The University Of Sheffield.

Electronic & Electrical Engineering.

EEE317 PRINCIPLES OF COMMUNICATIONS

Credits: 10

Course Description including Aims

This course considers the theory and techniques used by a wide range of communication systems, particularly the more recent digital systems.

The main aim is to create a theoretical background that applies to all communication systems and is not affected by any particular technology.

Outline Syllabus

Noise in AM and FM Modulation Systems. Comparison of analogue and digital modulation techniques. Matched filtering. Information and entropy. M-Ary signaling. Error correction. Spread spectrum objectives and techniques. PN codes. Examples of digital communication systems. Guest lecturer material will provide information on design of modern systems and commercial context.

Time Allocation

24 lectures plus 12 hours of additional support material.

Recommended Previous Courses

Mathematical knowledge equivalent to AMA242 "Mathematics III" is useful. Knowledge equivalent to EEE224 "Communication Electronics" is essential

Assessment

2 hour examination, answer 3 questions from 4

Recommended Books

Sklar, B	*Digital Communications, 2nd ed*	Prentice-Hall
Young, P.H	*Electronic Communication Techniques, 3rd ed*	Prentice-Hall
Ziemer	*Introduction to digital communications, 2nd ed*	Prentice-Hall
Benoit	*Digital television, 2nd ed*	Elsevier

Objectives

By the end of the unit a successful student will be able to

1. Calculate the signal to noise performance for a range of analogue modulation systems.
2. Understand that the signal to noise performance of an FM system can change abruptly with received signal strength, and the benefits of pre-emphasis and de-emphasis FM systems.
3. Understand what is meant by a matched filter as well as being familiar with various implementations thereof.
4. Understand what is meant by information and entropy, as well as some techniques to increase effective signalling speed of a channel.
5. Calculate the probability of error and know of some techniques to improve the error performance of a communications link.
6. Demonstrate familiarity with the properties and use of PN codes.
7. Display knowledge of some basic SS architectures and the benefits they offer.
8. Show awareness of some forms of M-Ary signalling and the inherent trade-offs between signalling speed and bandwidth efficiency.
9. Understand how the architecture and mode of operation of a COFDM system improves performance.

Detailed Syllabus

1. Calculation of noise in AM and FM systems, threshold effect in FM, pre-emphasis and de-emphasis systems. Relative merits of analogue and digital modulation techniques.
2. Principle of matched filtering. Mathematical description of a matched filter Transversal filter, integrate and dump matched filter, correlator receiver and matched filter for PCM codewords.
3. Information and entropy. Source coding including examples of Huffman and Psycho-acoustic encoding.
4. Probability of error. Simple parity checks, brief description of RS and convolutional codes. Use of Forney interleaving to increase code efficiency. Hard and soft decisions.
5. Properties of PN codes, generation of PN codes. Special PN codes.
6. Benefits of SS systems. DSSS systems, searching and tracking circuits, resistance to interference. FHSS systems, coding gain. Scrambling in DAB systems, conditional access.
7. M-Ary signalling. BPSK, waveforms, spectra and bandwidth efficiency. QPSK, spectra, bandwidth efficiency, variants (OQPSK, DQPSK, MSK, GMSK). M-PSK, robustness vs. bandwidth efficiency. QAM, generation, vector addition, BER vs. CNR, trade-offs.
8. COFDM systems. Why AM and FM has problems. How FDM helps combat multipath. Orthogonality. Guard intervals. Limits of multipath rejection, Single frequency networks. Architecture of a basic system, discussion of how data is structured in time and frequency. Robustness – CSI and its use in decoding, time + frequency interleaving and how this helps combat selective fading. Discussion of DAB, DVB-T, DVB-H, DMB and DRM.

UK-SPEC/IET Learning Outcomes

Outcome Code	Supporting Statement
SM1p	Study the signal to noise ratio in analogue communication system and derive the required equations. Comparison of digital and analogue communication system. This will be assessed by a formal exam.
SM1m	Learn the fundamental components of a digital communication system such as source and channel coding, spread spectrum, match filters as well as M-ary signalling. This will be assessed by a formal exam.
SM2p/SM2m	Detailed mathematical description of the match filter and how the physical meaning of the equations and their subsequent use in the design of a matched filter. This will be assessed by a formal exam.
SM3p/SM3m	Learn how to use probability theory in errors predictions and study method to minimise those errors. This will be assessed by a formal exam.
EA1p	Study the information theory and use it in data compression using a number of coding techniques such as Huffman coding. This will be assessed by a formal exam.
EA1m	Understanding of engineering principles and the ability to apply them to undertake critical analysis of key engineering processes. Learn the principles of orthogonal and non-orthogonal M-ary signalling and apply them to analysed and decide which is more suitable for a particular communication system. This will be assessed by a formal exam.
EA2p	Ability to evaluate the properties of pseudo noise codes using a defined procedure. Describe the signal to noise ratio performance at the output of AM and FM modulators using the relevant derived equations. This will be assessed by a formal exam.
EA2m	Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques Learn how to calculate the achievable SNR improvement at the output of a demodulator using mathematical equations for AM and FM modulations techniques. This will be assessed by a formal exam.
EA3p	Learn how to compress data streams using Huffman or run length coding. This will be assessed by a formal exam.
EA3m	Use the mathematical description of the matched filter to design a correlate receiver that can be used to detect arbitrarily shaped signals. Explain the capabilities and limitations of matched filters in detecting PCM codewords.
D2m/D2p	Study the detailed operation of MFSK and MPSK and evaluate the performance and constraints of each. Understand when to use MFSK or MPSK in practice. This will be assessed by a formal exam.
D3p / D3m	Work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies. Learn about the presence of random noise, or jamming signals, during the communication process and how to employ spread spectrum solutions in the design to minimise these effects. This will be assessed by a formal exam.
ET2p /ET2m	Understand the commercial applications of PN codes and study the widely used

	commercial PN sequence that is known as Barker code. This will be assessed by a formal exam.
ET3p/ET3m	Understand how an engineer can decide on choosing MFSK or MPSK in a practical problem. This will be assessed by a formal exam.
EP6p / EP6m	Learn COFDM systems and DAB, DVB-T, DVB-H, DMB and DRM. . This will be assessed by a formal exam.