S-72.3230 Radio transmission and network access
Exercise 3 - 4

P10 Determination of duplex frequency in a transceiver

Parameters:

- P_{tx} = 1W
- Srx = –96 dBm
- A_c = 25 dB
- tx oscillator phase noise specification: p.s.d. at duplex frequency better tban N_o = –140 dBc/Hz
- Receiver filter 4th order Butterworth filter, amplitude response
- $A(f) = \dfrac{1}{\sqrt{1+\left(\left(f - f_{c\_rx}\right)/B\right)^{2n}}}$
- Signal bandwidth W = 40 MHz
- Amplitude distortion (tx+rx) inside the signal bandwidth less than 1 dB

Task:

a) Determine the duplex spacing so that the signal to disturbance ratio at receiver sensitivity level is at least 20 dB

b) What is the minimum *n*-value if the duplex spacing is 340 MHz

P11 A FM-audio broadcast superheterodyne receiver should be able to receive signal in the band 87.5…108 MHz.

a) Determine the minimum value of the intermediate frequency so that no transmitter in this band could be on the mirror frequency.

b) A tunable pre-mixer filter of 1st order Butterworth type with a 250 kHz bandwidth is used to attenuate out of band mirror frequency signals. How large is the attenuation in dB with the IF-value obtained in part a?

P12 Derive the upper and lower bounds for the rate distortion function for a uniformly (-a, a) distributed signal producing independent samples when $0 \le D \le \sigma_x^2$. Draw the bounds for $10\log\left(\sigma_x^2/D\right)$-values in the range 0…100 dB.

P13

a) How large is the capacity of a telephone voice channel with a 3.1 kHz bandwidth having a 25 dB signal to noise ratio?
b) What is the minimum SNR (dB) required to obtain error free transmission of the 56 kbit/s modem in this voice channel?
c) Derive an expression of the capacity of a channel with infinite bandwidth?

Homework 3 Submission deadline 15th December 2005

A memoryless discrete source produces six symbols (A,B,C,D,E,F) with the occurrence probabilities P(A)=1/2, P(B)=1/4, P(C)=1/8, P(D)=P(E)=1/20, P(F)=1/40. The information of a symbol i according to Shannon's definition is $I = 1/\log_2\left(P(i)\right)$

a) Determine the information of the messages ABABBA and FDDFDF.
b) Compare the results with the average information of a 6-symbol message (=entropy).

Homework 4 Submission deadline 15th December 2005

The average signal to noise ratio of a flat Rayleigh-fading radio channel is 20 dB.The targeted bandwidth efficiency is 2 bit/s/Hz.

a) How large is the capacity outage?
b) If the capacity outage target is 1%, how large is then the achievable bandwidth efficiency?
c) If both the outage and bandwidth efficiency targets must be met, how many dB must the transmit power be increased?