HF&VHF Circuits and Techniques I

Serie 11
Noise Figure, Power Gain and Noise Temperature of an Amplifier

- The temperature T is equal to 290 Kelvin.

- We do the assumption that the power gain of each amplifier is constant on the frequency bandwidth B = 100 kHz and equal to zero outside this bandwidth B.

- We do the assumption that the noise factor of each amplifier is constant on the frequency bandwidth B = 100 kHz.

Question A
We consider the amplifier 1 such that its power gain in the frequency bandwidth B = 100 kHz is equal to G1 = 30 dB and its noise figure is equal to NF1 = 6.02 dB.

We consider the amplifier 2 such that its power gain in the frequency bandwidth B = 100 kHz is equal to G2 = 10 dB and its noise figure is equal to NF2 = 9.03 dB.

Calculate the noise factor F of the circuit constituted by the cascade of the amplifier 1 and of the amplifier 2.

Question B
We consider the amplifier 3 such that its power gain in the frequency bandwidth B = 100 kHz is equal to G3 = 10 dB and its noise figure is equal to NF3 = 6.02 dB.

We consider the amplifier 4 such that its power gain in the frequency bandwidth B = 100 kHz is equal to G4 = 30 dB and its noise figure is equal to NF4 = 9.03 dB.

Calculate the noise factor F of the circuit constituted by the cascade of the amplifier 3 and of the amplifier 4.

Question C
Calculate the power gain G of the circuit constituted by the cascade of the amplifier 1 and of the amplifier 2.

Calculate the power gain G of the circuit constituted by the cascade of the amplifier 3 and of the amplifier 4.

Question D
Calculate the noise temperature Tr associated to the circuit constituted by the cascade of the amplifier 1 and of the amplifier 2.

Calculate the noise temperature Tr associated to the circuit constituted by the cascade of the amplifier 3 and of the amplifier 4.

Question E
Calculate the Power Spectral Density of the basic noise generated by the circuit constituted by the cascade of the amplifier 1 and of the amplifier 2 by considering this noise at the input of the circuit (notation Np on p. 5-3 or Na on p. 5-6 of the HF&VHF course).

Calculate the Power Spectral Density of the basic noise generated by the circuit constituted by the cascade of the amplifier 3 and of the amplifier 4 by considering this noise at the input of the circuit (notation Np on p. 5-3 or Na on p. 5-6 of the HF&VHF course).

Question F
Calculate the average value of the noise factor F of the circuit constituted by the cascade of the amplifier 1 and of the amplifier 2 on the bandwidth B = 100 kHz.

Calculate the average value of the noise factor F of the circuit constituted by the cascade of the amplifier 3 and of the amplifier 4 on the bandwidth B = 100 kHz.

Question G
We do the assumption that the Signal over Noise Ratio at the input (SNRi) is equal to 10.

Calculate the Signal over Noise Ratio at the output (SNRout) of the circuit constituted by the cascade of the amplifier 1 and of the amplifier 2.

Calculate the Signal over Noise Ratio at the output (SNRout) of the circuit constituted by the cascade of the amplifier 3 and of the amplifier 4.

Question H
We do the assumption that the Signal over Noise Ratio at the output (SNRout) is equal to 1.
It is recalled that the bandwidth B = 100 kHz and that the temperature T = 290 Kelvin.

Calculate the minimum detectable signal (MDS) associated to the circuit constituted by the cascade of the amplifier 1 and of the amplifier 2.
Calculate the RMS value Vin_{RMS} of the input voltage; we do the assumption that the input impedance is equal to Rin = 50 Ohms.

Calculate the minimum detectable signal (MDS) associated to the circuit constituted by the cascade of the amplifier 3 and of the amplifier 4.
Calculate the RMS value Vin_{RMS} of the input voltage; we do the assumption that the input impedance is equal to Rin = 50 Ohms.

Question I
The circuit constituted by the cascade of the amplifier 1 and of the amplifier 2 is considered.
Calculate the output signal level Lout when the minimum detectable signal MDS is applied to the input of the circuit.

The circuit constituted by the cascade of the amplifier 3 and of the amplifier 4 is considered.

Calculate the output signal level Lout when the minimum detectable signal MDS is applied to the input of the circuit.