

No materials, no calculator. Prepared by M. Valkama.

NB 1: Pay special attention to clear handwriting. If I cannot read your text with reasonable effort, your paper cannot be unfortunately graded. So, please, try to write your responses and solutions in a clear manner. Danke schön.

NB 2: You are allowed to return only 1 response sheet that is distributed once we start. You can certainly write to all 4 individual sides of the response sheet. Also, extra sheets are available for possible intermediate/personal notes, but only one sheet can be returned.

Thank you. Enjoy. ☺

1. Explain shortly the following concepts in the context of electrical/electromagnetic communications: a) spectrum, b) nonlinear distortion, c) correlation, d) spectral density, e) thermal noise.

No need to dwell on all possible finest details, basic explanations which show your understanding are enough. (5p)

2. Explain the concepts of I/Q modulation and I/Q demodulation, in general. Illustrate the principles by drawing appropriate block-diagrams and some example spectral contents of relevant signals in different stages. Explain also how I/Q modulation principle utilizes the general bandpass signal characteristics. Finally, explain shortly the concept of lowpass equivalent or baseband equivalent signal. (5p)

3. Present the basic time domain mathematical model for ideal sampling process. Given the spectrum of a continuous-time signal, sketch (i.e., draw) also the corresponding spectrum after ideal sampling. Based on that, formulate the basic requirement in order to avoid aliasing. Explain also the basic idea of reconstruction in both time and frequency domains. Finally, tell the basic idea of sub-sampling principle in bandpass signal context. (5p)

Maximum points:  $5 + 5 + 5 = 15p$ .