ELEC-E3240 Photonics **Group Best**

Optical amplifiers homework

These are the homework questions from Group Best. The exercises deadline is on **Thu 2.2.** at midnight. The answers should be sent as a PDF file to Oskari Kuittinen, oskari.kuittinen@aalto.fi.

Question 1 – Semiconductor optical amplifiers (3.0 p)

Write a short essay explaining the following: What is a Semiconductor Optical Amplifier? How does it differ from semiconductor lasers? Additionally, list some of the downsides of using SOAs for general signal amplification.

Question 2 – Raman amplifiers (2.5 p)

2.1 - What is the basic principle behind Raman amplifiers? (0.5 p)

a) Erbium-doping
b) Stimulated Raman Scattering
c) Amplified Spontaneous Emission
d) Four-wave mixing
e) All of the above

2.2 - Which of following aspects affect the Raman gain? (0.5 p)

a) Pump laser power
b) Polarization of Pump laser
c) Input signal wavelength
d) Input signal power
e) Fiber used
f) Pump laser signal wavelength
g) Direction of pumping
h) All of the above

2.3 - What is the signal-to-noise ratio of a Raman amplifier dependent on? (0.5 p)

a) The noise characteristics of the pump laser
b) The signal-to-noise ratio (SNR) of the input signal
c) The length of the fiber
d) The gain of the Raman amplifier
e) All of the above

2.4 - How does the fiber length affect the Raman gain when the Pump laser power is constant? (0.5 p)

a) The Raman gain increases with increasing fiber length
b) The Raman gain decreases with increasing fiber length
c) The Raman gain is not affected by the fiber length
d) The Raman gain is affected by the fiber length, but the relationship is complex and nonlinear.

2.5 - There is a maximum Raman gain for a frequency offset of 13.2 THz, causing pump wavelength of 1456 nm to create peak-signal of 1550 nm. The pump of 1066 nm causes 1116 nm peak signal (See page 12 of lecture 4 notes.) Calculate the maximum Raman gain's amplitude (in nm) if the pump wavelength is 1200 nm. Show your calculation. (0.5 p)
Note: The differences, 1550-1456 = 92 nm, and 1116-1066 = 50 nm, are not equal.

Question 3 – Erbium-doped fiber amplifiers **(2.5 p)**

a) Draw a block diagram of an EDFA system and name each part in the amplifying system. (0.5 p)
b) Briefly explain the purpose of each part you named. (0.5 p)
c) Explain how noise is generated in the EDFA? (1.0 p)
d) Explain why EDFAs can only be used for a narrow wavelength spectrum (1.53-1.56 μm)? (0.5 p)

Question 4 – The usage and properties of optical amplifiers **(2.0 p)**

What are the most common uses for the following optical amplifiers? (1.0 p)

List one positive and negative aspect of each amplifier (SOAs, Raman amplifiers, EDFAs). (1.0 p)