Class: Sistem Pengaturan Berjaringan (EE185524)
Lecturer: Yurid E. Nugraha
Deadline: 2023/05/29

Assignment 4: Quantization and Sampling

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1. (**10%**) Consider a discrete controller

$$y[k] = ay[k-2] + by[k-1] + x[k]$$

where $a = 0.75$, $b = -0.5$, $x[0] = 0$. For word length 5 bits, determine $y_q[k]$.

2. (**15%**) Describe clearly the advantages and disadvantages of non-uniform quantization. Give an example in what situations non-uniform quantization may help.

3. (**15%**) Explain and give an example of a signal that is sampled with frequency sampling $\omega_s < 2\omega_0$, i.e., does not satisfy Nyquist criterion. What are the consequences?

4. (**15%**) Convert the following real value into bits using uniform quantization and then reconstruct them into a real value again and calculate the error. Explain the steps.
(a) 50 with 5-bit binary (b) 0.05, 10-bit (c) 35, 3-bit

5. (**15%**) Describe why second moment stability $sup_{k\in\mathbb{N}}\mathbb{E}(||X_k||^2) < \infty$ is important for networked systems as explained on the lecture. Why does it have to be second moment?

6. (**30%**) Consider a triple integrator system with transfer function $G(s) = \frac{4}{s^3}$. Design a controller (for a negative-feedback closed-loop system) in a discrete-time domain. Perform the sampling and reconstruction for the output signal $y(t)$ and control signal $u(t)$. Try at least three different sampling period and compare the results. Provide explanation to your results.