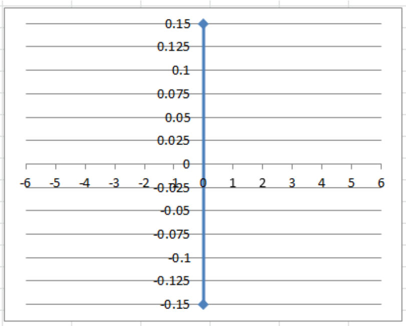
OPTI 600B Homework 2 Due: September 14, 2018

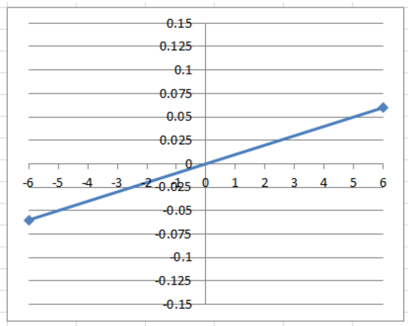
1. What are the matrices corresponding to a reflection about the x-axis and about the y-axis? Show that a reflection about the x-axis followed by a reflection about the y-axis is equivalent to a rotation of 180°.

2. The plots for the phase space example are shown below. On each of them, draw the equivalent line for a point source located at y = 3 mm in the object plane. Based on the plots what is the required diameter of the second lens so that vignetting does not occur?

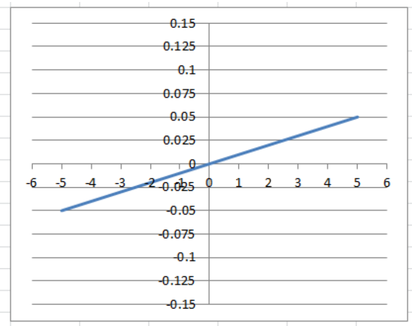
Object Plane



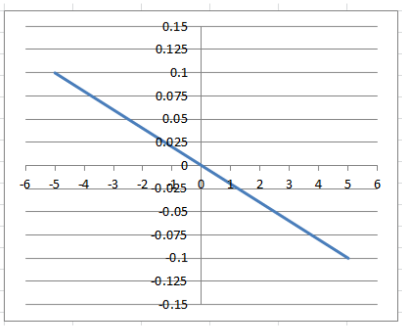
T_0



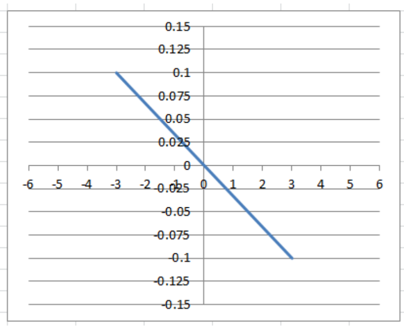
Clipping by Lens 1



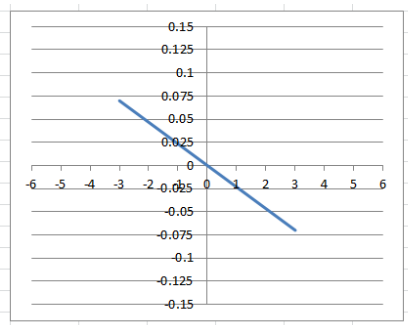
R_1



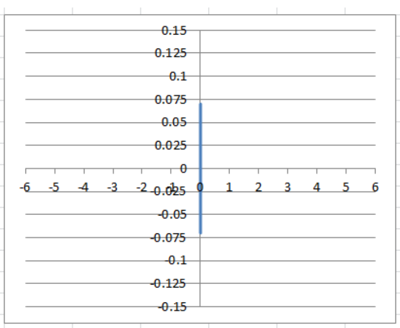
T_1



R_2



T_2



3. The concept for our paraxial raytracing technique can be extended to handle anamorphic systems with toroidal and cylindrical lenses oriented along the x and y axes. The vector describing each ray now has four elements and the refraction and transfer matrices are 4x4 matrices as follows:

$$\text{ray} = \begin{pmatrix} y \\ nu_y \\ x \\ nu_x \end{pmatrix} \qquad T_k = \begin{pmatrix} 1 & t_k & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & t_k \\ 0 & 0 & 0 & 1 \end{pmatrix} \qquad R_k = \begin{pmatrix} 1 & 0 & 0 & 0 \\ -\phi_y & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & -\phi_x & 1 \end{pmatrix}$$

Design a movie projection lens that takes a 36 x 24 mm frame and projects it onto a 15.8 x 6.7 m screen. You will need two toroidal thin lenses to accomplish this design. Assume the distance from the frame to the first lens is 100 mm, the distance from the first to second lens is 200 mm and the distance from the second lens to the movie screen is 40 m. What are the powers of the two toroidal lenses in the x and y directions?