1. Field strength **(3 pts)**

Calculate the amplitudes of $\vec{E}$ and $\vec{B}$ at a distance of 50 cm away from an isotropic, monochromatic point source that radiates at a constant power level of 100 W.

2. Sellmeier equation **(5 pts)**

Hecht, problem 3.57:

Show that Cauchy's equation, $n = C_1 + C_2/\lambda_2 + C_3/\lambda^4 + \ldots$, is an approximation of Sellmeier's equation,

$$n^2 = 1 + \sum_j \frac{A_j \lambda^2}{\lambda^2 - \lambda_{0,j}^2}$$

when $\lambda >> \lambda_{0,j}$ (where $\lambda_{0,j}$ are the wavelengths associated with the relaxation frequencies $\nu_{0,j}$).

3. Rayleigh scattering **(2 pts)**

Hecht, problem 4.2:

Determine the relative amount of scattering of a dilute gas mixture for the $\lambda = 580$ nm and $\lambda = 400$ nm components of white light. Implications?

4. Damped driven oscillator **(5 pts)**

Hecht, problem 4.4:

In the equation for the damped driven oscillator, $m_e\ddot{x} + m_e\gamma\dot{x} + m_e\omega_0^2 x = q_e E(t)$, explain the significance of each term and show that the amplitude x_0 of a harmonic solution depends on the field amplitude, E_0, as

$$x_0 = \frac{q_e E_0}{m_e} \frac{1}{\left[\left(\omega_0^2 - \omega^2\right) + \gamma^2\omega^2\right]^{1/2}}$$

How does the phase lag α depend on ω?

5. Wave in thin glass plate **(5 pts)**

Hecht, problem 4.5:

Show that an observer sees the field of a light beam, $E_u = E_0 \exp(i\omega[t - y/c])$ in vacuum, change to $E_p = E_0 \exp(i\omega[t - (n-1)\Delta y/c - y/c])$ in an absorption-free glass plate of index n and thickness Δy. Start with the no. of oscillations of the wave field within Δy in vacuum and in the medium. Then show that for $n \approx 1$, or if Δy is very small, $E_p = E_u + \omega(n-1)\Delta y/c \cdot E_u \exp(-i\pi/2)$. This result shows that the secondary wave in a medium is phase-shifted by 90° ($\alpha = \pi/2$) against the primary wave, even as $\Delta y \to 0$.