

Problem 4.51 Figure P4.51 shows three planar dielectric slabs of equal thickness but with different dielectric constants. If \mathbf{E}_0 in air makes an angle of 45° with respect to the z -axis, find the angle of \mathbf{E} in each of the other layers.

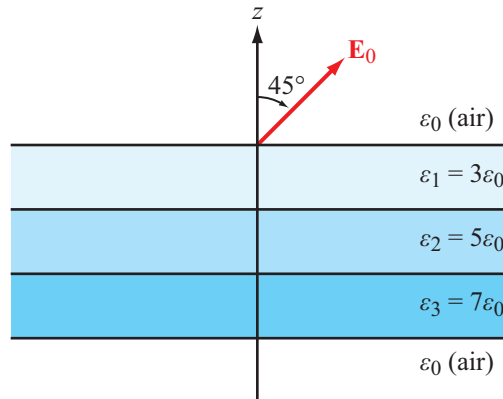


Figure P4.51: Dielectric slabs in Problem 4.51.

Solution: Labeling the upper air region as region 0 and using Eq. (4.99),

$$\begin{aligned}\theta_1 &= \tan^{-1} \left(\frac{\epsilon_1}{\epsilon_0} \tan \theta_0 \right) = \tan^{-1} (3 \tan 45^\circ) = 71.6^\circ, \\ \theta_2 &= \tan^{-1} \left(\frac{\epsilon_2}{\epsilon_1} \tan \theta_1 \right) = \tan^{-1} \left(\frac{5}{3} \tan 71.6^\circ \right) = 78.7^\circ, \\ \theta_3 &= \tan^{-1} \left(\frac{\epsilon_3}{\epsilon_2} \tan \theta_2 \right) = \tan^{-1} \left(\frac{7}{5} \tan 78.7^\circ \right) = 81.9^\circ.\end{aligned}$$

In the lower air region, the angle is again 45° .
