Examination
Lecture: Advanced Lens Design, WS 2013/14

Name:
Matriculation Number:

Task 1: Raytrace pts: 5/100

a) What are the differences in the real and the paraxial raytrace?
b) Explain, why in the paraxial raytrace table of Zemax, there are no numbers for the optical path length, the incidence angle and the surface normals.

Task 2: Spot diagram pts: 8/100

a) What kinds of aberrations can be recognized from a single spot diagram qualitatively?
b) What is the spot shape in the case of astigmatism?
c) Is it possible to distinguish between field curvature and astigmatism in one spot diagram? What can be done with several spot diagrams in some separated z-planes?

Task 3: Chromatical aberrations pts: 10/100

a) Explain the normal line for the description of the dispersion properties of glasses
b) What is the meaning of the relative dispersion for the correction of chromatical aberrations?
c) Explain the criteria for selecting the materials in a classical achromate
d) Why is there a negative lens in an achromate?

Task 4: Zernike polynomials pts: 10/100

a) Explain the meaning of the first 9 Zernike fringe coefficients
b) How can field curvature and distortion be seen in the Zernike coefficients?
c) Is it possible to evaluate the primary chromatical aberrations with Zernike polynomials?

d) Can the Zernike performance criteria be used in the case of a polychromatic illuminated system?

**Task 5: Correction procedure**

**pts: 10/100**

a) What are indicators that a lens in a system can be removed with only minor consequences for the performance?

b) Describe possible steps to get rid of a lens in the practical work with Zemax

**Task 6: Field curvature**

**pts: 8/100**

a) What are possible options for improving the field curvature of an optical system?

b) Usually a field lens is used to move the pupil without affecting the marginal ray. Can such a field lens be used to correct the field curvature too?

**Task 7: Correction with an asphere**

**pts: 12/100**

a) Which aberrations can be corrected by an asphere with high efficiency?

b) Which aberrations are definitely not influenced by an asphere?

c) If we consider a camera objective with several lenses, where should the aspherical surface be chosen to have the best opportunity to correct distortion? Explain your answer.

**Task 8: Pupil aberration**

**pts: 10/100**

a) Explain the properties of the pupil aberration

b) How can a pupil aberration be assessed quantitatively in Zemax?

**Task 9: Performance of non-symmetrical systems**

**pts: 12/100**

a) Assume we have a non-circular symmetric system, what kind of aberration do we have on axis?

b) Which of the available aberration representations in Zemax are no longer useful, if there is no symmetry?

Hint: consider Seidel diagram, spot diagram, Zernike coefficients, PSF, MTF, field curvature, grid distortion.
Task 10: Correction  pts: 15/100

a) Consider a Mangin mirror, which is built by two cemented thin lenses made of different materials (corresponds to a backside mirror coated achromate). Sketch the system setup with the marginal and the chief ray, if the system stop is located at the mirror.

b) Which are the degrees of freedom for correction has the system?

c) If we want to focus white light coming from an object in infinity, what kind of primary aberrations can be easily corrected with this setup by a proper selection of parameters?