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| **Exam Microphotonics**  Prof. R. Baets & Prof. D. Van Thourhout  31/8/2021 Afternoon  Start a new sheet of paper for each question!! Write your name on all pages.  On your first page please write the following Declaration of Honour:  *“I hereby declare that I am aware that this exam should be executed without getting help from or giving help to others and that I will comply with this”.*  All four questions have the same weight. |

**Question 1**

An imaging system consists of a single lens and is used for real imaging with magnification -1. It is free of aberrations. The lens focal length is 5 cm. Just in front of the lens there is a square aperture with a width of 2 cm (the lens is larger than this aperture).

1. Consider an object which is a periodic pattern and which is illuminated with white visible incoherent light. What is the smallest period of this periodic pattern for which the periodic pattern can be discerned in the image.
2. How does the MTF of this system look like?
3. Suppose one half of the square aperture (for example the lower half) is blocked. How will this change the MTF?

**Question 2**

A plane wave with a wavelength of 1 micrometer is incident from air on a plane-parallel glass plate (n=1.5) with an angle of incidence of 45 degrees relative to the normal.

1. A linear grating is formed on the air-glass interface on which the beam is incident. The grating lines are orthogonal to the direction of incidence. Choose the grating pitch such that the transmitted first-order diffracted beam (in air) is orthogonal to the transmitted zero-order beam (in air). Calculate this pitch.
2. What are the directions of all transmitted and reflected diffraction orders (all in air)?
3. Now you rotate the plate with the grating by 90 degrees in its plane. Once more: what are the directions of all the transmitted and reflected diffraction orders?

**Question 3**



Consider the integrated interferometer as sketched above. It consists of:

* A perfectly symmetric Y-junction
* Two waveguide arms. In the upper arm we can introduce a phase shift 
* A directional coupler with length L.

For each of the cases described below, calculate and sketch how the power transmission T1=P1/Pin and T2=P2/Pin to the output waveguides varies, if we change the length of the directional coupler from 0 to 2Lc. Lc is the coupling length of the directional coupler defined in section 5.3.2 of the course.

1. No phase change in upper arm (=0), symmetric directional coupler (=0, ).
2. No phase change in upper arm (=0), asymmetric directional coupler (≠0, ).
3. Phase change in upper arm =/2, asymmetric directional coupler (≠0, ).

For the definition of the symbols see section 5.3.2 in the course.

**Question 4**

a) Why do we in practice often use multiple order waveplates instead of a single order waveplate?

b) Give an expression for the wavelength dependence of such a multiple order waveplate.

c) Based on b) : explain the drawback of multiple order waveplates in quartz and propose a solution to overcome this drawback.

**Note P220！**