

Optical Modelling and Design

Final exam questions, 21.02.2011, Abbe School of Photonics, M.Sc. in Photonics

1. Why ray-based light representation is well suited for the modelling of imaging systems? What are the basic functions of the imaging system?
2. Make a sketch of the image formation with an ideal lens, which has negative refractive power ($f' < 0$). Mark relevant quantities, planes and distances.
3. Which quantity (single number) can be used to describe index of refraction on the wavelength dependency? How is it defined? Considering this quantity: how should the two different materials of an achromatic doublet be chosen?
4. Consider an imaging system composed of two lenses, where the first acts as an aperture stop. Make a sketch and mark the position of the exit pupil. Describe what the concept of exit and entrance pupils is used for.
5. Name five Seidel aberrations. Make a sketch of wavefront aberration crosssection (optical path difference plot) for one aberration (choose which you like).
6. Name the units of \vec{E} and \vec{H} .
7. Matter equations
 - a) Write down three material equations in frequency domain.
 - b) What is the relationship between refraction index and electric field permittivity?
8. Plane waves
 - a) What is the definition of the homogenous and inhomogenous (evanescent) plane waves?
 - b) What is the criteria in terms of k_x and k_y wavenumbers to distinguish between homogenous and inhomogenous waves?
 - c) Calculate the cutoff value for wavelength 532 nm and $n = 1.5$.
9. Polarization
 - a) Why harmonic fields are always polarized?
 - b) Describe the general case of harmonic fields polarization.
 - c) Discuss the difference between globally and locally polarized paraxial fields.
10. The z -component of harmonic field can always be calculated from it's x and y components. What are the basic arguments for deriving this dependency?
11. Spectrum of plane waves (SPW) integral
 - a) Formulate SPW integral for one component.
 - b) Derive the formula!
 - c) Is this formula also valid for the magnetic field?
12. Paraxial approximation
 - a) What is the paraxial approximation?
 - b) Give z -component of the wave vector in the paraxial approximation.