The application of Fourier theory to Fraunhofer diffraction problem interference phenomena generally, was hardly recognized before the late 1950s. Consequently, only textbooks written since then mention the technique. Diffraction theory, of which interference is only a special case, derives from principle: that every point on a secondary sources combine and interfere to form a field.

If we consider an area \( S \) giving at \( R \) a field, summed over the transparent part of the surface \( \frac{E}{q} \), each with its proper phase. (A wavefront which has come from a source can be calculated. We assume: 

\[
\begin{align*}
E' & = \int q (x,y) \exp \left( \frac{-i \pi}{\lambda} r \right) \, dS \\
& = \int q(x,y) \frac{\exp \left( \frac{-i \pi}{\lambda} r \right)}{r} \, dS
\end{align*}
\]

The dimensions of the aperture are small compared with the wavelength. In Fraunhofer diffraction we simplify. We assume:

\[
\begin{align*}
E & = \int q(x,y) \exp \left( \frac{-i \pi}{\lambda} r \right) \, dS \\
& = \int q(x,y) \frac{\exp \left( \frac{-i \pi}{\lambda} r \right)}{r} \, dS
\end{align*}
\]

1 Remember: phase change perpendicular to the plane of the diagram. To begin, suppose that the source, \( O \), lies on a line perpendicular to the surface \( S \), and to in-plane. Huygens' principle is now as follows:

\[
E = \int q(x,y) \frac{\exp \left( \frac{-i \pi}{\lambda} r \right)}{r} \, dS
\]

\[
\lambda = \frac{2 \pi}{k}
\]

\[
E = \int q(x,y) \frac{\exp \left( \frac{-i \pi}{\lambda} r \right)}{r} \, dS
\]

\[
\theta = \frac{2 \pi}{k}
\]

\[
E = \int q(x,y) \frac{\exp \left( \frac{-i \pi}{\lambda} r \right)}{r} \, dS
\]

\[
\frac{E}{q} \cdot \frac{\exp \left( \frac{-i \pi}{\lambda} r \right)}{r} \, dS
\]

Fig. 3.1. Secondary sources in Fraunhofer diffraction.

Fig. 3.2. Fraunhofer diffraction by a plane aperture.

Fourier transform theory is of central importance in a vast range of applications in physical science, engineering, and applied mathematics. This new edition of a successful student text provides a concise introduction to the theory and practice of Fourier transforms, using qualitative arguments wherever possible and avoiding unnecessary mathematics.

After a brief description of the basic ideas and theorems, the power of the technique is then illustrated by referring to particular applications in optics, spectroscopy, electronics and telecommunications. The rarely discussed but important field of multi-dimensional Fourier theory is covered, including a description of computer-aided tomography (CAT-scanning). The final chapter discusses digital methods, with particular attention to the fast Fourier transform. Throughout, discussion of these applications is reinforced by the inclusion of worked examples.

The book assumes no previous knowledge of the subject, and will be invaluable to students of physics, electrical and electronic engineering, and computer science.

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