Problem 1

Consider an electromagnetic wave propagating through a lossy dielectric medium with a complex index of refraction \( n(\omega) \).

(a) If the real part of \( n^2(\omega) \) is constant (no optical dispersion), show that the imaginary part is zero (no absorption).

(b) Conversely, if there is absorption, show that there must be dispersion. In other words, if the imaginary part of \( n^2(\omega) - 1 \) is not zero, show that the real part of \( n^2(\omega) - 1 \) is not constant.

Problem 2

Compute the asymptotic series expansion of the integral sine function

\[
Si(x) = \int_0^x \frac{\sin t}{t} dt
\]

for (a) small and (b) large values of \( x \). In each case compute the first four terms of the series explicitly, write down the general term and determine whether the infinite series converges.