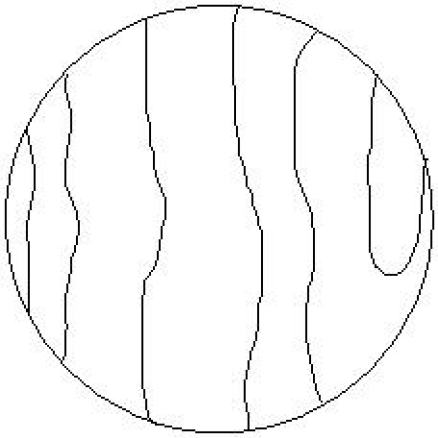
Basic Optical Testing

OT-1

a) Obtain the profile of the OPD across the center of the Fizeau interferogram shown below (= 587.6 nm). Subtract the appropriate amount of tilt.

b) Can the sign of the error be determined from the interferogram?

c) How can you determine the sign of the error by adjustment of the interferometer during the test?

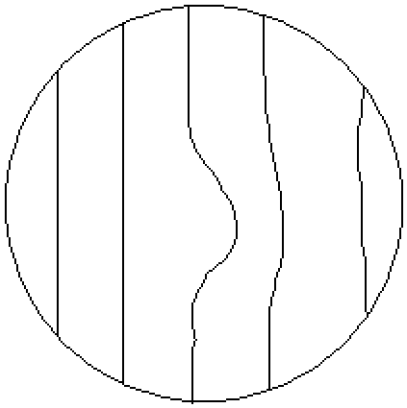


OT-2

The following interferogram was obtained testing a nearly flat mirror in a Twyman-Green interferometer using a helium-neon laser. The mirror is tested double pass at a 45 degree angle of incidence. When the reference mirror is pushed on so as to shorten the length of the reference arm the fringes move to the left in the interferogram.

a) What is the peak-valley error, in units of microns, of the mirror surface?

b) Is the center of the mirror a high point or a low point?



OT-3

An interferogram is digitized using a graphics tablet which has an error of 0.01 inches at any given point.

a) If I were to digitize an interferogram having 10 essentially equally spaced interference fringes across a diameter of 2 inches, what peak-valley error in the digitization process would be expected?

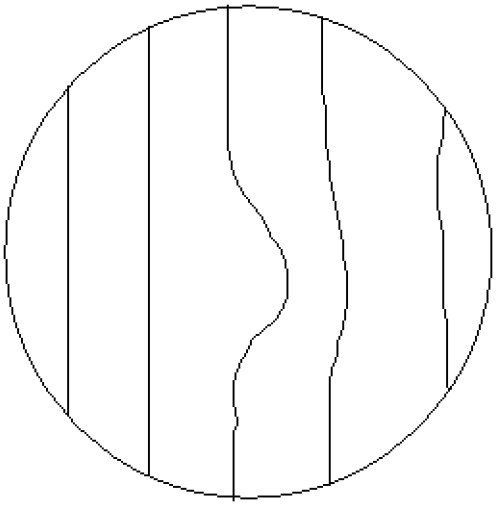
b) If an interferogram obtained testing a system having 3 waves of third-order spherical wave were analyzed, what would the P-V error in the digitization process be? Where on the interferogram would the error be a maximum?

OT-4

The following interferogram was obtained testing a window of refractive index 1.5 in a Mach-Zehnder interferometer using a helium-neon laser. When a hot tip of a soldering iron is placed in the arm of the interferometer containing the window the fringes bend toward the right in the interferogram.

a) What is the peak-valley error, in units of microns, in the thickness of the window?

b) Is the center of the window too thick or too thin? Explain.



OT-5

A computer was used to simulate the four interferograms shown below.

a) For interferogram #1, the aberration is of the form $A\rho^4 + B\rho^2$. If A is equal to 8, what is B? (It may be hard to see from the figure, but there is a bright fringe at the edge of the pupil.)

b) For Figures 2, 3, and 4 the aberration is of the form $8y\rho^2 + Ay + Bx$, where $\rho = \sqrt{x^2 + y^2}$ and $0 \le \rho \le 1$. What are A and B for the three figures?

c) What aberrations do the four figures represent?

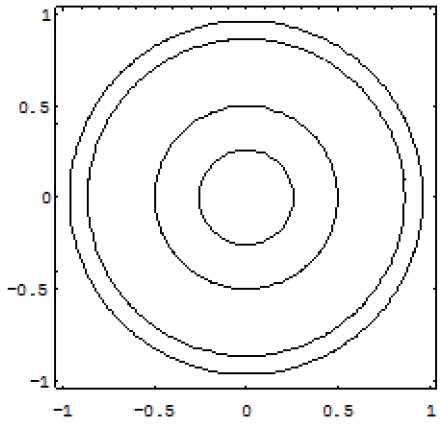


Figure 1.

