OC Problem Set 1

Friday, April 24, 2015.

Regular tutorial date and place: Friday, 11:30h-12:15h, Hörsaal 2, Bldg. 30.41

Problem 1: Fiber attenuation (1)

When the mean optical power launched into an 8 km length of fiber is 120 μW, the mean optical power at the fiber output is 3 μW. Determine:

a) The overall signal attenuation or loss in decibels (dB) through the fiber assuming that there are no connectors or splices that would introduce additional losses.
b) Show that constant loss α over a discrete distance Δz correspond to an exponential attenuation $\sim \exp(-\alpha z)$ (compare problem 1.2 in the script).
c) The signal attenuation per kilometer for the fiber.
d) The overall signal attenuation for a 10 km optical link using the same fiber with splices at 1 km intervals, each giving an attenuation of 1 dB.
e) The numerical input/output power ratio in c).

Problem 2: Fiber attenuation (2)

The mean optical power launched into an optical fiber link is 1.5 mW and the fiber has an attenuation of 0.5 dB/km. Determine the maximum possible link length (assuming lossless connectors) when the optical power level required at the detector is 2 μW.

Problem 3: Optical Power Combiner

Assume that three optical signals with powers P_1, P_2, and P_3 are superimposed in a hypothetical lossless optical combiner in such manner that their powers add up linearly. Calculate the total output power P_{out} for (a) $P_{dB,1}$=10dBm, $P_{dB,2}$=10dBm, $P_{dB,3}$=13dBm and (b) $P_{dB,1}=P_{dB,2}=P_{dB,3}$=0dBm.

Problem 4: Transatlantic fiber link

As highlighted in the lecture, it is not possible to optically transmit data over 7000 km (London – New York) of fiber length (attenuation 0.2 dB/km) without optical amplification. Therefore erbium doped fiber amplifiers (EDFA) are employed for a transatlantic fiber link. They amplify an optical input signal of –15 dBm to an output power of +1 dBm. Assume that the optical transmitter at London is sending with an optical power of +1 dBm, and that the receiver at New York is able to detect optical signals down to –35 dBm.

a) How many EDFA are necessary for a working optical transatlantic fiber link?
b) Each EDFA needs an electrical power supply. Estimate the power consumption of a single EDFA for 8 transmitted channels, if the wall-plug efficiency of the EDFA is $\eta = P_{opt} / P_{el} = 0.01$. How much is the power consumption for the whole transatlantic fiber link (assume that electrical power line losses can be neglected)?

Bonus program:

In three tutorials (not announced beforehand), your exercises will be collected. If you answered 75% of all collected exercises correctly, your oral examination grade will be improved by 0.3 or 0.4 (except grades of 1.0 and for failed examinations). If you cannot join the tutorial, you may also hand your exercises to the tutor **before** the respective tutorial.

For questions and suggestions on the OC tutorial please contact:
Stefan Wolf, Bldg. 30.10, Room 1.23, Phone: 0721/608-47173, s.wolf@kit.edu
Wladick Hartman, Room 2.23, Phone: 0721/608-48954, wladislaw.hartmann@kit.edu