

HW #3: Due Feb. 23, 2015
(Include Problem 6 from HW2)

Problem 1 (5 pts):

Which are valid wavefront coefficients for 10th order wavefront aberration of a rotational symmetric optical system?

- a. W_{555}
- b. W_{551}
- c. W_{372}
- d. W_{193}
- e. W_{464}
- f. W_{642}
- g. W_{730}
- h. W_{822}
- i. W_{821}
- j. W_{911}

Problem 2 (15 pts):

Assume an F/3 system is used for a wavelength of $0.5\ \mu\text{m}$, with a wavefront defined as $W_{351} = 2\ \mu\text{m}$.

- a. Write the expression for wavefront aberration.
- b. Derive the expression for tangential ray aberration (ϵ_y).
- c. What is the value of ray aberration at the edge of the field, and at $y_p=1$?

Problem 3 (40 pts):

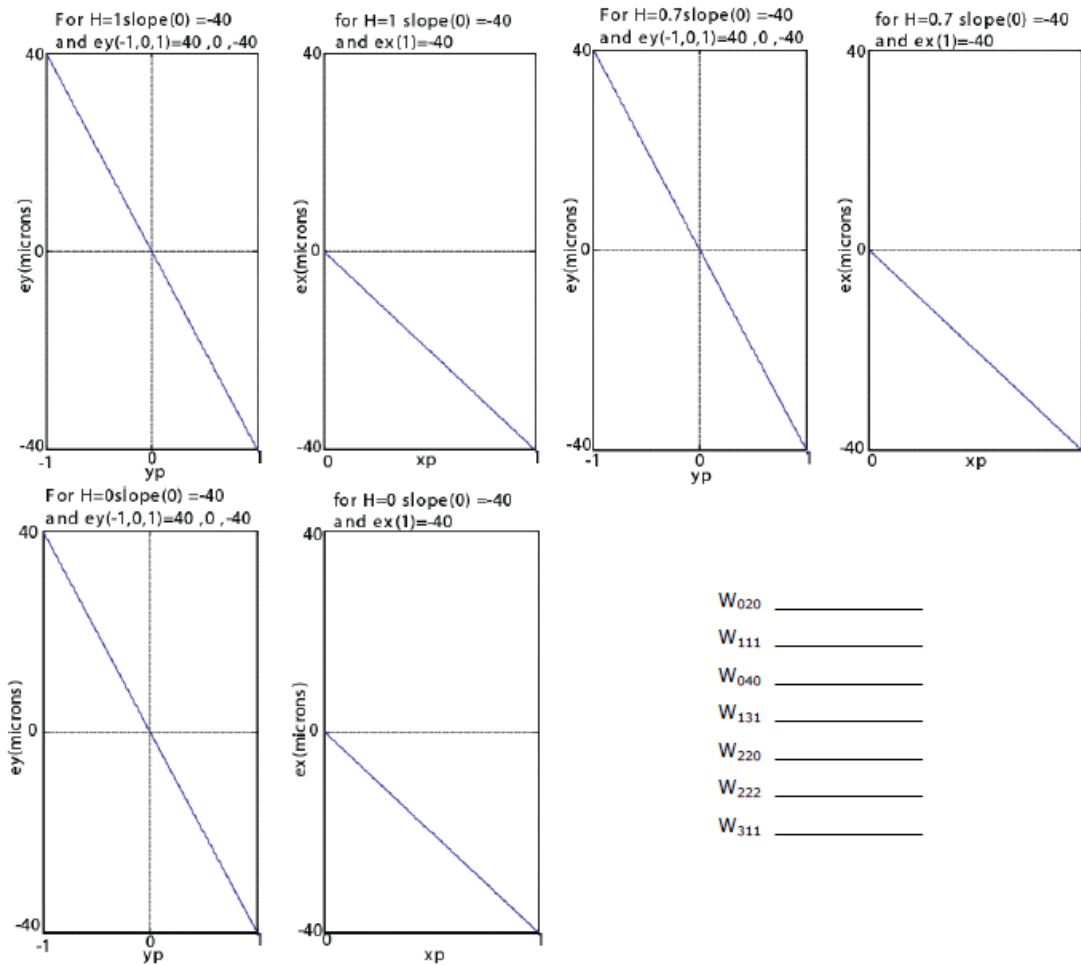
Assume an optical system having a spherical aberration W_{040} is used for a wavelength λ . Also, assume defocus W_{020} exists.

- a. Write the general expression for wavefront aberration.
- b. Plot wavefront aberration for $(F/\#)=3$, $\lambda = 0.5\ \mu\text{m}$, $W_{040} = 2\ \mu\text{m}$ and $W_{020} = 0, -1, -2$, and $-3\ \mu\text{m}$.
- c. Derive the expression for tangential ray aberration (ϵ_y).
- d. Plot ϵ_y for $(F/\#)=3$, $\lambda = 0.5\ \mu\text{m}$, $W_{040} = 2\ \mu\text{m}$ and $W_{020} = 0, -1, -2$, and $-3\ \mu\text{m}$.

Problem 4 (20 pts):

For an F/10, $\lambda = 0.5\ \mu\text{m}$ wavelength, the following ray fan plots were obtained of various field angles.

Among the aberrations listed below, what is the wavefront coefficient present and what is its value?

**Problem 5 (20 pts):**

According to Lord Rayleigh, wave aberration of $\lambda/4$ in peak-to-valley has a negligible effect on imaging quality (Rayleigh criteria). Using the criteria, obtain tolerance of defocus (maximum allowable amount of defocus) $\pm dz$ for a perfect optical system. Assume $\lambda = 0.5 \mu\text{m}$, and $(F/\#) = 10$.