

Digital Television Techniques

Exercise 2, Modulations, 17-Apr-2008

This exercise shall be returned to the lecturer (Jerker Björkqvist) in hard-copy format, a) at a lecture, b) to room B4052, ICT House or c) in the mail box on 4th floor. Deadline is May 2.

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

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

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. AM modulation can be written as 1

$$x_c(t) = x(t) \cos(2\pi f_c t)$$

where $x_c(t)$ is the modulated wave-form, $x(t)$ is the modulating wave-form (modulating signal) and f_c is the carrier frequency. Write a function in JAVA/C/Matlab syntax that generates the (discrete) modulated signal using a discrete in-signal

```
void am_modulator(float carrier_freq, float in_freq, float out_frequency,
int n_samples_in, int n_samples_out, float insignal[], float outsignal[])
```

In:

```
carrier_freq: The carrier frequency given in Hz
in_freq: The input frequency in Hz (1/Sampling time)
out_freq: The output frequency in Hz (1/Sampling time)
n_samples_in: Size of input buffer
n_samples_out: Size of output buffer
insignal: Array of sampled signal values
```

Out

```
outsignal: Array of sampled modulated signal values
```

4. 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 $C = B \log_2(1 + S/N)$.
5. 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 $t \in [0, 16T_c]$.