Physics 471 - Study guide for exam 2  
Dr Colton, Winter 2024

- Chapter 4 – Three Materials, Two Interfaces (the part that wasn’t covered on exam 1)  
  o How to use the matrix method to determine transmission and reflection for a multilayer stack

- Chapter 5 – Crystals  
  o Biaxial – Given $n_x$, $n_y$, and $n_z$, and a direction of travel, how to determine the index of refraction for the two main polarizations…  
    ▪ If traveling in x, y, or z, how to get the answers trivially  
    ▪ If traveling in a different direction, how to solve the Fresnel crystal equation to determine this (although if one polarization is in x, y, or z, it’s still trivial for that polarization)  
  o What are the “optic axes”—how to determine and what they mean  
  o Uniaxial – Given $n_o$ and $n_e$, and especially for the particular orientation where the optic axis points along the plane of the interface, and for both s and p polarizations…  
    ▪ What is the “fast axis”  
    ▪ Given a direction of travel, how to determine the index of refraction  
    ▪ How to determine the direction of the k-vector  
    ▪ How to determine the direction of the Poynting vector

- Chapter 6 – Jones & Stokes/Mueller  
  o What Jones vectors mean, how to determine them for a given situation  
  o What Jones matrices mean, how to use them to determine the effect of various optical elements on the Jones vector  
  o What Stokes vectors mean, how to determine them for a given situation  
  o What Mueller matrices mean, how to use them to determine the effect of various optical elements on the Stokes vector  
  o How to connect the vectors to quantities such as overall intensity  
  o Behavior of some common configurations such as quarter wave plate at ±45°, half waveplate at angle $\theta$

- Chapter 7 – Fourier and Dispersion  
  o How to determine phase and group velocities for a material given its dispersion relation and a given set (or range) of frequencies  
  o What are Fourier transforms—how to calculate them for basic cases, and what they mean  
  o What are delta functions—basic properties, how to use them, and what they mean  
  o What are convolutions—how to calculate them and what they mean  
    ▪ What are the convolution theorems and how to use them  
  o Linear dispersion – what impact it has on a pulse traversing a medium, how to calculate effects such as:  
    ▪ speed of travel  
    ▪ time delay  
    ▪ reduction of amplitude from absorption  
  o Quadratic dispersion – what impact it has on a pulse traversing a medium, how to calculate effects such as:  
    ▪ speed of travel  
    ▪ spreading out of pulse in time  
    ▪ reduction of amplitude (from absorption but also from spreading out)  
    ▪ pulse chirping (qualitative only)