The Hong Kong University of Science and Technology

UG Course Syllabus

Signal Processing and Communications

ELEC 3100

4 Credits

Prerequisite(s): (ELEC 2100 OR ELEC 2100H) AND (ELEC 2600 OR ELEC 2600H)

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Course Description

The course provides a comprehensive overview of signal processing and communications using quantitative modeling and analysis. Topics include: 7 layer communications model, discrete Fourier transform and z-transform, IIR and FIR filter design techniques and realizations, complexity and implementation considerations of FFT and FIR/IIR, source coding, digital modulation, PSD and spectrum, effects of noise to communication system designs, detection theory, matched filter, signal space and error analysis, channel models and channel coding. Application examples are provided to illustrate on how practical communication systems are designed using these quantitative tools. Design projects are set up so that the students can apply theory learnt in the class to physical problems. MATLAB CAD tools are being used as an integral part of this course.

List of Topics

Week 1. Introduction and Discrete-Time Signals

Week 2. Discrete-Time Systems and DTFT for DT Signals and Systems

Week 3. Discrete Fourier Transform

Week 4. Fast Fourier Transform and z-Transform

Week 5. z-Transform

Week 6. FIR Filter Design and Digital Filter and Source Coding

Week 7. Source Coding

Week 8. Channel Coding

Week 9. Baseband Communications and Noise and Optimal Receiver

Week 10. Optimal Receiver and Digital Modulation

Week 11. Digital Modulation and Signal Space

Week 12. Signal Space

Week 13. Channel Models and Multiplexing and Multiple Access

Laboratory Outline

1. CT and DT signals

2. Introduction to DFT

3. Convolution and Filter

4. Information theory

5. BER simulation

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1 - Understand the modeling of communication links as well as understand why we are interested to study communication systems.

2 - Be familiar with both mathematical and qualitative concepts regarding analog communication systems as well as digital communication systems.

3 - Understand the difference, pros and cons between analog and digital communication systems

4 - Understand how practical communication systems (analog and digital) are designed as well as explaining why these systems are designed that way.

5 - Understand how to utilize the mathematical tools of random variables and random process to quantify the performance of communication systems under noise.

6 - Use software tools (such as Matlab) to design and quantify the performance of communication systems

7 - Apply the concept of signal space to qualitatively explain the design of digital communication systems.

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for each assignment are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	Contribution to Overall Course grade (%)
Homework	10%
Laboratory	15%
Mid-term Examination	30%
Final examination	45%

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits

		a high capacity for scholarship and collaboration, going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn and the ability to work effectively with others.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.
F	Fail	Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Course AI Policy

Use of generative artificial intelligence tools is allowed provided that the use is declared. Note that the asse ssment tasks will be evaluated by human beings.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Required Texts and Materials

Textbooks

Sanjit K. Mitra, "Digital Signal Processing", McGraw-Hill, 4th Ed., 2011.

John G. Proakis, "Digital Communications", 5th Ed., 2008.

Reference Books/Materials

R.E. Ziemer and W.H. Tranter, "Principles of Communications: Systems, Modulation, and Noise", Wiley, 6th Ed., 2009.

F.G. Stremler, "Introduction to Communication Systems", Addison-Wesley, 3rd Ed., 1990.

S. Haykin, "Communication Systems", Wiley, 4th Ed., 2001.

S. Haykin "An Introduction to Analog and Digital Communications", Wiley, 1989.

A.B. Carlson, "Communication Systems: An Introduction to Signals and Noise in Electrical Communication", McGraw Hill, 5th Ed., 2010.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry for the University's definition of plagiarism and ways to avoid cheating and plagiarism.