

64. Let the $m = 10$ bright fringe on the screen be a distance y from the central maximum. Then from Fig. 36-8(a)

$$r_1 - r_2 = \sqrt{(y + d/2)^2 + D^2} - \sqrt{(y - d/2)^2 + D^2} = 10\lambda ,$$

from which we may solve for y . To the order of $(d/D)^2$ we find

$$y = y_0 + \frac{y(y^2 + d^2/4)}{2D^2} ,$$

where $y_0 = 10D\lambda/d$. Thus, we find the percent error as follows:

$$\frac{y_0(y_0^2 + d^2/4)}{2y_0D^2} = \frac{1}{2} \left(\frac{10\lambda}{D} \right)^2 + \frac{1}{8} \left(\frac{d}{D} \right)^2 = \frac{1}{2} \left(\frac{5.89 \mu\text{m}}{2000 \mu\text{m}} \right)^2 + \frac{1}{8} \left(\frac{2.0 \text{ mm}}{40 \text{ mm}} \right)^2$$

which yields 0.03%.