Problem Statement: Laser-induced polarization spectroscopy is used to measure the concentration of nitric oxide (NO) in the exhaust of a gas turbine combustor. A monochromatic probe laser with a pulse energy of 1 μJ is tuned to the peak of the P_{11}(3.5) resonance transition in the (0,0) vibrational band of the $A^2\Sigma^+ - X^2\Pi$ electronic transition of NO. The exhaust gases are at $T = 800 K$ and $P = 200 kPa$. The homogeneous, collision broadened linewidth $\Delta \omega_c$ is determined to be 0.50 cm$^{-1}$ at these conditions. For a certain operating condition, the mole fraction of NO in the exhaust gases is 500 ppm. A monochromatic, circularly polarized pump laser is used to create a non-isotropic Zeeman state distribution in the ground level of the transition such that $n_g = \frac{n_G}{2J_G + 1} \left( 1 + \frac{M_g}{100} \right)$. The length of the pump-probe interaction volume is 2 mm. Assume that the spectral width of the monochromatic probe laser radiation is much narrower than the spectral width of the absorption line. Calculate the number of photons from the probe beam that are transmitted through the polarizer analyzer.

For the NO P_{11}(3.5) transition, needed spectroscopic information can be found in J. R. Reisel, C. D. Carter and N. M. Laurendeau, “Einstein Coefficients for Rotational Lines of the (0,0) Band of the NO $A^2\Sigma^+ - X^2\Pi$ System,” Journal of Quantitative Spectroscopy and Radiative Transfer,” Vol. 47, pp. 43-54 (1992)].

$J_G = 3.5, \quad J_E = 2.5, \quad \nu'' = 0, \quad \nu' = 0, \quad \frac{\omega_{0\theta}}{2\pi c} = \tilde{v}_{EG} = 44,185.88 \text{ cm}^{-1}, \quad A_{z1} = A_{Eg} = 1.640 \times 10^6 \text{ s}^{-1}$