HOMEWORK I

Laser Physics II

Due Wednesday February 12

Polarization

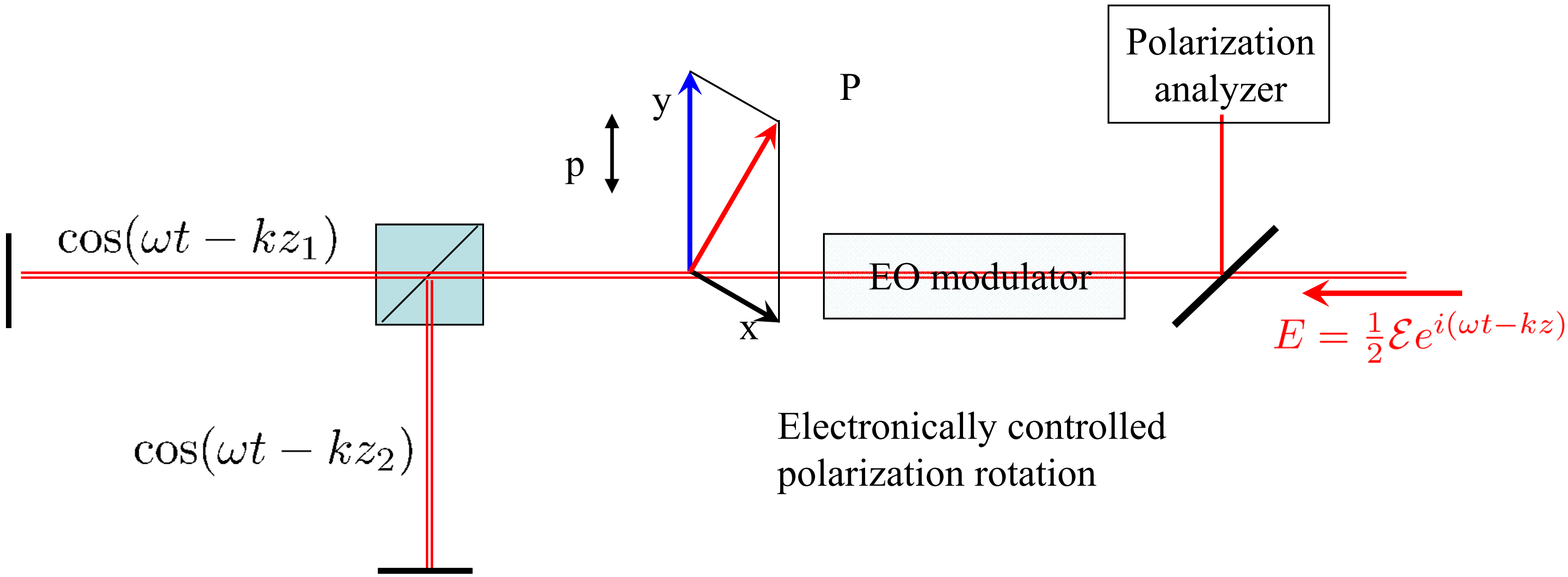
Problem 1. Typical waveplate problems

A bichromatic field is incident on a quarter wave plate, with the field given by:

$$E(t) = [\hat{x} + \hat{y}]\mathcal{E}\cos(\omega t) + [\hat{x} + \hat{y}]\mathcal{E}\cos(\omega + \Delta\omega)t$$

where $\Delta\omega \ll \omega$. Find the expression of the electric field transmitted by the quarter wave plate, and explain the polarization of the wave.

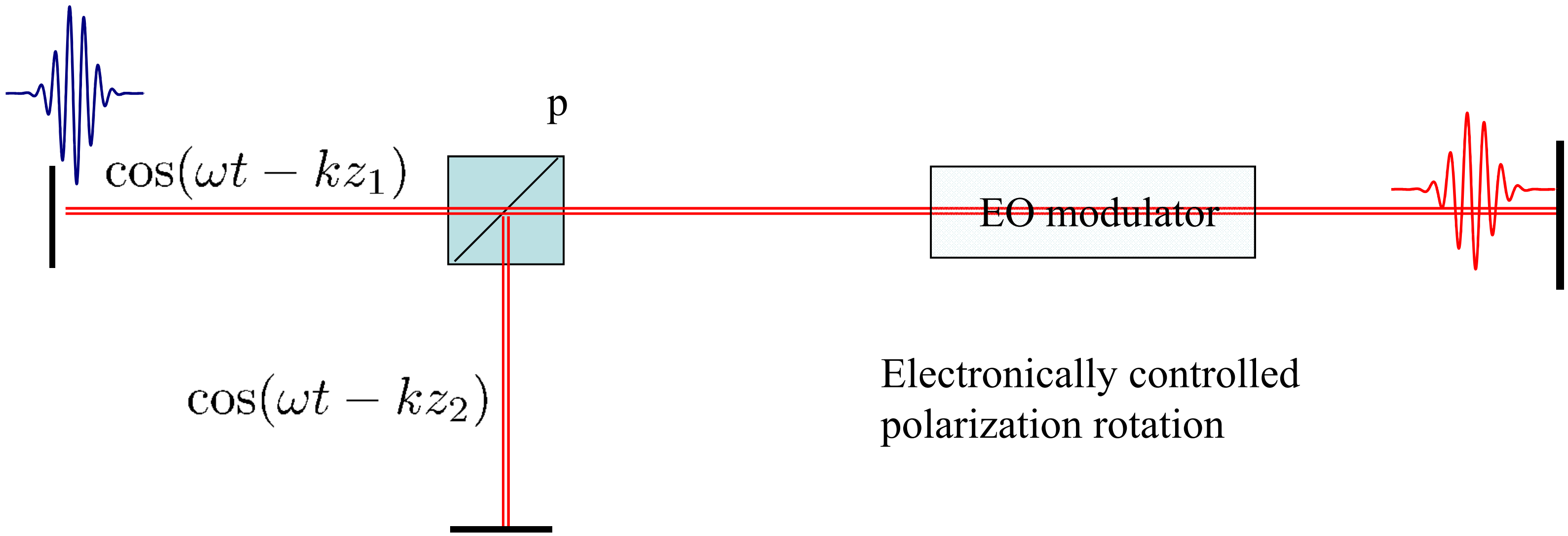
Problem 2. Polarization manipulation



What is the state of polarization on the analyzer, and its dependence on $\Delta z = z_2 - z_1$ when

1) You apply a half-wave voltage (π) on the modulator?
2) When the applied voltage creates a retardation of 80 degrees?

Put the Michelson like arrangement at the end of a laser cavity



3) Under which condition(s) could this be a viable mode-locked laser?

Problem 3: zero and multi-order waveplate

The indices of refraction for the fast and slow axis of quartz for 546 nm light are 1.5462 and 1.5553, respectively.

What is the thickness of a zero-order quarter-wave plate?

Estimate the bandwidth $\Delta\lambda$ of light centered at 546 nm that this quarter wave plate can handle, if the phase retardation must not deviate more than 5% of the desired value.

Repeat for a quarter wave plate of order 10

Problem 4: Ring lasers manipulation

Design a combination of polarization components such that the counter-clockwise beam enters the cell C as a right circular beam, and the clockwise beam enters the same cell as a left circular beam.

Find polarization elements such that the counter-circulating beams
have opposite circular polarization in the cell C (with respect to fixed axis).