# Modern Physics

Instructor: Prof. Bernd Pilawa (bernd.pilawa@kit.edu)

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Exercise 2

## § Classical Wave Optics §

### Problem 1: Thin film interference at an aerial wedge

Two glass plates are separated by a single hair with a diameter of 40 $\mu$m. As a result, an aerial wedge is formed of length 10 cm. Light with a wavelength of 550 nm arrives vertically on the glass plates (take the 1st glass plate as the horizontal one). The light reflected off this aerial wedge shows a peculiar pattern of bright and dark fringes.

**(1)** How can you explain this modulation of the reflected intensity?

**(2)** Calculate the condition of the $m$-th dark fringe with respect to the point of contact of the two glass plates. & *Hint*: Use the small angle approximation $\tan(\theta) \approx \theta$.

**(3)** Determine the distance between two adjacent dark fringes.

**(4)** What changes when the aerial wedge is filled with water instead?

### Problem 2: Fraunhofer diffraction: single slit, double split and optical grating

Parallel light with the wavelength of $\lambda = 600$ nm hits vertically on a single slit of width 5 $\mu$m. Behind the slit, a screen is placed at a distance of 1 m.

**(1)** Derive under which angles $\theta$ the first and second intensity minima are observed.

**(2)** Make a sketch of the intensity distribution viewed on the screen. What is the distance $y_0$ between the two minima of 1st order.

**(3)** Calculate the positions of the diffraction maxima in case of a double slit with a slit distance of d = 10 $\mu$m (from midpoint of one slit to midpoint of second slit) and a slit width of $a = \frac{d}{2} = 5$ $\mu$m. Make a sketch of the intensity distribution.

**(4)** How does the intensity distribution change on the screen, when the light impinges now on a diffraction grid with $N$ slits instead of a single slit or a double slit?

### Problem 3: Michelson interferometer

A 5 cm long empty tube with glass windows at both ends is inserted into one arm of a Michelson interferometer. The pipe is evacuated and the mirrors of the interferometer are adjusted such that there is a bright fringe in the center of the screen (detector). When the pipe is slowly vented, a total of 49.6 rings move by. The wavelength of the light is 589.29 nm. How many wavelengths fit into the pipe, when ...

**(1)** ... the pipe is evacuated?

**(2)** ... the pipe is vented?

**(3)** What value for the refractive index of air can you deduce from this experiment.