7-25. Using Eq. (7-39) with \( t_m \ll r_m, \)

\[
\begin{align*}
r_{11,1}^2 & \approx 2 \sqrt{2} R t_{11,1} = 2 R (11 - 1/2) \lambda_1/2 = r_{10,2}^2 \approx 2 R t_{10,1} = 2 R (10 - 1/2) \lambda_2/2 \\
\lambda_2 & = \lambda_1 (10.5/9.5) = (546 \text{ nm})(10.5/9.5) = 603.5 \text{ nm} \\
r_{11} & = \sqrt{2} R (11 - 1/2) \lambda_1/2 = \sqrt{2} (1) (10.5) (546 \times 10^{-9})/2 \text{ m} = 0.002398 \text{ m} = 2.39 \text{ mm} \\
t_{11} & = 10.5 \lambda_1/2 = 2.87 \times 10^{-4} \text{ cm}
\end{align*}
\]

7-26. Refer to Figure 7-20 and the surrounding discussion in the body of the text.

\[
\Delta m = \Delta x/x = 3.4/1 = 3.4 \Rightarrow d = \Delta m \lambda/2 = (3.4) \left( \frac{546.1}{2} \text{ nm} \right) = 928.4 \text{ nm}
\]

![Figure 7-20](a) Photograph of interference fringes produced by the arrangement shown in Figure 7-19. The trough-like depression evident in the interference pattern was made by evaporating the film over a thin, straight wire. (b) Sketch (not to scale) of the left side of the trough shown in the photo. The fringe pattern shifts by an amount \( \Delta x \) at the film edge. (Photo by J. Feldott.)

7-27. Refer to Figure 7-30 that accompanies the statement of the problem in the text. The cross-sections of the emergent reflected and transmitted beams are the same as that of the incident beam. Inside the film, the cross-section is modified due to refraction.

(a) \[ E_o = \frac{\Phi}{A} = \frac{10^{-3} W}{\pi (5 \times 10^{-4})^2 m^2} = 1273 \frac{W}{m^2} = (\varepsilon_0 c/2) E_0^2 \Rightarrow E_0 = 980 \text{ V/m} \]

(b) Snell’s law gives: \( \sin(45^\circ) = (1.414) \sin \theta_f \Rightarrow \theta_f = 30^\circ \)

(c) Using the Stokes relations,

\[
|r'| = |r| = 0.28 \\
t' = \sqrt{1 - r^2} = 0.9216
\]

(d) Reflected beams:

\[
\begin{align*}
E_1 & = r E_0 = (0.28) (980 \text{ V/m}) = 274 \text{ V/m}, (E_1/E_0)^2 = 0.078 = 7.8\% \\
E_2 & = r' t' E_0 = (0.28)(0.9216) (980 \text{ V/m}) = 253 \text{ V/m}, (E_2/E_0)^2 = 0.067 = 6.7\% \\
E_3 & = (r')^2 t' E_0 = (0.28)^2(0.9216) (980 \text{ V/m}) = 19.8 \text{ V/m}, (E_3/E_0)^2 = 0.00041 = 0.041\%
\end{align*}
\]

(e) Transmitted beams:

\[
\begin{align*}
E_1 & = t' E_0 = (0.9216) (980 \text{ V/m}) = 774 \text{ V/m}, (E_1/E_0)^2 = 0.85 = 85\% \\
E_2 & = (r')^2 t' E_0 = (0.28)^2(0.9216) (980 \text{ V/m}) = 70.8 \text{ V/m}, (E_2/E_0)^2 = 0.0052 = 0.52\%
\end{align*}
\]

(f) \[
m \lambda = 2 n_f t \cos \theta_f \Rightarrow t = \frac{\lambda}{2 n_f \cos \theta_f} = \frac{632.8 \text{ nm}}{2 (1.414) \cos(30^\circ)} = 258 \text{ nm}
\]
8.1. \[ \lambda = \frac{(2 \Delta d / \Delta m)}{523} = \frac{(2 \cdot 0.014 \text{ cm})}{523} = 4.6 \times 10^{-5} \text{ cm} = 436 \text{ nm} \]

8.2. Straight fringes are due to a wedge between one mirror and the image of the other (M2 and M1' in Figure 8-1). Interference then occurs as from reflection by an air wedge.

There are 12 fringes/cm, so there are 11 fringe spaces/cm.

\[ m \lambda = 2d \Rightarrow d = m \lambda / 2 = (11/2) \lambda = 5.5 \lambda. \]

\[ \theta = t / (1 \text{ cm}) = 5.5 \left( 5.461 \times 10^{-6} \right) / 1 = 3.00 \times 10^{-4} \text{ cm} = 0.0172^\circ = 1'2'' \]

8.3. The optical path difference due to the insertion of the thin sheet of width \( t \) and index \( n \) is

\[ \Delta = m \lambda = 2(n + t - t) = 2t(n - 1) \]

\[ t = \frac{m \lambda}{2(n - 1)} = \frac{35 \left( 589 \times 10^{-9} \text{ m} \right)}{2 \left( 1.434 - 1 \right)} = 23.75 \times 10^{-6} \text{ m} = 23.75 \mu \text{m} \]

8.4. (a) Using Eq. (8-5), \( m_{\text{max}} = \lambda / (2 \cdot 2 \text{ cm}) / (500 \times 10^{-7} \text{ cm}) = 80,000. \) (b) \( m = m_{\text{max}} - 6 = 79,994 \)

8.5. (a) The optical path length due to the presence of the cell of length \( L \) and index of refraction \( n \) is

\[ \Delta = N \lambda = 2nL - 2L = 2L(n - 1) \Rightarrow n = 1 + N\lambda / (2L) \]

(b) Rearranging the result from (a), \( N = 2L(n - 1) / \lambda = \frac{2 (0.1 \text{ m}) (1.00045 - 1)}{589 \times 10^{-9} \text{ m}} = 153 \)

8.6. At \( \theta = 0, \), \( m = 2d / \lambda = (20 \mu \text{m}) / (0.6238 \mu \text{m}) = 31.6. \) The smallest diameter dark ring corresponds to \( m = 31. \) Then,

\[ m \lambda = 2d \cos \theta \Rightarrow \cos \theta = \frac{m \lambda}{2d} = \frac{31 \lambda}{2d} = \frac{31 (0.6328)}{20} = 0.98084 \Rightarrow \theta = 11.23^\circ \]

The 10th dark ring is then of order \( m = 22: \)

\[ \cos \theta = \frac{22 \lambda}{2d} = \frac{22 (0.6328)}{20} = 0.69608 \Rightarrow \theta = 45.89^\circ \]