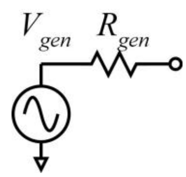
ECE 145b first problem set (noise)

Problem 1: In a communication channel, the received binary signal is + or - 10 mV, representing binary values. To this is added noise with a Gaussian distribution (zero mean) having 1 mV standard deviation. (a) Setting a decision threshold at 0 mV, what is the probability of error ? You will need the integral of a Gaussian distribution....please see notes set 7, pages 40-41.

Problem 2: A noise voltage $V_{in}(t)$, a zero-mean Gaussian random process, has spectral density $\tilde{S}_{V_{in}V_{in}} = 4kTR_0FG$ (V^2/Hz), where R_0 = 50 Ohms, F=5 dB, and G=40 dB, i.e., F=3.16 and G=10^4 in linear units (but of W/W gain, not V/V). This noise is passed though low-pass RC filters having transfer function $h_1(j2\pi f) = (1 + j2\pi f / 2\pi f_1)^{-1}$ and $h_2(j2\pi f) = (1 + j2\pi f / 2\pi f_2)^{-1}$ to produce $V_{out1}(t)$ and $V_{out2}(t)$. (a) Determine the spectral densities and cross spectral density of V_{out1} and V_{out2}. (b) From these quantities, determine the spectral density of $V_{out3} = V_{out1} + V_{out2}$

Problem 3: The generator is a 1 Volt sine wave at 1 GHz. Rgen is 10 Ohms, and is a physical resistor at room temperature. (a) find the spectral density of the noise voltage in V^2/Hz and (b) Find the signal/noise ratio in a 10 Hz bandwidth centered around 1 GHz.

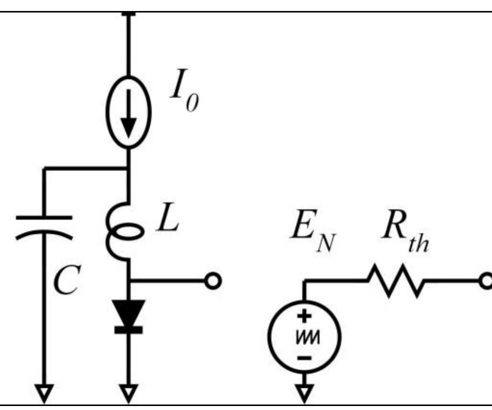


Problem 4: A noise voltage $V_{in}(t)$, a zero-mean Gaussian random process, has spectral density $\tilde{S}_{V_{in}V_{in}} = 4kTR_0FG$ (V^2/Hz), where R_0 = 50 Ohms, F=5 dB, and G=40 dB. This noise is passed though a low-pass RC filter having transfer function $h(j2\pi f) = (1 + j2\pi f / 2\pi f_0)^{-1}$ to produce $V_{out}(t)$. (a) If the 3-dB bandwidth of the filter is 500 MHz, give the power spectral density $V_{out}(t)$.

218B additional problems:

(a) If the 3-dB bandwidth of the filter is 500 MHz, compute the autocorrelation function and variance of $V_{out}(t)$. (b) Compute the cross spectral density and cross correlation function of $V_{in}(t)$ and $V_{out}(t)$.

Problem 5: In the diagram to the right, L and C are open- and short- circuits at the frequencies of interest. The diode is ideal. Compute a Thevenin noise model (rightmost diagram) as a function of DC current Io, finding the spectral density of En and the equivalent resistance Rth. Assume that Io is much greater than the diode saturation current Is. What is the available noise power in units of Watts/Hz or Joules ? How does this compare to a physical resistance.



Problem 6: (a) Compute the power spectral density of Vo as a function of R and C.

218B additional problem: (b) Compute the total RMS noise voltage as a function of R and C.