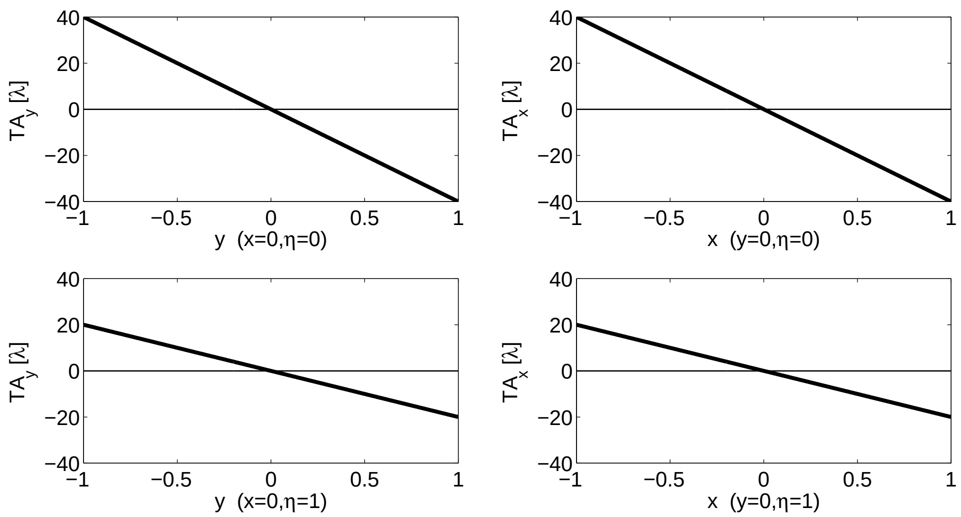
Exam SK2330 Optical Design 2017-01-16 8-13 FB51

No devices that allow for communication with the outside world, or that would permit installation of commercial optical design software, are permitted (i.e., no phones, computers or anything in between). Any other material such as books, notes, and calculators may be used.

Solutions should be well outlined and explained, and figures used when needed. Answers without explanations give 0p, even if correct.

Grading limits: 0-10p F, 10p or over Fx, 12p or over D, 15p or over C, 19p or over B, 22–24p A

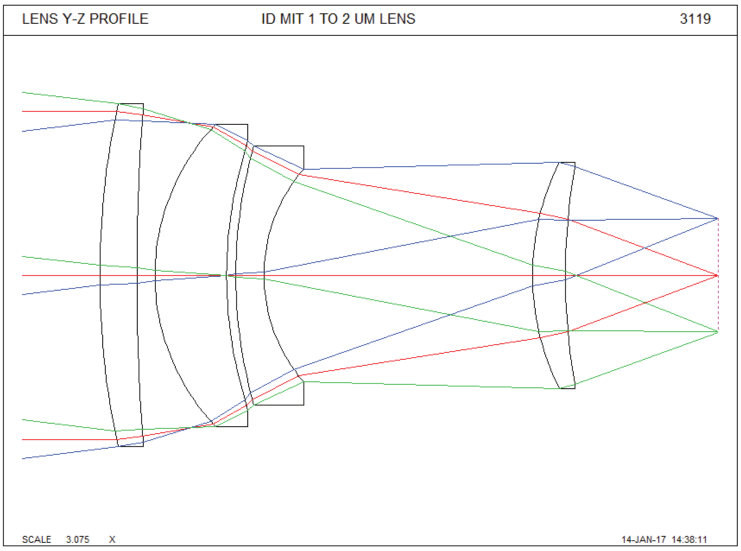
1. A lens has an exit pupil radius of 15 mm and the paraxial image plane, in air, is 125 mm from the exit pupil. The ray aberration plots of the lens are given below, where (x, y) are normalized pupil coordinates and $(0, \eta)$ normalized image coordinates. No higher-order aberrations are present.
   a) Explain which aberrations are present in this system, and which are not. Motivate your answer! (2p)
   b) Plot the corresponding wavefront aberration curves. The axes must be graded. (2p)



2. In microscopy, if the object plane lies inside the sample, aberrations may be introduced by the sample itself. Derive the contributions to the Seidel aberration coefficients introduced by the sample surface, as a function of the refractive index n if the object, the marginal ray angle u at the object plane, the principal ray angle $\bar{u}$ at the object plane and the distance d between the object plane and the sample surface. The sample surface is flat. (5p)

3. Can you construct a thin positive lens with a negative S_{I}, for object at infinity using glass with a refractive index of 1.6? (5p)

4. Below is an optical system, drawn in natural scale. Assuming the system is diffraction limited, sketch the image-space MTF curve of the system. The axes must be graded. (5p)



5. For infrared wavelengths, material transparent at those wavelengths are used, and the refractive index is often several times higher than for visible light. Below is a list of materials used in the 3- to 5-μm waveband, and their refractive indeces at different wavelengths.
a) Select two materials suitable for creating an achromatic doublet for this waveband. (2p)
b) Suggest a design, including radii of curvature, for a cemented achromatic doublet for this waveband with a focal length of 100 mm. You need only take chromatic aberration into account, not the monochromatic aberrations. (3p)

Material	$n(3\mu\mathrm{m})$	$n(4\mu\mathrm{m})$	$n(5\mu\mathrm{m})$
Silicon	3.4323	3.4253	3.4220
Germanium	4.0442	4.0254	4.0159
Zinc selenide	2.4376	2.4331	2.4295
Zinc sulphide	2.2572	2.2518	2.2461