1. (Prob. 9.37) As the air is pumped out, the index of refraction of the air in the chamber will decrease smoothly from $n_{\text{air}} = 1.00029$ (from Table 4.1) to $n_{\text{vacuum}} = 1.00000$. Since the light travels twice through the chamber of length $d = 10.0\, \text{cm}$, the optical path length will change by $2d(n_{\text{air}} - n_{\text{vacuum}})$. The number of fringe-pairs (max and min) $N$ produced by this change will be the change in optical path length divided by the vacuum wavelength $\lambda_0$.

$$N = 2d(n_{\text{air}} - n_{\text{vacuum}})/\lambda_0 = 2 \times 0.100m(1.00029 - 1.00000)/600 \times 10^{-9}m = 97.$$ 

2. (Prob. 9.40) (a) From Eqn. 9.60,

$$F = 4r^2/(1 - r^2)^2 = 4(0.8944)^2/(1 - (0.8944)^2)^2 = 79.96.$$

(b) The half-width $\gamma$ from p.423 is

$$\gamma = 2\delta_{1/2} = 4 \arcsin(1/\sqrt{F}) = 4 \arcsin(1/\sqrt{79.96}) = 0.448.$$ 

Note that the approximate formula 9.69 gives essentially the same result. (Remember that the argument of arcsin is here in radians, not degrees.)
(c) From Eqn. 9.70 the finesse is

$$\mathcal{F} = \pi \sqrt{F}/2 = 14.0.$$ 

(d) From the equation above 9.65, where $R = r^2$, it is clear that $I_s/I_i$ has its maximum value when $\cos \delta = 1$ and its minimum value when $\cos \delta = -1$. This gives

$$C = (1 + R)^2/(1 - R)^2 = [(1 - R)^2 + 4R]/(1 - R)^2 = 1 + F = 80.96.$$ 

3. (Prob. 9.47) Here there is an extra phase of $\pi$ upon reflection from each surface, so this phase change can be ignored. From Eqn.9.36 with normal
incidence ($\theta_t = 0$) and choosing $m = 0$ for minimum thickness, noting that $\lambda_f = \lambda_0/n$, the film thickness for no reflection should be

$$d = \lambda_0/4n = 500 \times 10^{-9} m/(4 \times 1.30) = 9.60 \times 10^{-8} m.$$ 

4. (Prob. 10.7) Here $R = 1.0m$ is much larger than $b^2/\lambda = (0.1\times10^{-3}m)^2/461.9 \times 10^{-9}m = 0.02m$ so the diffraction pattern will be of the far-field (Fraunhofer) type. We can then use the formulas in Sec. 10.2.1 to find that the first zero next to the central maximum is at $\theta_1$ where $\beta_1 = \pi b \sin \theta_1/\lambda = \pi$, i.e when

$$\theta_1 = \arcsin(\lambda/b) = \arcsin(461.9 \times 10^{-9}m/0.1 \times 10^{-3}m) = 0.265^\circ.$$ 

The angular width of the central maximum is just twice this or $0.53^\circ$.

5. (Prob. 10.11 ) Here again $b^2/\lambda \approx 0.02m$ is small compared to $2.5m$ so one has Fraunhofer diffraction. With two slits of finite width one has Young’s fringes modulated by the single slit diffraction pattern, more-or-less as illustrated in Fig. 10.13 for the particular case $a = 3b$. (Here $a = 2b$.) Again the first zero of the single slit pattern is at $\sin \theta_1 = \lambda/b$,

while the Young’s maxima are at

$$\sin \theta_{Ym} = m \lambda/a.$$ 

Since $a = 2b$, $\sin \theta_{2Y} = \sin \theta_1$, so the 2nd Young’s fringe is “killed” by the zero in the single slit pattern, just as the 3rd fringe is “killed” in Fig. 10.13. There are then 3 Young’s fringes ($m_Y = -1, 0, +1$) in the central bright band. This can be confirmed by plotting Eqn. 10.24 for $\alpha = 2\beta$, as shown in the accompanying figure.