EECS 562

Homework 13

1. A BPSK system needs to transmit 20 Mbit/sec and provide a 10^{-5} BER. Let N_0=-100 dBW/Hz. The path loss is 50dB.

a. Find the minimum required RF transmission bandwidth, BRF.

b. Find the required transmitter power in dB_W.

2. A 8-PSK system needs to transmit 20 Mbit/sec and provide a 10^{-5} BER. Let N_0=-100 dBW/Hz. The path loss is 50dB.

a. Find the required RF transmission bandwidth in MHz, BRF.

b. Find the required transmitter power in dB_w.

3. A BPSK system needs to provide the customer with a 1 Mb/s transmission rate with a performance specification of BER= 10^{-5}. $S_n(f) = N_0/2$ with $N_0 = 2.16 \times 10^{-17}$W/Hz. The path loss between the transmitter and receiver is 105 dB.

a. The noise $S_n(f)$ is input to an ILPF with a bandwidth of 2 MHz. What is the noise power at the filter output in dB_W?

b. How much RF bandwidth (in MHz) is needed if raised cosine pulses are used with $\alpha = 1$.

c. Find the required transmit power in dBW.

d. What is the benefit of switching the system to 16-QAM?

e. If the system uses 16-QAM with the BER fixed at 10^{-5} the transmit power needs to be increased or decreased compared to the power found in part c.

4. A radio link has the following parameters:

Carrier frequency, f_c	1 GHz
Transmit power	1 W
Transmitter Antenna Gain	0 dB
Path loss	151.1 dB
Antenna temperature	290 K
Receiver antenna gain	20 dB
Receiver noise figure	6 dB
Information bit rate	1 Mb/s
BPSK modulation	

a. For BPSK the received signal is $A\cos(2\pi f_c t)$ or $A\cos(2\pi f_c t + \pi)$, find A.

b. Find the energy/bit = E_b.

c. What is the Bit Error Rate?

5. For a fixed E_b/N_0=5dB, the BER for

a. QPSK

b. 8-PSK

c. 16-QAM

d. 64-QAM

e. 256-QAM

f. Why does the BER increase as the modulation changes from part a. to part e.

6. Given a 8-PSK system operating at f_c=2.4Ghz over a d=33.3 km distance in an environment resulting in a path loss of 130.5dB.
The receiver has a 6 dB noise figure and an antenna temperature of 100^o.
The transmit and receive antennas are isotropic.
The customer requires a bit rate of 2.7Mb/s with a BER of 10^{-6}.

a. What is the required $\frac{E_b}{N_0}$?

b. What is N_0 in dB?

c. What is E_b in dB?

d. What is E_s in dB?

e. What is the symbol rate r_s?

f. Find the receiver sensitivity in dB_W, that is, the received power, P_R, to achieve a BER=10^{-6}.

g. What is the path loss?

h. What are the antenna gains?

i. Find the required transmiter power in Watts and dB_W.

j. With all the link parameters given above the receiver moves away from the transmitter. Find the distance (in km) such that the system has to switch to QPSK to maintain a BER=10^{-6}; switching to QPSK reduced its transmission rate to 1.8 Mb/s.