Werkcollege 1: huiswerkopgaven

Hieronder volgen de huiswerkopgaven voor het 1e werkcollege Telecommunicatietechniek. Bij het werkcollege wordt verwacht dat je deze opgaven vooraf thuis hebt voorbereid.

Tijdens het werkcollege is er nog enige tijd om aan de lastige onderdelen, waar je thuis niet uit bent gekomen, met collega-studenten verder te werken. Daarna worden een aantal opgaven op het bord voorgemaakt.

Question 1.

Geef de volgende decibel omzettingen

a.	120 pW	==>	dBμW
b.	54 dBW	==>	kW
c.	270 μV	==>	dBV
d.	36 dBμW	==>	mW
e.	1.5 W	==>	dBm
f.	87 dBnV	==>	μV

Question 2.

Assume that a computer terminal has 110 characters (on its keyboard) and that each character is sent using binary words.

a. What is the number of bits needed to represent each character?

b. How fast can the characters be sent (characters/sec) over a telephone line channel having a bandwidth of 3.2 kHz and a signal-to-noise ratio of 20 dB?

c. What is the entropy of each character if they are equally likely to be sent?

Question 3.

A high-frequency generator with an output resistance of 75Ω delivers a power of -10 dBm into a resistive load of 50Ω.

a. Calculate the voltage over the open terminals of the generator expressed in decibel with respect to 1V.

b. Calculate the **maximum available signal power** in dBW that can be delivered to a resistive load (hint: which load is required for maximum power delivery).

c. What percentage of the maximum available power is delivered to a resistive load of 150Ω?

Question 4.

The two-sided power spectral density (PSD) of a baseband signal is given by the exponential function:

$$P(f) = A^2 \exp\left(-\frac{|f|}{2\alpha}\right) \quad \forall f$$

with $\alpha = 10^4$.

a. Determine the 30 dB bounded spectrum bandwidth for this signal spectrum in kHz.

b. Determine the equivalent signal bandwidth (in the same way defined as the equivalent noise bandwidth) for this signal spectrum.

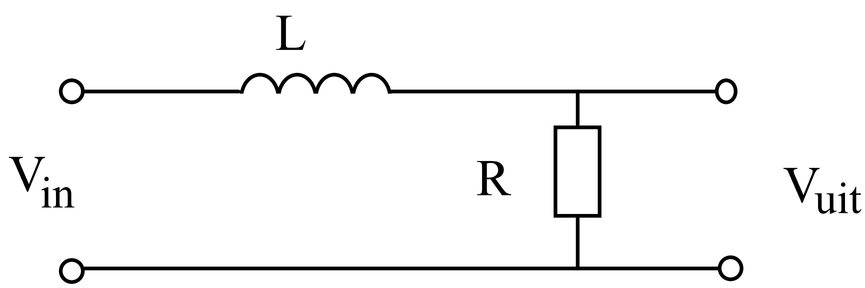
c. Calculate the 99% power bandwidth of this signal in kHz.

Question 5.

Assume the following signal:

$$x_1(t) = 1 + 2\sin(\omega_0 t) + 3\cos(3\omega_0 t).$$

This signal is input to the 2-port of the figuur below, which represents a first order lowpass filter with transfer function $H(f) = V_{uit}(f)/V_{in}(f)$. The -3dB frequency of the lowpass filter is $f_{-3dB} = 2f_0$, with $f_0 = \omega_0 / 2\pi = 1500$ Hz.



LR-lowpass filter

a. Give a mathematical expression and a sketch of:

1. the power spectral density (PSD) of the signal $x_1(t)$,
2. the power transfer function $|H(f)|^2$ of the 2-port, and calculated the value of the time constant $\tau = L/R$,
3. the PSD of the output signal.

Now let $x_2(t) = \sin(\omega_0 t)$ be the input signal of the 2-port. Added to this signal is the noise signal n(t) with two-sided PSD: $N_0/2 = 10^{-5}\ V^2/Hz$

b.1 Calculate the equivalent noise bandwidth of the 2-port.

b.2 Derive the mathematical expression for the signal-to-noise ratio at the output of the 2-port and calculate the value of this SNR.

b.3 Calculate the value of the time-constant $\tau = L/R$ which maximizes the SNR.