Cylindrical Lens Creator

INTRODUCTION

FRED does not currently include a built-in cylindrical lens creator. Cylindrical lenses must be entered either manually surface by surface or by adding a catalog cylindrical lens and adjusting it accordingly. This knowledge base article includes a script that generates a cylindrical lens based on user specifications entered into a Basic dialog, shown below. Using this utility cylindrical lenses can be created in much the same way as axially symmetric lenses are generated. The Cylindrical Lens Creator can be used for both circular/elliptical and square/rectangular aperture lenses and the axis of power (x or y) can be specified.

USING THE CYLINDRICAL LENS CREATOR

The dialog input parameters are fairly self-explanatory, but a few matters are clarified below:

- The surface parameters may be entered as either radii or curvatures. In either case, a value of 0 should be used for a flat plano surface.
- The thickness is the center thickness between the two surfaces on-axis.
• Only materials that are present in the FRED file’s “Materials” folder appear as choices in the substrate and immersion drop-down menus.
• “Power Axis” refers to the axis along which the surfaces are curved. For example, if $y$ is chosen as the power axis, rays will be focused in the $y$-direction but not in the $x$-direction.
• Just as with axially symmetric lenses, the cylindrical lens is assigned a “Transmit” coating and “Transmit Specular” raytrace property.
• Warnings appear in the Output Window if any of the following situations are encountered:
  o An element of the same name already exists in the Geometry folder.
    ▪ It is typically not recommended to have two elements with the exact same names.
  o The semi-aperture of a surface is larger than its radius.
    ▪ In this case the surface is only created up to its radius.
  o The semi-aperture of a surface is very close to its radius (i.e. smaller than the radius, but larger than 0.975*radius).
    ▪ The toroidal surfaces will not render properly if the edge extends further than 0.975*radius using the tessellation setting that is defined when the toroidal surfaces are created. Increasing the tessellation of the surface in question will improve the rendering.
    ▪ This issue should only affect the visual representation, not the functional/mathematical one used for raytracing and performing analyses.
  o The edge thickness is less than 0.

Note that when these Warning situations are encountered the lens is still created, although it may not be physical.

Figure 2. Two cylindrical lenses, with circular and square apertures.
THE SCRIPT

The Cylindrical Lens Creator script is structured as follows:

1. Generate a list of materials in the “Materials” folder.
2. Display dialog prompting for various user inputs.
   a. Insert default values.
   b. Terminate script if “Cancel” button is pressed.
3. Assign dialog inputs as variables.
4. Create first and second surfaces.
   a. Use “Plane” surface if there is no curvature and a “Toroidal Asphere” if there is.
   b. Calculate surface sag at the edge.
      i. Set to 0 if the aperture specification extends further than the radius.
   c. Assign trimming specs.
      i. Center z-trimming on sag/2
      ii. If sag is under 0.1, set z trimming semi-aperture as 0.1, otherwise set it as |sag|*(3/5), which is a bit larger than 1/2 so that the surface is properly rendered.
   d. Set materials, coating, and raytrace property.
   e. Scale tessellation by 0.15 in the x, y, and z directions so that the toroidal surfaces are properly rendered.
   f. Shift the second surface by the lens thickness value.
5. Calculate edge thickness and print warning if it is less than 0.
6. Create lens edge
   a. Calculate total length of edge
      i. Center thickness + (absolute value of sag of surface 1 if it’s concave) + (absolute value of sag of surface 2 if it’s concave)
      ii. Note that because the surfaces are only curved in one direction, the edge surface must extend the entire lens “length”.
   b. Use “Cylinder” surface if the lens is circular/elliptical.
   c. Use a curve with a “Tabulated Cylinder” if it is rectangular/square.
      i. Create segmented curve
      ii. Create tabulated cylinder using the segmented curve as the directrix curve.
   d. Assign trimming specs.
      i. Center z-trimming on (edge length)/2 + (absolute value of sag of surface 1 if it’s concave).
ii. If surface 1 is concave, the lens edge extends into \(-z\).
iii. Use the two lens surfaces to trim the edge

    e. Scale tessellation by 0.05 in the \(x, y,\) and \(z\) directions so that the edge surface is properly rendered.

7. Done!