Phys 473
Fall 2015

Modern Optics: Homework 2

Due: 21 August 2015

1 Bennett, *Principles of Physical Optics*, 1.17, page 16. Note that there is a typo in the second line of Eq 1.40. It should read

$$\frac{z_1}{z_2} = \left(\frac{x_1 x_2 + y_1 y_2}{x_2^2 + y_2^2} \right) + i \left(\frac{y_1 x_2 - x_1 y_2}{x_2^2 + y_2^2} \right).$$

2 Bennett, *Principles of Physical Optics*, 1.18, page 17.

3 Real and imaginary parts of sums and products

In general it is true that

$$\operatorname{Re}[z_1 + z_2] = \operatorname{Re}[z_1] + \operatorname{Re}[z_2]$$

but it is not always true that

$$\operatorname{Re}[z_1 z_2] = \operatorname{Re}[z_1] \operatorname{Re}[z_2].$$

Choose two complex numbers z_1 and z_2 that show that

$$\operatorname{Re}[z_1 z_2] \neq \operatorname{Re}[z_1] \operatorname{Re}[z_2].$$

and check that they satisfy the rule for the real part of a sum.

4 Bennett, *Principles of Physical Optics*, 1.29, page 23.

5 Complex representations of harmonic waves

The general complex representation of a harmonic wave is

$$\tilde{\Psi}(x,t) = A e^{i(kx \mp \omega t + \phi)}$$

and the associated real harmonic wave is

$$\Psi(x,t) = \operatorname{Re}[\tilde{\Psi}(x,t)].$$

a) Choose $\phi = -\pi/2$ determine the associated real harmonic wave.

b) Suppose that

$$\begin{aligned} \Psi_1(x,t) =& A \sin(kx - \omega t) \\ \Psi_2(x,t) =& A \sin(kx + \omega t) \end{aligned}$$

Determine the associated complex representation for each, use them to form

$$\tilde{\Psi}(x,t) = \tilde{\Psi}_1(x,t) + \tilde{\Psi}_2(x,t),$$

simplify this and determine an expression for the real harmonic wave in the form

$$\Psi(x,t) = (\text{function of } x) \times (\text{function of } t).$$