EECS 562

Homework 12

1. An AM receiver uses an envelope detector. The transmitter operates at total transmit power of 50KW with a 85% modulation index. The information signal is $x_{bb}(t) = \cos(2\pi f_m t)$, f_m=10kHz. The path loss between the transmitter and AM receiver is 95 dB. The noise power spectral density of N_0=-117 dB_W/Hz. The RF bandwidth is 50kHz.

a. What is the post-detection S/N?

b. Repeat part a. with DSB-SC.

2. A 10 kHz message signal is transmitted using DSB-SC with a carrier frequency f_c=980kHz over a nosey channel with noise power spectral density of $N_0/2=10^{-15}$ W/Hz. The receiver sensitivity is -57 dB_m. The receiver sensitivity is defined as the minimum received signal power (pre-detection) that will provide a demodulated signal with acceptable performance. What is the post-detection S/N?

3. A radio link has the following parameters:

Transmit power	10 W
Transmitter Antenna Gain	10 dB
Path loss	135 dB
Antenna temperature	290 K
Receiver antenna gain	10 dB
Receiver noise figure	3dB
Antenna Temperature	290
Information signal bandwidth	6 MHz
DSB-LC with modulation index 0.75	

a. What is the $(S/N)_{pre}$ in dB?

b. What is the $(S/N)_{post}$ in dB?

c. Your supervisor tells you that to reduce the receiver cost there has been a design change and the receiver noise figure has changed to 6dB. The customer wants same output S/N found in part a. What system parameter would your change and by how much?

d. Repeat b. with FM with β=5.

4. A 4 kHz message signal is transmitted using DSB-SC with a carrier frequency f_c=610kHz over a nosey channel with noise power spectral density of $N_0/2=8\text{x}10^{-15}$ W/Hz. The received signal power is -55dBm.

a. What is the post-detection S/N?

b. Repeat part a. with FM with β=1.

5. Suppose the following costs have been determined for a specific communication system.
RF Bandwidth: $200/kHz
Power: $2/watt
The customer wants a (S/N)post= 20 dB.
The fixed link parameters are an information bandwidth of 10 kHz, a path loss of 60 dB, and a constant noise power spectral density of $N_0 = 0.5 \text{ x } 10^{-9}$ watts/Hz.

a. Calculate the cost to the customer if DSB-LC is used with a 85% modulation index .

b. Repeat a. for SSB.

c. Repeat a. for DSB-SC.

6. Consider a communication system with a required (S/N)post of 25 dB and an information signal bandwidth of 10 kHz. The received signal consists of the transmitted signal plus noise where $S_n(f) = \frac{N_0}{2} = 0.5 \times 10^{-9}$ watts/Hz. The path loss between the transmitter and receiver is 100 dB. Find the required transmitter power in dB_W for:

a. SSB
b. DSB-SC
c. DSB-LC μ=1
d. FM β=0.2
e. FM β=5

7. Consider an FM transmitter with a transmitter power of 50KW. The path loss is 97dB, N_0 =-116dBW/Hz. The baseband bandwidth is 200 kHz.

a. Find β such that the (S/N)post =25 dB?
b. What is BRF in kHz?

8. Comparison of system resources (power and BRF) for different modulation schemes. In this case:

- Path loss = 93dB
- N_0=-113dBW/Hz
- B_{bb}= baseband bandwidth = 100 kHz

a. Fill out the table below to meet a required output signal-to-noise ratio, (S/N)post =35dB
BW Expansion Factor = B_{RF}/B_{bb}

Mod	Mod Index	Gp(dB)	Pt(dBw)	Pt(KW)	Brf (kHz)	BW Expansion Factor
DSB-SC						
SSB						
AM	0.75					
AM	1					
FM	1.67					
FM	2					
FM	4					

b. For the FM cases above discuss the trade-off between B_{RF} and P_T.
c. Comment of the feasibility of using each modulation format given the required transmit power.