EECE7105— OPTICS FOR ENGINEERS— Fall 2025

Mid–Term Exam: Rev 1

Submit by email as a single .pdf file before Tuesday 28 Oct, at 23:59:59.

1 Laser Polarization

We design a carbon dioxide laser at $\lambda = 10.59\mu$m with a rear mirror having a 0.999 reflectivity and a front mirror having a reflectivity of 0.95 (transmitting 5% as the laser output). The one-way amplitude gain is $g - 1.03$. The laser tube is sealed with Brewster plates made from Germanium, $n = 4$.

a. What is the reflectivity of one surface of the Brewster plate for S polarized light?

b. What is the transmission matrix for one pass through one Brewster plate? Remember the matrix is in terms of amplitude and not irradiance.

c. Now let's assume the Brewster plates are perfectly aligned at Brewster's Angle, but that one of them is rotated relative to the other by an angle, $\zeta = 1.5$deg. Start at a point approaching the output coupler and compute the round–trip Jones matrix. Find the eigenvalues and eigenvectors. Will the laser operate at all, and if so, on what polarization(s) will it operate?

d. Plot the irradiance transmission for the higher eigenvalue as a function of ζ over enough range to determine what maximum alignment error, $\delta\zeta$, will permit operation.

2 Confocal Microscope

In a reflectance confocal microscope, we usually employ the T/R switch discussed in class. Let's assume for a particular sample of skin, a fraction, $F_a = 10^{-6}$, of the incident light is reflected back to the system with no change in polarization. Another fraction, $F_b = 0.5 \times 10^{-6}$, is scattered multiple times in the tissue, resulting in complete depolarization. Assume a transmitted power of $P = 1 - $mW. Using coherency matrices, determine the coherency matrix of each component of the returned light for two cases:

2. A beamsplitter that transmits 95% of the P–polarized light and reflects 1% of the S–polarized light, and a waveplate that has an actual retardance is 94 degrees instead of 90 degrees, perhaps because I used it at a different wavelength than the one for which it was designed.

Again, be careful about amplitudes and irradiances in forming the matrices, and about the order of multiplication.