Open Optical Networks
Lab 8

December 13, 2022

These exercise sets cover some aspects you will find useful for the final exam software development. This exercises can be part of the material for the final exam questions. You are strongly encouraged to find yourself a solution to the presented problems.

Exercises

The aim of these exercises is to define in the network abstraction a more precise evaluation of the noise introduced by the propagation through a fiber-optic line.

Suggestion: Use only linear units in the operations within mathematical or physical function and use only logarithmic units for plots and input/output data.

1. Include in the class **Line** the attribute **n_amplifiers** that express the number of optical amplifiers on that line. This number have to be calculated using the line length, supposing that an amplifier is necessary every 80 km. Moreover, include the attributes **gain** and **noise_figure** that are fixed for each amplifier to 16 dB and 5.5 dB, respectively.

2. Define in the class **Line** the method **ase_generation** that evaluate the total amount of amplified spontaneous emissions (ASE) in linear units generated by the amplifiers supposing that a cascade of amplifiers introduces a noise amount which follows the expression:

$$ASE = N\left(hfB_n\mathrm{NF}\left[G-1\right]\right), \tag{1}$$

where N is the number of amplifiers, h is the Plank constant, f is the frequency which would be fixed to 193.414 THz (C-band center), B_n is the noise bandwidth fixed to 12.5 GHz, NF and G are the amplifier noise figure and gain, respectively.

3. Include in the class **Line** an attribute for the following physical features of the fibers necessary to evaluate the nonlinear interference noise, supposing that all the lines are composed of the same fiber variety:

- $\alpha_{dB} = 0.2\,\mathrm{dB/km}$;
- $|\beta_2| = 2.13\,\mathrm{e}{-26}\ \mathrm{ps^2/km}$;
- $\gamma = 1.27\mathrm{e}{-3}\,(\mathrm{W\,m})^{-1}$;

Remember that: $\alpha = \frac{\alpha_{dB}}{10\,log_{10}(e)}$;

4. Include in the class **Lightpath** the attributes **Rs** and **df** which represent the signal symbol rate and the frequency spacing between two consecutive channels.

   - $R_s = 32$ GHz
   - df = 50 GHz

5. Define in the class **Line** the method **nli_generation** that evaluate the total amount generated by the nonlinear interface noise using the formula (in linear units):

$$NLI = Pch^3\,\eta_{nli} N_{span} B_n \quad \text{with} \quad B_n = 12.5\ \text{GHz}$$