FO-3
August 2015 QE

1. (30 points)

   Calculate the reflection at the interface between air ($\epsilon_r = 1$) and silicon ($\epsilon_r = 3.5$) in the infrared at normal incidence, neglecting absorption.

2. (30 points)

   Consider a structure consisting of 3 layers:

   (a) Semi-infinite layer of air ($\epsilon_r = 1$, $\mu_r = 1$)
   (b) Finite layer of thickness t ($\epsilon_r = \epsilon$, $\mu_r = 1$)
   (c) Semi-infinite layer of titanium dioxide ($\epsilon_r = 5.0625$, $\mu_r = 1$)

   Find the smallest possible thickness t and dielectric constant ϵ needed to achieve zero reflection at normal incidence when $\lambda = 600$ nm.

3. (20 points)

   Using the parameters obtained in the last problem, find the reflection at normal incidence when $\lambda = 400$ nm.

4. (20 points)

   Now consider a slightly different structure with 3 layers:

   (a) Semi-infinite layer of air ($\epsilon_r = 1$, $\mu_r = 1$)
   (b) Finite layer of thickness t' ($\epsilon_r = 4$, $\mu_r = 1$)
   (c) Semi-infinite layer of air ($\epsilon_r = 1$, $\mu_r = 1$)

   What is the smallest possible thickness t' required to achieve extremely low reflection ($< 0.02\%$) at normal incidence when $\lambda = 600$ nm? Is this value larger or smaller than the thickness t from Problem 2, and why?