

Physics 319

Optics

Maple Worksheet

Zoom lens condition

Front lens and screen are fixed, lenses #2 and #3 move as necessary to fulfill the condition of an in focus image at the focal plane (i.e. the film). We look for a contour gives positions for lens #3 corresponding to a specified position for lens #2.

```
>
>
> with(linalg):
Warning, new definition for norm
Warning, new definition for trace
Define the system matrix in terms of the focal lengths of the lenses and positions x1, x2, and x3 of the lenses.
```

```
> R1:=matrix(2,2,[1.,4.05,0.,1.]);
          R1 :=  $\begin{bmatrix} 1. & 4.05 \\ 0 & 1. \end{bmatrix}$ 
```

```
> R2:=matrix(2,2,[1,-12.25,0.,1.]);
          R2 :=  $\begin{bmatrix} 1 & -12.25 \\ 0 & 1. \end{bmatrix}$ 
```

```
> R3:=matrix(2,2,[1.,11.78,0.,1.]);
          R3 :=  $\begin{bmatrix} 1. & 11.78 \\ 0 & 1. \end{bmatrix}$ 
```

```
> d12:=x2-x1;
          d12 :=  $x2 - x1$ 
```

```
> T1:=matrix(2,2,[1,0,-d12,1]);
          T1 :=  $\begin{bmatrix} 1 & 0 \\ -x2 + x1 & 1 \end{bmatrix}$ 
```

```
> d23:=x3-x2;
          d23 :=  $x3 - x2$ 
```

```
> T2:=matrix(2,2,[1,0,-d23,1]);
          T2 :=  $\begin{bmatrix} 1 & 0 \\ -x3 + x2 & 1 \end{bmatrix}$ 
```

Find the system matrix in terms of the parameters x1,x2, and x3.

```
> Smat:=evalm(R3*T2*R2*T1*R1):
>
The back vertex focal length (distance from last lens to back focal plane) is given by c/a:
```

```
> fbv:=Smat[2,2]/Smat[1,2]:
>
>
```

Fix the position of the first lens:

```
> FBVee:=subs(x1=.044,fbv):
```

```
>  
The following is needed for contour plots:
```

```
> with(plots):
```

```
>  
The zoom lens condition is that the sum of the back vertex focal length and x3, the position of the last lens must equal the screen distance. The contour plot will draw a curve with a constant value of  $x_3 + \text{fbv}$ . I request contours for which this value is equal to my screen distances of .71, .72,.73,.74 meters.
```

```
>  
>  
>  
> contourplot(x3+(7.62*x3-7.62*x2+4.63*(12.25*x3-12.25*x2+1.)*(-x2+.44e-1)+1.)/(4.16+89.7636*x3-89.7636*x2+4.63*(-.47+144.3050*x3-144.3050*x2)*(-x2+.44e-1)),x2=0.230..0.3,x3=0.37..0.45,contours=[.74,.73,.72,.71]);
```

