ELEC321 - Communication Systems (3 Credit Points)

Unit Outline

1. Introduction

ELEC321 is compulsory for some BTech students, but is also available to all students with the relevant prerequisites. These include electronics, to ensure a knowledge of basic circuits and their behaviour, and mathematics, because of the considerable maths content of communication theory.

2. Aims

Students will examine communication systems with an emphasis on the systems rather than the circuit aspects, but mainly dealing with the physical level rather than the higher levels of the network model. Both analogue and digital techniques (the latter being the staple of fibre-optic systems) will be included. The general topics to be covered are listed as below:

week 1 -
1. Introduction to Signals and Operations
2. Review of Fourier Series
3. Fourier Transform

week 2 -
4. Classification of Systems, Impulse Response, and Transfer Function
6. Amplitude Modulation and Demodulation

week 3 -
7. Double-Sideband Modulation
8. Single-Sideband and Vestigial-Sideband Modulation
9. Angle Modulation

week 4 -
10. Wideband Frequency Modulation
11. Angle Modulation
12. Sampling Theorem, Pulse-Amplitude Modulation, and Time-Division Multiplexing

week 5 -
14. Pulse Code Modulation
15. Quantisation Noise and Nonuniform Quantisation
16. -

week 6 -
17. Delta Modulation
18. Examples of Time Division Multiplexed PAM and PCM Systems
19. Waveform Shaping and Eye Patterns

week 7 -
20. Line Coding
21. Orthonormal Representation of Signals
22. Amplitude-Shift Keying (ASK) Modulation

week 8 -
23. Phase-Shift Keying (PSK) Modulation
24. Frequency-Shift Keying (FSK) Modulation and Quadrature Amplitude Modulation (QAM)

week 9 -
25. Spectral Representation of Random Signals
26. Performance of Binary Baseband Signals in the Presence of Noise
27. Random Signals Through Linear Systems and Matched-Filter Detection

week 10 -
28. Narrowband Noise Representation
29. Output Signal-to-Noise Ratios in AM and FM
30. Signal Space Analysis of BASK, BFSK, BPSK, and QAM

week 11 - 31. Concept of Information and Entropy
32. Shannon Information Capacity Theorem and Implications
33. -

week 12 - 34. Lossless Source Coding - Huffman and Shannon-Fano Coding
35. Encoding of Linear Block Codes
36. Examples and Modifications of Linear Block Codes

week 13 - 37. Syndrome Decoding and Performance of Block Codes
38. Polynomial and Matrix Descriptions of Cyclic Codes
39. Encoding and Syndrome Decoding of Cyclic Codes

Practical work will support the theory and will take various forms, from examining the behaviour of simple functional blocks, to constructing small systems, to simulating larger systems.

3. Textbook

There is no formal textbook. Most of the teaching materials were based on the book by Mischa Schwartz, 'Information Transmission, Modulation, and Noise', 4/e, McGraw-Hill, 1990. Other books may be used by students as background reading. For further readings, try:

[1] Hsu, H. P., ‘Schaum’s Outlines of Theory and Problems of Analog and Digital Communication’, McGraw-Hill, 1993.

[2] Couch, Leon W., II, 'Digital and Analog Communication Systems', 5/e, Prentice-Hall, 1997.

[3] Haykin, S., ‘Communications Systems’, 4/e, J. Wiley & Sons, 2001.

[4] Sklar, B., 'Digital Communication : Fundamentals and Applications', Prentice-Hall, 1988.

[5] Gibson, J. D., 'Principles of Digital and Analog Communication', 2/e, MacMillan, 1993.

4. Lectures

There are three lectures per week, which will fairly closely follow the timetable in section 2. Accordingly some material will be omitted and some will not be covered so thoroughly.

5. Assignments

One form of assignment will consist of preparation for practical sessions. This will apply to all sessions to some extent, while at times formal preparation will be a requirement for attendance.

Another form of assignment will consist of preparation for tutorial sessions. At each tutorial session a list of problems, mainly from Schwartz, will be supplied; these will normally cover the topics of the previous three lectures. Students should submit written answers to these problems at least an hour before the next tutorial session. They will (obviously) not be marked, but a record will be kept of each reasonable submission, and the two or three problems which caused most difficulty noted. At the tutorial session a student may be selected to demonstrate (or at least lead a discussion on) how each of the selected problems may be answered.

The overall tutorial record will affect the final result of students who would otherwise be on the borderline of two grades. Finally, it is possible that there will be a more substantial

revision assignment, due back soon after the break. This may well attract some marks (up to 10%) towards the final grade, but this is yet to be decided.

6. Practical Sessions

Each student must attend weekly 3-hour sessions, initially using equipment which performs the various functions at an abnormally low frequency to keep the cost low while still illustrating the principles; later sessions use a workstation running a package capable of simulating a wide variety of systems; still later we study more complex systems at a low frequency. No student without proper shoes will be admitted to the laboratory, for insurance reasons. (That is, no bare feet, no thongs, no sandals.)

7. Tutorials

Each tutorial session will normally be started by the tutor's inviting and answering questions based on the lectures of the previous week, or perhaps on the last or next practical session. The main business, however, will be to discuss the answers to the problems set at the previous tutorial session - see section 5.

8. Assessment

Unless assignments play a bigger part in ELEC321 than is envisaged at the time of writing this outline (see section 5), assessment will consist of:

practical work	25%
final examination	75%
Total	100%

Also, attendance at practical sessions is regarded as compulsory. To be precise, any student who is absent from more than two sessions may be regarded as not complying with requirements, and not permitted to sit for examination. Documented evidence that such attendance was substantially impossible, for example because of protracted illness, may, of course, allow this requirement to be relaxed.

9. Closed-book Examination

A closed-book written examination of 3 hours duration will be conducted. Calculators will be permitted in the examination according to the policy of the Division of Information and Communication Sciences.

Exclusion

Students may be excluded from sitting for the examination if they fail to complete the assignments satisfactorily.

Special Examinations

See Bachelor Degree Rule 9: Regarding unavoidable disruption to performance in the final examination. Students with unsatisfactory results in the tutorial sessions **OR** laboratory sessions will **not** be offered a supplementary examination.

Plagiarism

Instances of plagiarism will be punished by the awarding of negative marks.

10. Lectures and Other Materials

Most of these (in .pdf format) are available at the following website:

http://www.elec.mq.edu.au/~cl/teaching.html.

You will need a recent version of the Adobe Acrobat Reader to read them.

11. Generic Skills

If you take full advantage of the lectures, the tutorial and practical sessions, and the assignment, then you should expect to gain or reinforce the following generic skills:

- Management of complexity; communication systems are often very complex, and it is normally necessary to make carefully chosen approximations to analyse them.
- Mathematical ability; both the theory and the practical sessions involve application of mathematics from a range of areas.
- Observation and measurement; in the practical sessions you will test circuits whose properties you predicted in a lecture session, and will need to find reasons for discrepancies.
- Report writing; while it will not be formally tested, there will be tests to check that each report is a good record of your practical work.
- General knowledge; you will appreciate the background of communication system design techniques that have done much to shape the modern world.
- Time management; Communication Systems builds up a tree of knowledge, and you will need to study regularly to understand and absorb this developing theory.

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