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1)

Solution:

$$k^2 = \frac{w^2}{c^2}\varepsilon(w)$$

2)

Solution:

From the Helmholz equation

$$\left[\Delta + \frac{w^2}{c^2}\varepsilon(w)\right]\vec{E}(\vec{r}, w) = 0$$

$$-k^2 + \frac{w^2}{c^2}\varepsilon(w) = 0$$

$$k = k' + ik'' \qquad \varepsilon(w) = \varepsilon' + i\varepsilon''$$

$$\therefore \quad k'^2 - k''^2 + 2ik'k'' = \frac{w^2}{c^2}\varepsilon' + i\frac{w^2}{c^2}\varepsilon''$$

$$k'^2 - k''^2 = \frac{w^2}{c^2}\varepsilon'$$

$$2k'k'' = \frac{w^2}{c^2}\varepsilon''$$

3)

Solution:

$$\because \vec{k}' + i\vec{k}'' = \hat{k}\,\frac{w}{c}(n + iK) \qquad k' = \frac{w}{c}n \quad k'' = \frac{w}{c}K$$

$$\therefore \begin{cases} n^2 - K^2 = \varepsilon' \\ 2nK = \varepsilon'' \end{cases}$$

4) Solution

$$U_0(\alpha, \beta) = \left(\frac{1}{2\pi}\right)^2 \iint_{-\infty}^{\infty} u_0(x, y)\exp[-i(\alpha x + \beta y)]\,dx\,dy$$

5)

Solution:

$$U(\alpha, \beta; z) = U_0(\alpha, \beta)\exp[i\gamma(\alpha, \beta) z]$$