Problem P2.3

In a ferrite, the magnetic moment $\overline{M}$ roughly obeys the relationship $d\overline{M}/dt = g\mu_0\overline{M} \times \overline{H}$, where g is the gyromagnetic ratio. When a $\hat{z}$-directed dc magnetic field $\overline{H}_0$ (zeroth order) is present, the total fields take the form $\overline{H} = \hat{z}H_0 + \overline{H}_1$, $\overline{M} = \hat{z}M_0 + \overline{M}_1$, and $\overline{B} = \mu_0(\overline{H} + \overline{M})$.

(a) For the cross product $\hat{z} \times \overline{H}_1$, convert it to be $\overline{\overline{z}} \cdot \overline{H}_1$. What is $\overline{\overline{z}}$?

(b) To the first order approximation, $\overline{M}_1 \times \overline{H}_1$ is negeligible. Show that the permeability $\overline{\overline{\mu}}$ which satisfies $\overline{B}_1 = \overline{\overline{\mu}} \cdot \overline{H}_1$ has the form of

$$\overline{\overline{\mu}} = \begin{bmatrix} \mu & i\mu_g & 0 \\ -i\mu_g & \mu & 0 \\ 0 & 0 & \mu_z \end{bmatrix}$$

(c) Find dispersion relations for the first-order fields in kDB system.

(d) Show that Faraday rotation exists in the ferrite.

Problem P3.1

Use the kDB system to determine the dispersion relations for a biisotropic medium (Tellegen medium) with the constitutive relation

$$\overline{D} = \epsilon\overline{E} + \xi\overline{H}$$
$$\overline{B} = \xi\overline{E} + \mu\overline{H}$$

Problem P3.3

In a ferrite, the magnetic moment $\overline{M}$ roughly obeys the relationship $d\overline{M}/dt = g\mu_0\overline{M} \times \overline{H}$, where g is the gyromagnetic ratio. When a $\hat{z}$-directed dc magnetic field $\overline{H}_0$ (zeroth order) is present, the total fields take the form $\overline{H} = \hat{z}H_0 + \overline{H}_1$, $\overline{M} = \hat{z}M_0 + \overline{M}_1$, and $\overline{B} = \mu_0(\overline{H} + \overline{M})$. Find dispersion relations for the first-order fields. Show that Faraday rotation exists in the ferrite.