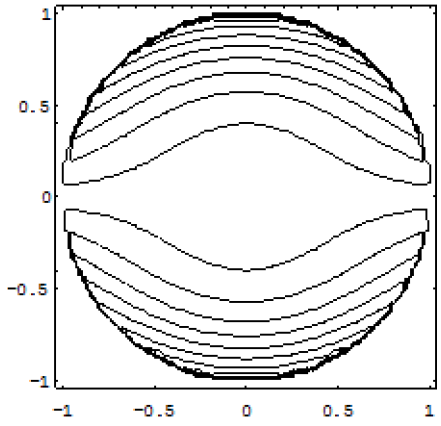


Figure 2.

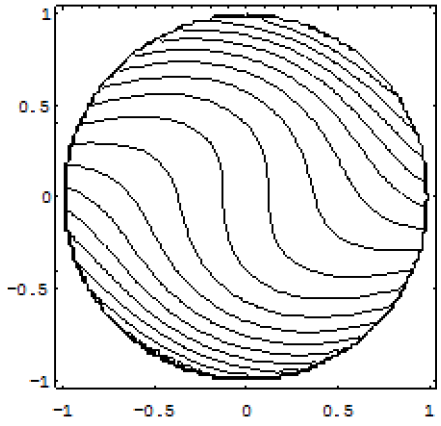


Figure 3.

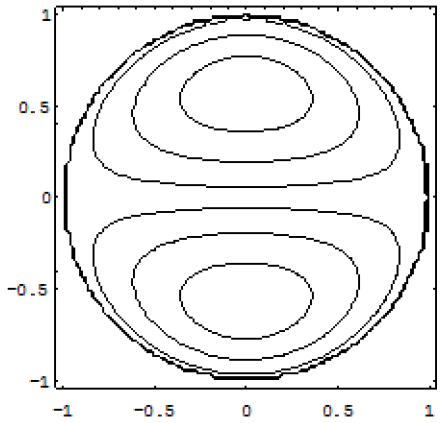
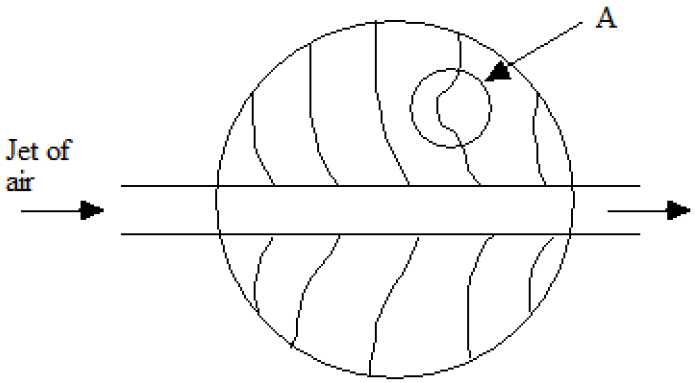


Figure 4.

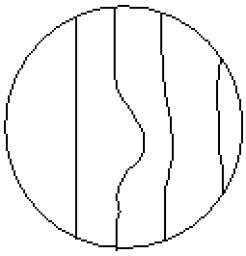
OT-6

I am testing what is essentially a plane parallel plate in a Twyman-Green interferometer. During the test I blow a jet of air having a refractive index larger than that of room air into the test beam. If I obtain the following interferogram, does portion A correspond to a too thick or a too thin region of the glass plate? Explain your answer.



OT-7

The following interferogram was obtained using a two beam interferometer to test a sample at a wavelength of 500 nm.



If the sample being tested is a flat mirror, what is maximum departure from flatness if

a) the sample is tested at normal incidence in a Twyman-Green interferometer?

b) the sample is tested at an angle of incidence of 60 degrees in a Twyman-Green? Sketch the interferometer setup.

c) the sample is tested using a Mach-Zehnder interferometer where the sample is used as one of the mirrors in the interferometer? Sketch the interferometer setup.

If the sample being tested is a plane parallel plate of refractive index 1.5,what is the maximum thickness variation if

d) the sample is tested in a Twyman-Green interferometer?

e) the sample is tested in a Mach-Zehnder interferometer?

OT-8

The following three interferograms were obtained testing a nearly spherical mirror in a laser-based Fizeau interferometer using a 633 nm light source.

a) What is the name of the aberration present?

b) What is the peak-valley surface height error in units of microns? Give any assumptions you are making.

c) How was the interferometer adjusted in going from the interferogram on the left to the interferogram on the right?

d) Describe the motion of the fringes in the middle interferogram as you push in on the mirror to move the mirror closer to the reference surface. State any assumptions being made.

OT-9

Give an equation describing the basic shape of the moiré pattern obtained using two patterns whose line positions are determined by the equations $6\,\rho^2 + 4x = m$ and $-6\,\rho^4 + 4x + 2xy = m$, where m is an integer.

