SP14 MS Comprehensive Exam – Photonics (Graduate)

Problem 1: Lasers and interference.

A laser source emits a collimated Gaussian beam of 532nm wavelength light. The beam is divided equally by a 50/50 beamsplitter, and then the two beams are combined and illuminate a piece of film, which records the intensity. The full angle between the two beams is 10 degrees.

1) Sketch the intensity recorded by the film, and label the spacing between the fringes formed, when the film is positioned so the two beams overlap completely. What is the fringe contrast?

2) Sketch the intensity distribution recorded if the film is moved closer to the laser, so that the two beams overlap only for half of their area. What is the fringe contrast?

3) The wavelength of the laser source indicates that it is very likely a particular common type of laser. Identify the gain material, the type of optical pump source, and the optical technique used to obtain the specific 532 nm output wavelength.

Problem 2: Diffraction

A diffraction grating has a spatial period of 1 micron and a sinusoidal amplitude transmission. The peak transmission is 1, the minimum transmission is zero, and all light which is not transmitted is absorbed. The grating is illuminated by 1 Watt of light normally incident on the grating.

1) Write an expression for the transmission function t(x,y) of the diffraction grating.

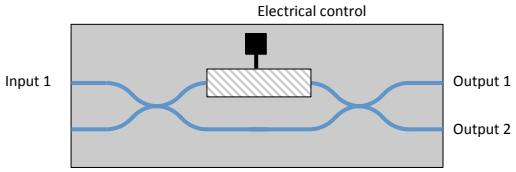
2) Sketch the direction and label the intensity of diffraction orders transmitted if the light illuminating the grating has wavelength 632nm.

3) Label the direction and intensity of diffraction orders transmitted if the light illuminating the grating has wavelength 1.6 microns.

4) How many diffraction orders would this grating generate if it were illuminated by light of wavelength 250nm?

Problem 3: Modulation

A waveguide device is fabricated with a one input, two 50/50 couplers, and an electrically controlled region, as drawn below. Electrical current is supplied to the black pad to accomplish switching of an input to the either of the two outputs.



1) Identify by name the type of optical waveguide modulator drawn, and the optical parameter is changed in the shaded region to accomplish modulation.

2) The device is set to route the input to output 2 for a particular center wavelength, λ. Sketch the intensity transmission of output 2 as a function of incident wavelength.

3) If the modulator is set to switch the input to output 2, and a 100% reflecting mirror placed at the output port, where would the reflected signal go? Justify your answer.