EE 105 Spring 2026

Homework 6 – upload to grade scope

(Due April 30, before class, late submission will incur 20% points/day penalty)

Instructions: Perform the following tasks based on the concepts discussed in class. Be sure to show all work where applicable.

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1. Explain different types of noise that exist in an optical communication system. Discuss specifically the types of noise in photodetector readout circuit.

2. If you had a circuit element with a resistance of 1000 Ohm, what would the thermal noise voltage be at 300 K? Assume bandwidth of 100 KHz.

3. Imagine I had a photodetector in reverse bias with light shining on it connected to a 10 kOhm resistor. We measure the voltage across this resistor at 300 K. A) What are the sources of noise for the voltage measured across the device? B) If I have 1 mA of photocurrent in my photodetector, what will the actual RMS noise level of the voltage measured across the resistor be? Assume a sampling rate of 200 kHz (leading to a bandwidth of 100 KHz).

4. If I then take the setup from problem 3 and transmit a signal with a frequency of 30 kHz and a bandwidth of 10 kHz, the issue is that if I keep sampling at 200 kHz, I get roughly the same amount of noise on the signal due to the entire 100 kHz bandwidth. However, my signal is only in the frequency band from 25 kHz to 35 kHz. What strategies might I use to reduce the noise, and what would be the numerical RMS noise voltage after using those strategies?

5. An optical detector system consists of: a photodiode operating at reverse bias of 5V. A resistor for converting current to voltage with resistance of 50kΩ. Incident light producing 2μA of photocurrent. Calculate: a) The output voltage of the resistor, b) The RMS noise voltage if the system bandwidth is 1MHz and the photodiode dark current is 1nA. Consider the noise current sources to be thermal noise, shot noise from the photocurrent, and shot noise from the photodiode dark current. c) The signal-to-noise ratio (SNR = signal voltage^2 / noise voltage^2)