OT-10

A moiré pattern described by the equation $4\,\rho^4 + 6\,\rho^2 - 2\,x\,y + 2\,x = m$, where m is an integer, is obtained using two patterns A and B. Pattern A can be described by the equation $6\,\rho^4 + 6\,\rho^2 - 2\,x\,y - 2\,x = m$. Give an equation describing pattern B.

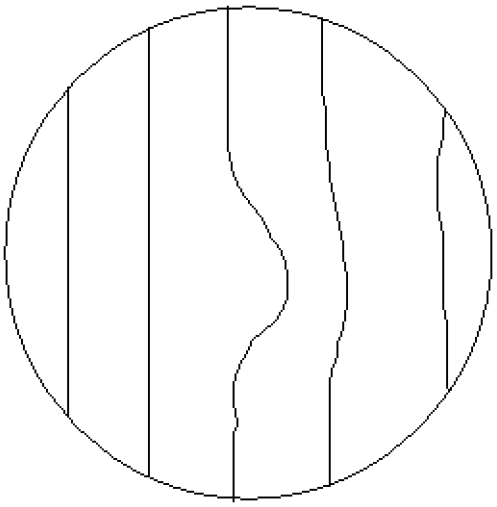
OT-11

a) Sketch a laser based Twyman-Green interferometer for testing a concave spherical mirror. Be careful to show the correct position of the spherical mirror.

b) Which 3 optical elements in the interferometer need to be of high quality.

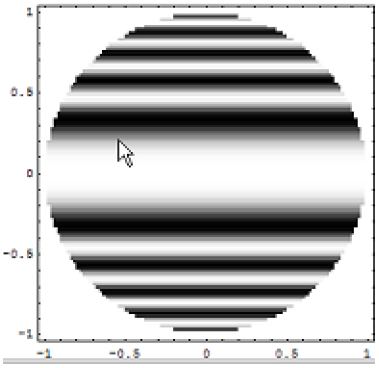
c) Let the spherical mirror being tested have a diameter of 10 cm and a radius of curvature of 100 cm. Initially the interferometer is adjusted so a single bright fringe is obtained. Including the center fringe, how many bright circular fringes will we have if the spherical mirror is translated 400 wavelengths toward the interferometer?

d) The following interferogram was obtained using a HeNe laser source operating at a wavelength of 633 nm. In units of nm, what is the surface height error in the test mirror. When the test mirror is pushed on to move the mirror toward the rest of the interferometer the fringes move to the left. Is the mirror surface near the center of the mirror too high or too low? Explain.

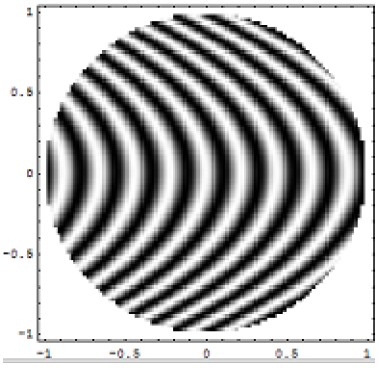


OT-12

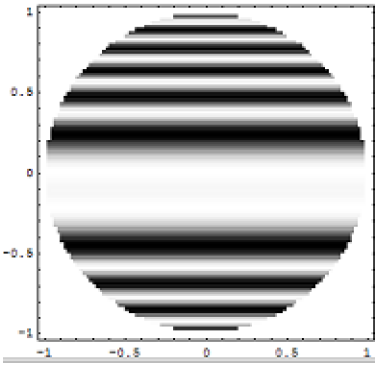
The 5 interferograms shown below were obtained testing a mirror in a Twyman-Green interferometer. For each interferogram give the number of waves of astigmatism, focus, x-tilt, and y-tilt.



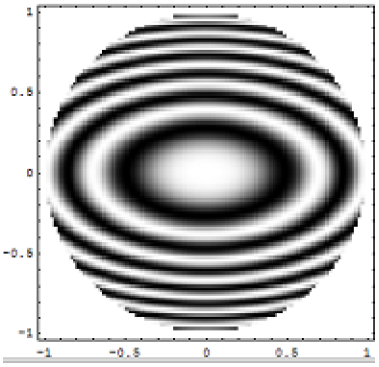
a) Dark fringe at top and bottom.



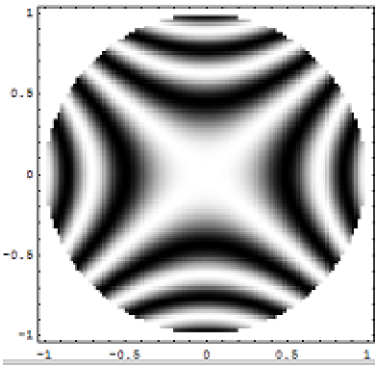
b) Dark fringe at left and right.



c) Dark fringe at top and bottom.



d) Dark fringe at top and bottom.



e) Dark fringe at top and bottom. Bright fringe at left and right.