

Questions and answers for Module 1

R. Ganapathy
Senior Assistant Professor
School Of Electrical and Electronics Engineering
SASTRA University

Table of Content

1	QUESTIONS	3
2	ANSWERS	4

1 Questions

1. What are the various classifications of nanophotonics ?
2. Write the macroscopic Maxwell's equations in differential form.
3. How is an optical near field generally characterized ?
4. In what way is an optical near field different from an evanescent field ?
5. What does the quantum theoretical description of an optical near field explain ?

2 Answers

1. The various classifications of nanophotonics are as follows:

- The study of optical properties of matter, especially semiconductor and dielectric materials, when the electron wave propagation in matter is controlled.
- The study of optical properties of structured dielectrics, especially photonic solids, when the light wave propagation in the structured dielectric is controlled.
- The study of light-matter interaction in nanostructures with light wave propagation in nanostructures being controlled; and
- The study of the optical properties of metal-dielectric nanostructures with emphasis on the electron excitations at metal-dielectric interfaces called surface plasmons.

2. The macroscopic Maxwell's equations in differential form are as follows:

$$\begin{aligned}\nabla \cdot \mathbf{E} &= \frac{\rho}{\epsilon}, \\ \nabla \cdot \mathbf{B} &= 0, \\ \nabla \times \mathbf{E} &= -\frac{\partial \mathbf{B}}{\partial t}, \\ \nabla \times \mathbf{B} &= \mu \mathbf{J} + \mu \epsilon \frac{\partial \mathbf{E}}{\partial t}.\end{aligned}$$

3. A non propagating optical near field is generally characterized by a localized electromagnetic field around a nanometer sized photonic device. The decay length of the localized electromagnetic field is made to be much smaller than the wavelength of incident light.
4. An evanescent field is governed by the periodic alignment of electric dipoles that in turn depends on the spatial phase of the incident light. As a result, the components of the wave vector along the material surface can take any real numbers, thereby making it to come under the category of diffraction limited conventional propagating light waves. But as the alignment of the electric dipole moments depends only on the size, conformation and structure of the nanometric sized particles that are much smaller than the wavelength of the incident light, the ensuing optical near field is independent of the spatial phase of the incident light. As a result, and optical near field is free of diffraction.
5. The quantum theoretical description of optical near fields explains electronic and vibrational matter excitations on an equal footing with photons.