

**PHYS 704 - Test 1.**

- 1. [10 points] Derive the equation

$$\frac{\epsilon(\omega)}{\epsilon_0} = 1 + \frac{Ne^2}{\epsilon_0 m} \sum_j f_j (\omega_j^2 - \omega^2 - i\omega\gamma_j)^{-1}$$

Describe the behavior of the real and imaginary parts of  $\epsilon(\omega)$  as a function of frequency.

- 2. [10 points] A TM wave in a rectangular waveguide propagates along the  $z$ -direction and has

$$E_z = E_0 \sin\left(\frac{m\pi x}{a}\right) \sin\left(\frac{n\pi y}{b}\right)$$

Find the remaining components of the electric and magnetic fields. Derive any equations you may need from Maxwell's equations.