Photonics in Semiconductors, Spring 2017

Exercise 3, 9.2.2017

1. Coherence length in terms of linewidth

a) Derive an expression for the coherence length of a wave in terms of the linewidth $\Delta\lambda_0$ corresponding to a frequency bandwidth of $\Delta\nu$.
b) Estimate the coherence time and length of white light from the spectral width, given the usual limits: $\lambda_{UV} = 350\ nm$, $\lambda_{IR} = 750\ nm$.

2. Coherence length of different light sources

Find the coherence length of the following light sources.
a) An LED emitting at 1550 nm with a spectral width 150 nm.
b) A semiconductor laser diode emitting at 1550 nm with a spectral width 3 nm.
c) A quantum well semiconductor laser diode emitting at 1550 nm with a spectral width of 0.1 nm.
d) A multimode HeNe laser with a spectral frequency width of 1.5 GHz.
e) A specially designed single mode and stabilized HeNe laser with a spectral width of 100 MHz.

3. Coherence length: Michelson interferometer example

A Michelson interferometer is illuminated by red cadmium light with a mean wavelength of 643.847 nm and a linewidth of 0.0013 nm. The initial setting is for zero O.P.D., i.e. d = 0. One mirror is then slowly moved until the fringes disappear. By how much the mirror must be shifted? How many wavelengths does this correspond to? Hint: Check e.g. Hecht how Michelson interferometer works.

Bonus. Coherence function (continuation of problem 3)

Assume that the spectrum of the light source in problem 3 has a Gaussian shape. Derive the functional form of the fringe constrast (coherence function) as a function of the mirror position.