Multiple interference in optical cavities

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Solution: *The wave is reflected several times. For the field within the cavity we find, using* $r_j = 1 - t_j$*,*

$$E_{cav}(x) = E_{in}t_1 \sum_n \left[(r_1r_2)^n e^{\imath k[2nL+x]} - r_2(r_1r_2)^n e^{\imath k[(2n+2)L-x]}\right] = E_{in}t_1 \frac{e^{\imath kx} - r_2 e^{\imath k(2L-x)}}{1 - r_1r_2e^{\imath k2L}} ,$$

using the Fourier expansion of $(1-s)^{-1} = \sum_n s^n$*. The reflected and transmitted fields are,*

$$E_{rfl} = r_1E_{in} + E_{in}\sum_{n=0}^{\infty} t_1(-r_2)(r_1r_2)^n t_1 e^{\imath k2(n+1)L} = E_{in}\left(r_1 - \frac{e^{\imath k2L}t_1^2r_2}{1 - r_1r_2e^{2ikL}}\right)$$

$$E_{trns} = E_{in}\sum_{n=0}^{\infty} t_1(r_1r_2)^n t_2 e^{\imath k(2n+1)L} = E_{in}\frac{t_1t_2e^{\imath kL}}{1 - r_1r_2e^{2ikL}} .$$

The phase shift is calculated by,

$$\phi = \arctan\frac{Im\ E}{Re\ E} .$$