

No materials, no calculator. Prepared by and return to: Mikko Valkama

NB: 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. Thank you.

1. Explain shortly the following concepts: a) spectrum, b) cross-correlation, c) intermodulation distortion, d) spectral density, e) white noise. No need to dwell on details, rough explanation which shows your understanding is enough. (5p)
2. Assume $x(t)$ is white noise. Suppose another random signal $y(t)$ is created as $y(t) = x(t) + x(t - T)$ where T is a known constant. First, calculate the autocorrelation function of $y(t)$. Then, calculate also the spectral density of $y(t)$ and illustrate it graphically. (5p)
3. Explain the general concepts of (i) amplitude modulation, (ii) frequency modulation, and (iii) I/Q modulation. (5p)
4. Explain shortly the basic principle of Nyquist pulse-shaping filtering and pulse amplitude modulation (PAM), in the context of baseband digital communication. What does the concept of intersymbol interference (ISI) mean? What is the minimum bandwidth that still allows for avoiding ISI? How is the achievable physical layer bitrate determined in a baseband PAM system? (5p)
5. Suppose you are to design an I/Q modulated single-carrier M-QAM digital communication system where the target physical layer bit rate is 90 Mbit/s, and that you have 20 MHz bandwidth available around a center-frequency of 2600 MHz. Design the system in terms of the needed QAM symbol alphabet size, symbol rate and feasible nonzero excess bandwidth (rolloff) factor for a raised-cosine type of pulse. (5p)
6. Explain shortly the concepts of entropy, mutual information and channel capacity. What is the meaning of channel capacity for a communications engineer? In a bandlimited additive Gaussian noise channel, what factors are dictating or determining the channel capacity? (5p)

Maximum points, Full Exam: 5+5+5+5+5+5 = 30p.