

Problems on Holography

Semester V (2019 batch)

Nov. 2019 to Feb. 2020

Question 1

Consider two plane waves travelling in the $x - z$ plane making angles θ_1 and θ_2 with the z -axis. A photographic plate is kept on the plane $z = 0$. Obtain the interference pattern obtained on the plane. What should be the fringe width?

Question 2

Consider a plane wave propagating along the z -axis and a spherical wave emerging from a point source placed on the axis at a point $z = -d$. A photographic plate is kept on the plane $z = 0$. Obtain the shape of the fringes produced.

Question 3

The photographic plate in **Question 2** is developed and made into a hologram. a) If this is normally illuminated by a plane wave, what would be the output waves? b) If the hologram is illuminated by a spherical wave from a point source placed at $z = -d$, what would be the output from the hologram?

Question 4

In continuation of **Question 2** show that the interference pattern, when the incident plane wave makes an angle θ with the z -axis is given by

$$4B^2 \cos^2 \left\{ kd - kx \sin \theta + \frac{k}{2d}(x^2 + y^2) \right\}$$

Assume $B \simeq A/d$, where A and B are the amplitudes of the spherical wave and the plane wave respectively.

Question 5

Suppose the reference wave in a hologram is given by $E_r = E_0 \exp\{-i(\omega t - k_z - k_x \sin\theta)\}$ and the spherical wave emanating from a point source is given as

$$E_{sph} = E_1 \exp\left\{-i\left(\omega t - k_z - \frac{k_x^2}{2z_0}\right)\right\}$$

Find out the resultant intensity on the plate. Show that the condition for maxima in the hologram is given by, $\Delta x = 4\lambda$ (choose $\theta = 15^\circ$)

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References

- [1] K.Thyagarajan, Ajoy Ghatak. *Lasers-Fundamental and Applications*. Trinity Press.
- [2] Ajoy Ghatak. *Optics*. McGraw Hill Education.