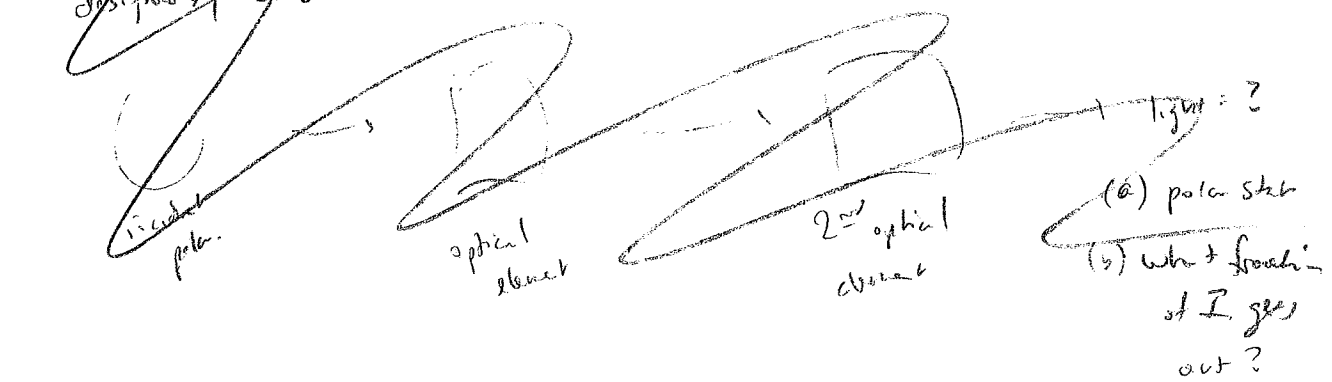
Sample problem

designed by class:



Ellipsometry

→ use BRT slides

end of chapter

Chap 7 start

Recall Poynting vector

$$\vec{S} = \vec{E} \times \frac{\vec{B}}{\mu_0}$$

we showed

$$= E_0 \cos(kz - \omega t) \cdot \frac{1}{\mu_0 c/n} E_0 \cos(kz - \omega t)$$

$$= \frac{n}{\mu_0 c} E_0^2 \cos^2(\ )$$

$$\langle S \rangle = \frac{1}{2} \frac{n}{\mu_0 c} E_0^2$$

$$= \frac{1}{2} n \epsilon_0 c |E_0|^2$$

$\frac{1}{\mu_0 c} = \epsilon_0 c$

$c^2 = \frac{1}{\epsilon_0 \mu_0}$ ✓

We glossed over some pts:

1) $\vec{S} =$ real $\vec{E} \times \frac{1}{\mu_0}$ real $\vec{B}$

that's why we used cosines, not exponentials

2) In last step we could write $|E_0|^2$ in place of E_0^2

$|E_0|^2$ ↓ also amplitude^2 because if you wrote $\tilde{E} = \tilde{E} e^{i(kx - \omega t)}$ ↓ $E_0 e^{i\delta}$ $|\tilde{E}|^2 = E_0^2$

E_0^2 ↓ amplitude^2, really means $E_0 E_0^*$

3) valid for time scales $\gg$ period $(= 2\pi/\omega)$

4) Derivation assumed plane waves

This chapter - considers groups of plane waves added together
w/ potentially different $\vec{k}$'s and ω's

$$\vec{E} = \sum_j \vec{E}_j e^{i(\vec{k}_j \cdot \vec{r} - \omega t)}$$

$\vec{B}$ = similar sum,

$$\vec{B} = \sum_j \frac{\vec{k}_j}{\omega_j} \times \vec{E}_j$$

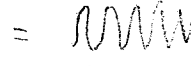
Book: Take Real [ ] $\times \frac{1}{\mu_0}$ Real [ ]

Do a lot of algebra... (I'm skipping!)

$$\langle S \rangle = \frac{1}{2} n \epsilon_0 c |E|^2$$

↑ total field $\vec{E}(\vec{r}, t)$

Obvious? Maybe (maybe not
1. $|E|^2$ now has more meaning
2. Difference is time scales.

plane wave E = 
it's clear that time ave → time >> $2\pi/\omega$

sum of waves =  (possibly)

$\langle S \rangle$ = 
averaged out the fast time but not the "slowly" varying stuff

Limitations:
1) Assumed n is constant for all ω
2) Assumed $\vec{k}$'s are all (mostly) parallel
(that's ok, otherwise it wouldn't form a beam)

Phase velocity vs Group velocity → Phys 123 PPT slides
↳ speed of fast oscill. ↳ speed of $\langle S \rangle$ peaks

We have → proof in P 7.3 (not assigned)

Show Animation 1 (lower group)
plane waves beating.avi

Ani. 2. beats, negative.avi

Anim 4 pulse chirping

Can start on Fourier handout if time

(Get through first part of handout through bottom of page 1 exponential form)