OPTI 415 Final Project Due: May 4, 2022

1. Suppose we have a Shack-Hartmann system with a relay magnification $m = -1.0$. The lenslet array focal length is $8mm$ and the pitch is $0.5mm$. If we measure a wavefront with spherical aberration $W(r,\theta) = W_{040}r^4$, with $W_{040} = 0.001mm^{-3}$ over a $5mm$ diameter pupil, do the following:

   (a) Plot the spot positions for a perfect plane wave.

   (b) Calculate the spot deviations Δx and Δy for the aberrated wavefront.

   (c) On the plot from part (a), superimpose the spot pattern for the aberrated wavefront.

   (d) Use the least squares technique to fit the measured slope values to Zernike polynomials. How does this result compare to the theoretical Zernike representation of the wavefront?

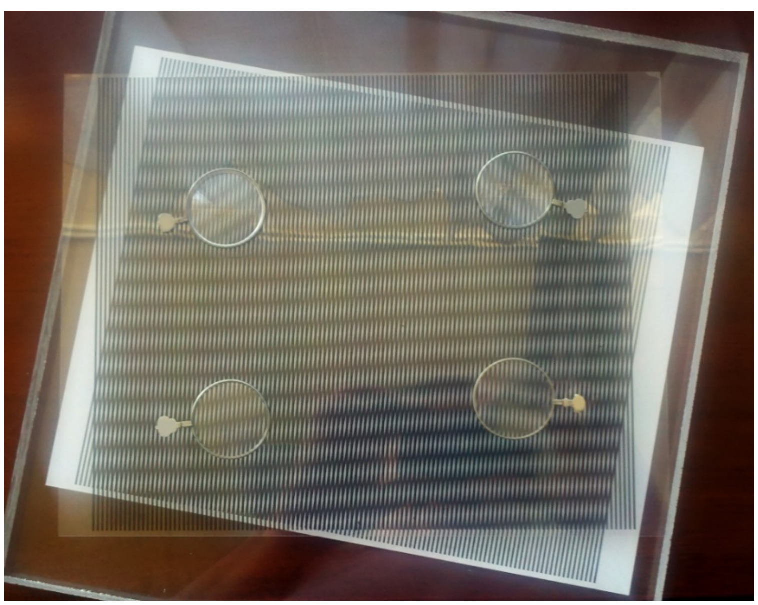
2. A Moiré deflectometry system is shown below (original online). The patterns are separated by a distance of $17.036mm$ and the camera is $530mm$ from the first grating.

   (a) The white sheet of paper is 8.5" × 11". How many pixels/mm in the image?

   (b) The two gratings are identical. What are the grating periods $g_1 = g_2$?

   (c) Measure the angle θ_o of the Moiré fringes formed by the two rotated gratings. How does this compare to the theoretical value? By our sign convention α is negative in the image.

   (d) The four lenses are placed in contact with the first grating. Measure the angle of the Moiré fringes for each of the lenses. What is the power of each lens?



3. The anterior radius of a test part is $24.5mm$ and its diameter is $18.8mm$. Examine the test plate library from Pacific Coast Optics (www.pcoptics.com/servicesLargeTestPlate.html) and specify the plate which best matches the surface. Create a simulation of the Newton's Ring pattern resulting from testing this surface with the chosen test plate. Assume a wavelength of $\lambda = 546.1nm$.

4. Download the file Interferograms.zip from the course website. The zip file contains five files in total. Each file is a comma delimited text file that contains the pixel values for the image sensor of an interferometer. The files frame1.csv, frame2.csv, frame3.csv and frame4.csv contain interferograms with phase shifts of 0, π/2, π and 3π /2, respectively. Read in these files and normalize them by 1024 to get the relative intensity at each pixel. The file mask.csv has a value of 1 for valid data and a value of 0 for invalid data.

    a) Use the Four-Step algorithm to reconstruct the wrapped phase function $\phi(x, y)$. Use the mask data to hide invalid data. Plot the wrapped phase map.
    b) Plot a map of the visibility $\gamma(x, y)$ for the valid data.
    c) What is the range of visibility values? Why are some values greater than 1?

5. The following page is a *non*-ISO10110 compliant drawing of a double from Edmund Optics. Based on the details provided on this drawing, create two ISO10110 compliant drawings, one for each of the optical elements. You can just hand sketch the optical elements. A blank ISO10110 sheet is included at the end.

