11-1. See Figure 11-18 that accompanies the problem in the text for a sketch of the setup. The minima are located as position, y_m determined as,

$$m\,\lambda = b \sin\theta_m = b\,y_m/f \Rightarrow y_m = m\,\lambda\,f/b$$

(a) The first minimum occurs at $y_1 = \lambda\,f/b = (546.1 \times 10^{-6}\,\text{mm})\,(60\,\text{cm})/(0.015\,\text{cm}) = 2.18\,\text{mm}$.
(b) The separation of the first and second minimum is

$$y_2 - y_1 = (2-1)\lambda\,f/b = 2.18\,\text{mm}$$

11-3. See Figure 11-19 that accompanies the problem in the text.
(a) The diffraction minima are located at angles $\theta_m = y_m/L$ where $L = 2$ m is the slit to screen distance, The positions of the minima are given by $m\,\lambda = b \sin\theta_m = by_m/L \Rightarrow y_m = m\lambda L/b$. Then,

$$y_3 - y_{-3} = \Delta y = (3-(-3))\lambda\,L/b \Rightarrow b = \frac{6\,\lambda\,L}{\Delta y} = \frac{6\,(632.8 \times 10^{-7}\,\text{cm})\,(200\,\text{cm})}{5.625\,\text{cm}} = 0.013\,\text{cm} = 0.13\,\text{mm}$$

(b) $L_{\min} = b^2/2\lambda$, so,

$$\frac{L}{L_{\min}} = \frac{200\,\text{cm}}{(0.0135\,\text{cm})^2/(2 \cdot 632.8 \times 10^{-7}\,\text{cm})} = 139$$

The screen is in the far field.

11-4. Let $m_1 = 5$ for λ_1 and $m_2 = 4$ for λ_2. Then,

$$m_1\,\lambda_1 = m_2\,\lambda_2 = b \sin\theta$$
$$5\,\lambda_1 = 4\,\lambda_2 = 4\,(620\,\text{nm}) \Rightarrow \lambda_1 = 496\,\text{nm}$$

11-5. Let the full angle breadth between the first minim on either side of the central maximum be $\varphi = 2\,\theta$, where θ is the angle that locates the first minimum relative to the center of the pattern. For $m = 1$,

$$\lambda = b \sin\theta = b \sin(\varphi/2) \Rightarrow b = \frac{\lambda}{\sin(\varphi/2)} = \frac{550\,\text{nm}}{\sin(\varphi/2)}$$

For $\varphi = 30°$, $b = 2.125\,\mu\text{m}$, for $\varphi = 45°$, $b = 1.437\,\mu\text{m}$, for $\varphi = 90°$, $b = 0.778\,\mu\text{m}$, for $\varphi = 180°$, $b = 0.55\mu\text{m}$.

11-10. $1.22\,D \sin\theta = D\,y/f \Rightarrow y = R = 1.22\,\lambda\,f/D = (1.22)(5.5 \times 10^{-5}\,\text{cm})(150)/12 = 8.39 \times 10^{-4}\,\text{cm}$

11-11. Using Eq. (11-21) the angular half-width of the Airy disc formed on the moon will be,

$$\Delta\theta_{1/2} = \frac{1.22\,\lambda}{D}$$

where D is the diameter of the circular aperture. The radius R of the airy disc formed on the moon, which is a distance L from the aperture is

$$R = L \tan\Delta\theta_{1/2} \approx L\,\Delta\theta_{1/2} = \frac{1.22\,\lambda\,L}{D} = \frac{1.22\,(10.6 \times 10^{-6}\,\text{m})(3.76 \times 10^{8}\,\text{m})}{10^{-3}\,\text{m}} = 4.86 \times 10^{6}\,\text{m}$$

The diameter of the laser spot on the moon is about 9.72×10^6 m. The irradiance in the spot (assuming a nearly constant irradiance over the spot (this is not really the best approximation, but it gives an order of magnitude estimate),

$$I = \frac{\Phi}{A} = \frac{\Phi}{\pi\,R^2} = \frac{2000\,\text{W}}{\pi\,(4.86 \times 10^{6}\,\text{m})^2} = 2.7 \times 10^{-11}\,\text{W/m}^2$$

11-13. The distance L for the headlights to be barely resolvable if they are separated by a distance y is given be Eq. (11-22), as,

$$\Delta\theta_{\min} = y/L = 1.22\,\lambda/D \Rightarrow L = \frac{y\,D}{1.22\,\lambda} = \frac{(45 \times 2.54\,\text{cm})(0.5\,\text{cm})}{1.22\,(5.5 \times 10^{-5}\,\text{cm})} = 8.517 \times 10^5\,\text{cm} = 27,900\,\text{ft} = 5.3\,\text{miles}$$