The University Of Sheffield.

Electronic & Electrical Engineering.

EEE6222 ADVANCED COMMUNICATION PRINCIPLES

Credits: 15

Course Description including Aims

This course considers the mathematical foundations and the derived theories and techniques used by a wide range of communication systems, particularly the more recent digital systems. The aim of this course is to

1. Provide the very mathematical foundation for understanding modern communication systems.
2. Present the structure of modern communication systems and the basic issues at each stage in the system.
3. Create a theoretical background that applies to all communication systems and is not affected by any particular technology.

Outline Syllabus

Components of a typical communication system. Discrete-time samplimg and frequency domain representation. Random signals. Power Spectrum Estimation. Formatting and source encoding. Information and entropy. Channel capacity. Hartley-Shannon law. Probability of error in transmission. M-ary signalling. Types of transmission channel and their limitations. Maximum Likelihood receiver. Matched Filter. Methods of Transmission. Methods of synchronisation. Multiplexing and multiple access. Spread spectrum objectives and techniques.

Time Allocation

36 lectures plus 12 hours of additional support material.

Recommended Previous Courses

Assessment

3 hour examination, answer 4 questions from 6.

Recommended Books

Sklar, B.	*Digital Communications*	Prentice-Hall
Roden, M.S	*Digital Communication Systems Design*	Prentice-Hall
Brewster, R.L.	*Telecommunications Technology*	Ellis Horwood
Young P.H.	*Electronic Communication Techniques*	Macmillan
Lee W.C.Y.	*Mobile Communications Design Fundamentals*	Wiley

Objectives

By the end of this module students will be able to

1. Understand that communication is the process of exchanging information.
2. Understand the key basic mathematical concepts underpinning communication systems
3. Understand the function of the key building blocks of a generic digital communication system and the main techniques used for each block calculate the information content and coding efficiency of a message and where possible, reduce (or compress) the average code length of the message.
4. Display familiarity with techniques that maximise spectrum utilisation.
5. Understand how noise limits the information rate and to be aware of techniques that maximise signal detection in the presence of noise.
6. Appreciate the fundamental nature of the trade-off between error performance and bandwidth in a communications system.
7. Describe current technological advances and show how they allow a closer approximation to theoretical information capacity limits.

Detailed Syllabus

1. Introduction to principles of communication; historical summary, digital vs analog, bandwidth, block diagram and components of a typical communication system.
2. Random variables, distribution function, probability density function, conditional distributions, joint and marginal distributions. Expectation, moments.
3. Information and entropy, channel capacity, Hartley-Shannon law, probability of error in transmission, SNR performance, M-ary signalling.
4. Discrete sampling; frequency domain representation of signals; power spectrum estimation.
5. Formatting and source encoding; sampling, errors, PCM, companding, voice techniques, redundancy-reducing coding, Huffman code, coding for fax.
6. The channel: media, noise and interference, distortion.7.. The Maximum Likelihood receiver and matched filtering
8. Transmission: Modulation and demodulation
7. Synchronisation: levels of synchronisation, methods of symbol and frame synchronisation, Barker and Willard sequences.
9. Multiplexing and multiple access: FDMA, TDMA, comparing FDMA and TDMA, CDMA, space and polarisation division MA.
10. Spread spectrum objectives, pseudonoise sequences, processing gain, frequency, hopping, robustness and frequency diversity, fast versus slow hopping.

UK-SPEC/IET Learning Outcomes

Outcome Code	Supporting Statement
SM1m / SM1fl	Information measurement, necessity of modulation, error correction, moving from analogue systems to digital ones. (assessed by examination)
SM2p	Study of information theory and its application in source coding and channel capacity calculation. (assessed by examination)
SM2m / SM2fl	The study of statistics and its use in the derivation of the channel capacity, the study of central limit theorem and its demonstration based on computer simulations; the linear time invariant channel model and its limitation. (assessed

	by examination)
SM4m	The development of OFDM and MIMO based techniques in the evolution of modern communication systems. (assessed by examination)
EA1m / EA1fl	Understanding the operation of TDMA and FDMA and analyse their message delays. Study of coding theory and the variable-length coding schemes such as the Huffman and Shannon-Fano codes and applying them to different scenarios of data compression and also for assessing the performance of different codes. (assessed by examination)
EA2fl	Understand the operation of MIMO system using fundamental knowledge about matrix operations. (assessed by examination)
EA2m	Using error model to calculate the probability of error of a cascaded channel; Markov model for sources with memory. (assessed by examination)
EA3m	Apply MAP and ML detectors to a specific detection problem and their limitations. (assessed by examination)
EA5m	Understand the operation of MIMO system using fundamental knowledge about matrix operations. (assessed by examination)
EP6p	The μ-law and A-law in speech processing. (assessed by examination)