Digital Television Techniques

Exercise 3, FEC/COFDM, 18-April-2013

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Deadline is 3 May 2013.

1. The *Pseudo Random Binary Sequence* in DVB-T is generated using 15 shift registers and the polynomial generating sequence

$$1 + X^{14} + X^{15}$$

   and the shift registers initially are loaded with the values $\{0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 1\}$.
   Generate the PRBS signal for the sequence

$$\{0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 1\}$$

2. A digital system uses a convolutional encoder where the generator polynomials are given by $G_1 = 6_{Oct}$ and $G_2 = 3_{Oct}$. Sketch the encoder. Sketch the trellis diagram for the code.

3. A black and white TV screen has approximately $3 \cdot 10^5$ image elements (pixels) which can have one of ten distinct intensity levels with the same probability. Suppose that the transmission rate is 25 pictures per second and that the signal-to-noise ratio is 30 dB. Find the necessary bandwidth of the channel. Assume the Shannon's theorem $C = B \log_2(1 + S/N)$.

4. The binary signal $\{01000100011010\}$ is sent using QPSK (Quadrature Phase Shift Keying), using constellations (bits) 0 (00) , $\pi/2$ (01), π (10) and $3\pi/2$ (11). The symbol length is $2T_c$ where $T_c = 1/f_c$, amplitude $A_c = 1$. Draw the modulated signal $x_c(t)$ for $t \in [0, 16T_c]$.

5. A multi-path channel shows a maximum time delay of $\tau_{max} = 0,8\mu s$. How long should the Guard interval (Cyclic Prefix) of an OFDM system with $N = 64$ sub-carriers and a carrier spacing of $\Delta f = 312,5$kHz be dimensioned for the transmission over the channel? Note, select among guard intervals of length 1/4, 1/8, 1/16, 1/32 etc.