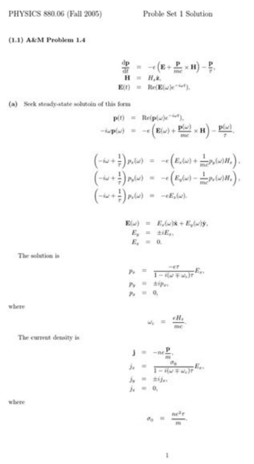

PHYSICS 880.06 (Fall 2005) Proble Set 1 Solution

(1.1) A&M Problem 1.4

$$\frac{d\mathbf{p}}{dt} = -e\left(\mathbf{E} + \frac{\mathbf{p}}{mc} \times \mathbf{H}\right) - \frac{\mathbf{p}}{\tau},$$
$$\mathbf{H} = H_z\hat{\mathbf{z}},$$
$$\mathbf{E}(t) = \mathrm{Re}(\mathbf{E}(\omega)e^{-i\omega t}).$$

(a) Seek steady-state solutoin of this form

$$\mathbf{p}(t) = \mathrm{Re}(\mathbf{p}(\omega)e^{-i\omega t}),$$
$$-i\omega\mathbf{p}(\omega) = -e\left(\mathbf{E}(\omega) + \frac{\mathbf{p}(\omega)}{mc} \times \mathbf{H}\right) - \frac{\mathbf{p}(\omega)}{\tau}.$$

$$\left(-i\omega + \frac{1}{\tau}\right)p_x(\omega) = -e\left(E_x(\omega) + \frac{1}{mc}p_y(\omega)H_z\right),$$
$$\left(-i\omega + \frac{1}{\tau}\right)p_y(\omega) = -e\left(E_y(\omega) - \frac{1}{mc}p_x(\omega)H_z\right),$$
$$\left(-i\omega + \frac{1}{\tau}\right)p_z(\omega) = -eE_z(\omega).$$

$$\mathbf{E}(\omega) = E_x(\omega)\hat{\mathbf{x}} + E_y(\omega)\hat{\mathbf{y}},$$
$$E_y = \pm iE_x,$$
$$E_z = 0.$$

The solution is

$$p_x = \frac{-e\tau}{1 - i(\omega \mp \omega_c)\tau}E_x,$$
$$p_y = \pm ip_x,$$
$$p_z = 0,$$

where

$$\omega_c = \frac{eH_z}{mc}.$$

The current density is

$$\mathbf{j} = -ne\frac{\mathbf{p}}{m},$$
$$j_x = \frac{\sigma_0}{1 - i(\omega \mp \omega_c)\tau}E_x,$$
$$j_y = \pm ij_x,$$
$$j_z = 0,$$

where

$$\sigma_0 = \frac{ne^2\tau}{m}.$$

1

Download PDF version of :

Solid State Physics Ashcroft Mermin Solutions