

PHY660: Non-linear Optics  
Mid Term Examination, Feb 2025

Date: Feb 06, 2025

---

Total marks: 20

1. For a lossy and isotropic medium, the linear susceptibility  $\chi^{(1)}$  is a complex quantity. If  $\chi^{(1)} = \chi_r + i\chi_i$  where  $\chi_r$  and  $\chi_i$  are the real and imaginary parts of the complex susceptibility, derive the expressions for the real and imaginary parts of the complex wave-vector  $k$ .

5 marks

2. Consider the following Jones vector.

$$J = \begin{pmatrix} \cos \pi/8 \\ i \sin \pi/8 \end{pmatrix}.$$

Find the stokes vector corresponding to this Jones vector. Also find the coordinates of this vector on the Poincaré sphere. 5 marks

3. Prove that

$$\chi_{ijk}^{(2)}(\omega_i, \omega_j, \omega_k) = \chi_{ikj}^{(2)}(\omega_i, \omega_k, \omega_j)$$

for lossless systems.

5 marks

4. Consider the equation

$$\ddot{x} + 2\gamma\dot{x} + \omega_0^2 x = -\frac{eE(t)}{m}$$

If  $E(t) = E_0 \exp i\Omega t$ , prove that the solution  $x(t)$  of the above equation will also have a component oscillating with  $\Omega$  frequency. 5 marks