668.

Problem 37.37E (HRW)

Suppose that the central diffraction envelope of a double slit diffraction pattern contains 11 *bright fringes and the first diffraction minima eliminate* (*are coincident with*) *bright fringes. We have to find the bright fringes that lie between the first and the second minima of the diffraction envelope*.

Solution:

Let the width of each slit be *a* and the separation of their midpoints be *d*.

The condition for the first and the second diffraction minima are

$$\frac{a\sin\theta_1}{\lambda}=1,\ \left(\text{first diffraction minima}\right)$$

and

$$\frac{a\sin\theta_2}{\lambda}=2,\ \left(\text{second diffraction minima}\right)$$

It is given that there are 11 bright fringes within the central diffraction envelope, and that the first diffraction minima eliminate bright fringes, therefore the sixth

Young's double-slit bright fringe on either side of the first diffraction envelope should coincide with it. This condition implies that

$$\frac{d \sin \theta_1}{\lambda} = 6,$$

$$\therefore \quad \frac{d}{a} = 6.$$

We now obtain that

$$\frac{d \sin \theta_2}{\lambda} = \frac{6a \sin \theta_2}{\lambda} = 6 \times 2 = 12.$$

We conclude that between the first and second diffraction minima there will lie 5 bright fringes, which correspond to $m = 7, 8, 9, 10,$ and 11.