Exercise Sheet 6 : RF Receiver Architectures

Exercise 1

An FM receiver consists of an amplifier with a gain of 8 dB and a noise factor of 2 dB, followed by a demodulator characterized by a gain of 2 dB and a noise factor of 5 dB. The receiver bandwidth is 10 kHz, and its input impedance is 50 Ω. Calculate for this receiver:

1. The noise factor, the gain, and the equivalent temperature.
2. The noise floor.
3. The sensitivity if we require an SNR of 10 dB at its output.

Exercise 2

In a heterodyne FM receiver, the input filter has a bandwidth of 20.33 MHz, and the IF filter has a bandwidth of 63.1 kHz. The equivalent temperature of the receiver is 440 K.

We want to use this receiver to capture a transmitter that sends power at 20 dB in the form of an electromagnetic wave. The signal attenuation is 130 dB per 100 m.

Calculate the maximum distance from the transmitter to detect its signal with this receiver.

Exercise 3

The FM broadcasting band is limited to the frequencies 88–108 MHz, with channels of 250 kHz. To receive transmitters in this band, an FM superheterodyne radio receiver with an IF frequency of 10.7 MHz is used. The bandwidth of the IF filter is 300 kHz, and the frequency of the local oscillator is lower than the signal frequency.

1. Provide the block diagram of this receiver.
2. Find the frequency range covered by the local oscillator.
3. We aim to receive "Channel 1," which uses a frequency of 91 MHz in the eastern region of Algiers. Calculate the frequency of the local oscillator that allows receiving this channel.

4. Find the image frequency corresponding to "Channel 1."
5. What happens if another transmitter uses this image frequency?
6. Determine the frequency range that the input filter must cover to eliminate image frequencies for the FM band. Is it possible to use a fixed input filter?
7. Represent the frequency spectra at the output of each block in the case of receiving "Channel 1."