EECS 562
Homework #5

1. A received signal is r(t) is composed of the transmitted signal x(t) plus noise n(t), i.e., r(t)=x(t)+n(t). The received signal is r(t) is input to a filter H(f) to produce the output signal y(t).
   a) Find the output S/N in dB given H(f) is an IBPF centered at 100 MHz with a bandwidth B of 50 kHz and the following parameters

   $S_n(f)=\frac{\eta}{2}$ with $\eta=4x10^{-11}$
   $x(t)=A\cos(2\pi f_c t)$ with $f_c=100\text{MHz}$ and $A=6x10^{-3}$

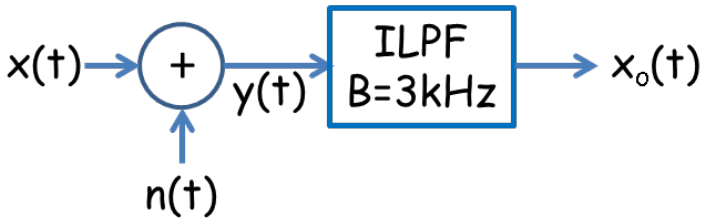
   b) As A decreased the output S/N increases, circle TRUE or FALSE.

2. A receiver has a bandwidth of 2.5 MHz, sensitivity of -94 dB_m and a noise figure of 12 dB. What is the minimum predetection S/N in dB. The receiver sensitivity is defined as the minimum received signal power (pre-detection) that will provide a demodulated signal with acceptable performance. Assume $T_i=T_o$ and $G_P=1$

3. Problem 11.12

4. Problem 11.22

5. A received signal, y(t), is the sum of the desired information signal x(t) and noise, n(t). y(t) = x(t) + n(t). Here x(t) = $2\cos(2\pi 1000t) + \cos(2\pi 2000t)$ and $S_n(f) = 10^{-4}$ W/Hz. The receive structure is:



   a) What is the power in x(t)?
   b) Find the output signal-to-noise ratio in dB.
   c) How would you redesign the receiver structure to improve the output signal-to-noise ratio?

6. An LTE the downlink - base station (eNodeB) transmitting & hand set (UE) receiving - has the following parameters:

eNodeB transmit power	40 W
Transmit antenna gain	5 dB
Carrier frequency	1900 MHZ
Distance between UE and ENodeB	10km
Receive antenna gain	0 dB
Receiver antenna temperature	10^0 K
UE noise figure	10 dB
Bandwidth	10 MHz

a) What is the UE noise temperature?
b) What is the path loss in dB?
c) What is the EIRP in dB_W?
d) What is the UE (output) S/N?
e) The eNodeB needs to communicate to a UE 20 km from the eNodeB with the same output S/N found above. What system parameter would your change to compensate for the increase path loss? Specify if you would INCREASE or DECREASE the selected system parameter and by how much.

7. Calculate the overall equivalent system noise temperature and noise figure for the following cases

a) For the system shown in Fig. (a), the receiver noise figure is 12 dB, the cable loss is 5 dB, the Low Noise Amplifier (LNA) gain is 50 dB and its noise temperature is 150K. The antenna noise temperature is 35 K. The LNA is placed with the antenna.

b) Repeat the calculation of when the system of Fig. (a) is arranged as shown in Fig. (b). The LNA is placed with receiver, e.g., at bottom of tower.

c. Which configuration (a) or (b) exhibits better performance? If the antenna is at the top of a 50 ft tower would you place the LNA at the antenna and run a cable to the receiver at the bottom of the tower, or run a cable from the antenna to a combined LNA/receiver at the bottom of the tower?

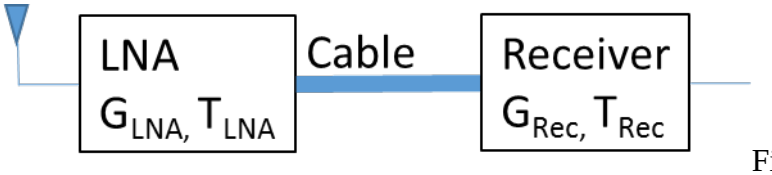


Fig. (a)

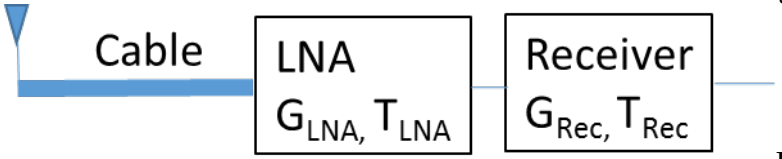


Fig (b)

8. Go to http://www.rflambda.com/search_lownoiseamplifier.jsp What is the gain and noise figure and frequency range of R13M02GSA?

9. Go to https://www.fcc.gov/media/engineering/dtvmaps enter 66044 for the zip code, click on KTWU.

   a. What is the receive power in dBm?
   b. Click on the Gain/Loss Map; is Lawrence included in the viewing area?