RF Design - Noise

Exercise 1: What are the minimum possible values of T_e and F?

$T_e = 0\,K$ is minimum (no added noise)

this gives $F = 1$ (0 dB).

Exercise 2: The datasheet for a low-noise amplifier (LNA) specifies a noise figure of 2 dB. What is the noise temperature T_e?

$F = 2\,dB \qquad T_e = ?$

$= 1.58$

$= \frac{T_o + T_e}{T_o} = 1 + \frac{T_e}{T_o}$

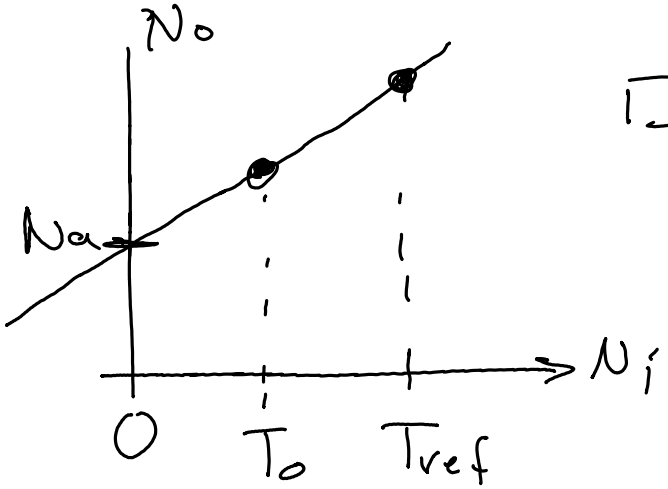
$\frac{T_e}{T_o} = 1 - 1.58 = 0.58 \qquad T_e = 290 \cdot 0.58 \approx 168\,K$

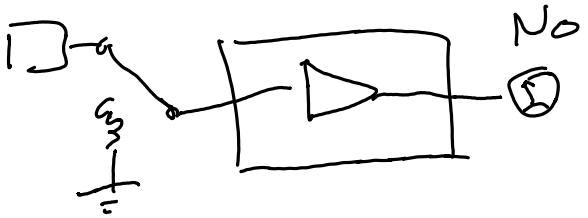
Exercise 3: An LNA with a noise figure of 0.3 dB receives a signal with an SNR of 6 dB. What is the output SNR?

$F = \frac{S_i/N_i}{S_o/N_o} \qquad S_i/N_i = 6\,dB = 4$

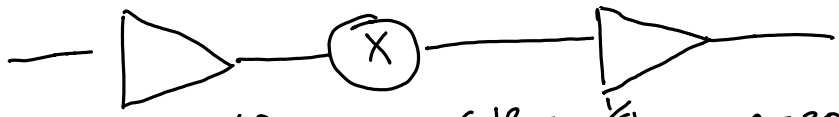
$F = 0.3\,dB = 10^{\frac{0.3}{10}} = 1.0715$

$S_o/N_o = \frac{S_i/N_i}{F} = \frac{4}{1.0715} = 3.73 = 5.7\,dB$





Exercise 4: A What is the system noise figure of a receiver that consists of a 10dB amplifier with 3 dB noise figure followed by a mixer with a 6dB loss and an IF amplifier with a 20dB gain and noise figure = 10 dB



$G_1 = 10\,dB = 10$ $F_1 = 3\,dB = 2$

$G_2 = -6\,dB = \frac{1}{4}$ $F_2 = 6\,dB = 4$

$G_3 = 20 = 100$ $F_3 = 10\,dB = 10$

$$F_{sys} = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2}$$

$$= 2 + \frac{4-1}{10} + \frac{10-1}{10 \cdot \frac{1}{4}} = 2 + 0.3 + 3.6$$

$$= 5.9 \simeq 8\,dB$$