NOTES:

1. SUBSTRATE:
   ELEMENT A: GRADE A FINE ANNEALED
   SCHOTT: N-BK7 517/642

   ELEMENT B: GRADE A FINE ANNEALED
   SCHOTT: N-SF5 673/322

2. ROHS COMPLIANT

3. CENTERING TOLERANCE (AT 587.6nm):
   BEAM DEVIATION (HALF ANGLE): <1 ARCMIN

4. COATING (APPLY ACROSS COATING APERTURE)

   S1 & S4: VIS 0°
   R(AVG) ≤ 0.4% FROM 425-675nm @ 0° AOI
   S2 & S3: NONE

5. (△) FINE GRIND SURFACE

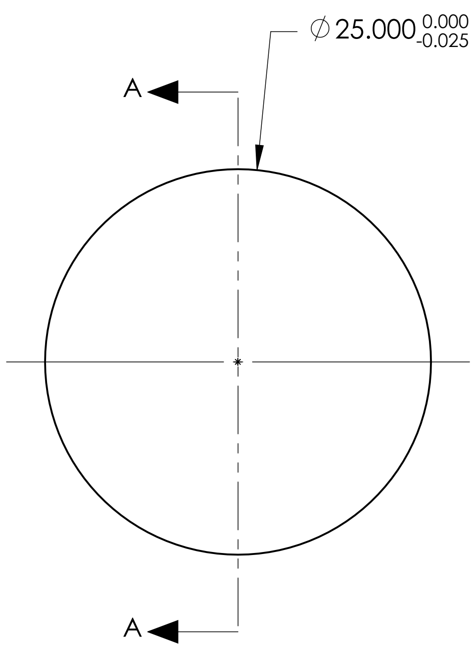
6. POWER, IRREGULARITY, AND SURFACE QUALITY SPECIFICATIONS APPLY ACROSS CLEAR APERTURE

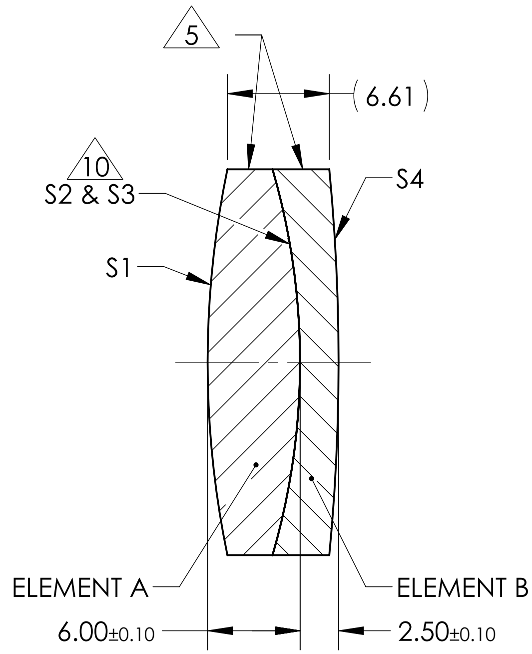
7. FOCAL LENGTH (EFL): 100.00mm ±2%
   BACK FOCAL LENGTH (BFL): 95.92mm

8. PROTECTIVE BEVEL AS NEEDED

9. DESIGN WAVELENGTH: 587.6nm

10. (△) ELEMENTS TO BE CEMENTED WITH NORLAND OPTICAL ADHESIVE NOA61





SECTION A-A

FOR INFORMATION ONLY:
DO NOT MANUFACTURE PARTS TO THIS DRAWING

	SPECIFICATIONS AFTER CEMENTING			
ELEMENT TITLE	ELEMENT A		ELEMENT B	
SURFACE	S1	S2	S3	S4
SHAPE	CONVEX	CONVEX	CONCAVE	CONVEX
RADIUS	61.47	44.64	44.64	129.94
SURFACE QUALITY	40 - 20	40 - 20	40 - 20	40 - 20
MIN CLEAR APERTURE	∅24.00	∅24.00	∅24.00	∅24.00
MIN COATING APERTURE	∅24.00	N/A	N/A	∅24.00
POWER AT 632.8nm	3.00 RINGS	3.00 RINGS	3.00 RINGS	3.00 RINGS
IRREGULARITY AT 632.8nm	0.50 RINGS	0.50 RINGS	0.50 RINGS	0.50 RINGS

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE
DIMENSIONS ARE FOR REFERENCE ONLY

Edmund Optics®

THIRD ANGLE PROJECTION

ALL DIMS IN mm

TITLE: 25mm Dia. x 100mm FL, VIS 0 Coated, Achromatic Lens

DWG NO 47641

SHEET 1 OF 1

Dimensions in Millimeters

Left Surface	Material	Right Surface
R Ø$_E$ Ⓐ 3/ 4/ - 5/ - 6/ -	GLASS: Nd = Vd = 0/ - 1/ - 2/ -	R Ø$_E$ Ⓐ 3/ 4/ - 5/ - 6/ -

ISO Element Drawing Indications According to ISO 10110

DATE	SCALE	DRAWN	APPRV
1/25/2016	2.5000:1		

PROJECT/TITLE

32718

PART/DRAWING	REVISION