COMMUNICATION SYSTEMS II

EX 702

Lecture : 3 **Year : IV**
Tutorial : 0 **Part : I**
Practical : 3/2

Course Objectives:

To introduce the student to the principles and building blocks of digital communication systems and effects of noise on the performance of communication systems.

1. Introduction **(3 hours)**

1.1 Digital communication sources, transmitters, transmission channels and receivers.

1.2 Noise, distortion and interference. Fundamental limitations due to noise, distortion and interference

1.3 Source coding, coding efficiency, Shannon-Fano and Huffman codes, coding of continuous time signals (A/D conversion)

2. Sampling Theory **(4 hours)**

2.1 Nyquist-Kotelnikov sampling theorem for strictly band-limited continuous time signals, time domain and frequency domain analysis, spectrum of sampled signal, reconstruction of sampled signal

2.2 Ideal, flat-top and natural sampling processes, sampling of band-pass signals, sub-sampling theory

2.3 Practical considerations: non-ideal sampling pulses (aperture effect), non-ideal reconstruction filter and time-limitness of the signal to be sampled (aliasing effects)

3. Pulse Modulation Systems **(8 hours)**

3.1 Pulse Amplitude Modulation (PAM), generation, bandwidth requirements, spectrum, reconstruction methods, time division multiplexing

3.2 Pulse position and pulse width modulations, generation, bandwidth requirements

3.3 Pulse code modulation as the result of analog to digital conversion, uniform quantization.

3.4 Quantization noise, signal to quantization noise ratio in uniform quantization.

3.5 Non uniform quantization, improvement in average SQNR for signals with high crest factor, companding techniques (μ and A law companding)

3.6 Time Division Multiplexing with PCM, data rate and bandwidth of a PCM signal. The T1 and E1 TDM PCM telephone hierarchy

3.7 Differential PCM, encoder, decoder

3.8 Delta Modulation, encoder, decoder, noises in DM, SQNR. Comparison between PCM and DM

3.9 Parametric speech coding, vocoders

4. Baseband Data Communication Systems (7 hours)

4.1 Introduction to information theory, measure of information, entropy, symbol rates and data (bit) rates.

4.2 Shannon Hartley Channel capacity theorem. Implications of the theorem and theoretical limits.

4.3 Electrical representation of binary data (line codes), Unipolar NRZ, bipolar NRZ, unipolar RZ, bipolar RZ, Manchester (split phase), differential (binary RZ-alternate mark inversion) codes, properties, comparisons

4.4 Baseband data communication systems, Inter-symbol interference (ISI), pulse shaping (Nyquist, Raised- cosine) and bandwidth considerations

4.5 Correlative coding techniques, duobinary and modified duobinary encoders

4.6 M-ary signaling, comparison with binary signaling

4.7 The eye diagram.

5. Bandpass (modulated) data communication systems (4 hours)

5.1 Binary digital modulations, ASK, FSK, PSK, DPSK, QPSK, GMPSK, implementation, properties and comparisons

5.2 M-ary data communication systems, quadrature amplitude modulation systems, four phase PSK systems

5.3 Demodulation of binary digital modulated signals (coherent and non-coherent)

5.4 Modems and its applications.

6. Random signals and noise in communication systems (7 hours)

6.1 Random variables and processes, random signals, statistical and time averaged moments, interpretation of time averaged moments of a random process stationary process, ergodic process, psdf and AC function of a ergodic random process

6.2 White noise, thermal noise, band-limited white noise, the psdf and AC function of white noise

6.3 Passage of wide-sense stationary random signals through a LTI

6.4 Ideal low-pass and RC filtering of white noise, noise equivalent bandwidth of a filter

6.5 Optimum detection of a pulse in additive white noise, the matched filter. Realization of matched filters (time co-relaters). The matched filter for a rectangular pulse, ideal LPF and RC filters as matched filters

6.6 Performance limitation of baseband data communications due to noise, error probabilities in binary and M-ary baseband data communication.

7. Noise performance of band-pass (modulated) communication systems (8 hours)

7.1 Effect of noise in envelop and synchronous demodulation of DSB-FC AM, expression for gain parameter (ratio of output SNR to input SNR), threshold effect in non-linear demodulation of AM

7.2 Gain parameter for demodulations of DSB-SC and SSB using synchronous demodulators

7.3 Effect of noise (gain parameter) for non-coherent (limiter-discriminator-envelop detector) demodulation of FM, threshold effect in FM. Use of pre-emphasis and de-emphasis circuits in FM.
7.4 Comparison of AM (DSB-FC, DSB-SC, SSB) and FM (Narrow and wide bands) in terms power efficiency, channel bandwidth and complexity.
7.5 Noise performance of modulated digital systems. Error probabilities for ASK, FSK, PSK, DPSK with coherent and non-coherent demodulation.
7.6 Comparison of modulated digital systems in terms of bandwidth efficiency, power efficiency and complexity.

8. Error control coding techniques (4 hours)

8.1 Basic principles of error control coding, types, basic definitions (hamming weight, hamming distance, minimum weight), hamming distance and error control capabilities
8.2 Linear block codes (systematic and non-systematic), generation, capabilities, syndrome calculation
8.3 Binary cyclic codes (systematic and non-systematic), generation, capabilities, syndrome calculation.
8.4 Convolutional codes, implementation, code tree, trellis and decoding algorithms.

Practical:

1. Study of line codes
2. Study of PCM
3. Study of DPCM
4. Study of DM
5. Study of ASK, FSK and PSK
6. Study of eye diagram

References:

1. S. Haykin, "Analog and Digital communication systems", latest editions
2. Leon Couch, "Digital and analog communication systems", latest edition
3. B.P.Lathi, "Analog and Digital communication systems", latest edition
4. J. Proakis, "Analog and Digital communication systems", latest edition
5. D. Sharma, Course manual "Communication Systems II".