

The Hong Kong University of Science and Technology

UG Course Syllabus Template

Error-Correcting Codes and Basic Information Theory

ELEC4010U

3 Credits

Pre-requisite: ELEC1200

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Office Hour (tentative): 13:30 – 14:30 (Thu) in Room 2451, and email inquiries are welcome anytime

Course Description

This course gives an introduction to error-correcting codes and basic information theory, which have been one of the key driving forces of the Digital Revolution and are indispensable tools in designing modern communication and storage systems.

Key topics in error-correcting codes: linear block codes; cyclic block codes (CRC & BCH codes) and syndrome decoding; convolutional codes and Viterbi decoding; interleaving for burst error correction; advanced coding topic(s)

Key topics in basic information theory: information measures (entropy & mutual information); source coding bound; channel capacity.

Intended Learning Outcomes (ILOs)

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

ILO1: Apply knowledge of discrete mathematics, probability, and the coding principle to solve communication/storage system design problems

ILO2: Use a coding and information-theoretic approach to formulate communication/storage system design problems

ILO3: Recognize and understand common coding-related terminology in technical specifications and standardization documents

ILO4: Conduct a presentation and/or complete a course project related to the development and applications of coding schemes

ILO5: Use software tools to simulate coding schemes and evaluate them based on theoretical bounds and practical system performance measure

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:

[List specific assessed tasks, exams, quizzes, their weightage, and due dates; perhaps, add a summary table as below, to precede the details for each assessment.]

Assessment Task [#]	Contribution to Overall Course grade (%)	Due date (tentative)
Homeworks	20%	10/10/2025*, 24/10/2025*, 11/11/2025 *
Project tasks	40%	21/11/2025*, 23/12/2025*
Term exam	40%	24/11/2025*

[#] Assessment marks for individual assessed tasks will be released within two weeks of the due date; unless stated otherwise.

* Assignment due dates & term exam date are tentative and shown for reference only. Please refer to the Canvas announcements for the finalized dates.

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Homeworks	ILO1, ILO2, ILO3	Homeworks assess students' ability to apply coding and information theoretic knowledge to formulate problems (ILO 2), solve problems (ILO 1), and understand coding-related terminology in technical specifications (ILO 3).
Term exam	ILO1, ILO2, ILO3	Term exam assesses students' ability to apply coding and information theoretic knowledge to formulate problems (ILO 2), solve problems (ILO 1), and understand coding-related terminology in technical specifications (ILO 3).
Project tasks	ILO3, ILO4, ILO5	Project tasks assess students' ability to understand coding-related terminology in technical spec (ILO 3), address project tasks related to developing & applying coding schemes (ILO 4), and use software tools to simulate coding schemes and benchmarking them against theoretical and practical performance limits.

Grading Rubrics (Project)

	A	B	C	D	F
Linear block code encoder & Syndrome decoder software development	Works for all standard test vectors. Code is modular, well-documented.	Works for all standard test vectors. Code is readable but lacks full documentation.	Correctly works for most but not all error patterns.	Only works for special cases. Significant logical gaps.	Non-functional code. Produce garbage output.
Word error rate (WER) simulation of linear block code over AWGN channel and verify against WER bound	Simulation produces smooth and reliable WER curves. Comparison to bound shows expected variations only.	Simulation produces a plausible WER curve. Comparison to bound shows some deviation.	Simulation runs but produces unexpected results. Comparison to bound contains errors.	Simulation produces no WER curve. Comparison with WER bound is missing.	No simulation results. No verification against WER bound.
Design and develop block interleaving scheme for use with BCH & LDPC encoder/decoder	Correct interleaver / deinterleaver implementation. Interleaving parameters are appropriately chosen for the target channel, encoder and decoder.	Interleaver / deinterleaver implemented, but has minor issue. Design choices acceptable but not well-justified.	Interleaver / deinterleaver implemented, but only works for trivial cases.	Interleaver / deinterleaver implemented, but does not work in the presence of burst error.	No working interleaver / deinterleaver. Produce incorrect output for all test inputs.
Measure and compare the burst error vector lengths of these two schemes in a practical barcoding channel	Correct burst length measurement for both schemes. Insightful comparison explaining the superiority of one burst error correction scheme to the other one.	Burst length measurement performed for both schemes. Comparison lack detailed explanation.	Burst length measurement attempted but results are inconsistent. Comparison is superficial.	Burst length measurement results clearly incorrect. No meaningful comparison.	No burst error measurement results. Produce incorrect output for all test inputs.
Report / presentation	Professional report / presentation with thorough discussion. Correctly use coding terminology from standards.	Report / presentation contains all necessary information but some part lacks depth. Terminology mostly correct.	Report / presentation is adequate but incomplete. Some terminology errors.	Report / presentation is minimal. Many basic terminology errors.	No meaningful report or presentation.

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a precise and comprehensive grasp of subject matter, expertise in applying key coding concepts to solve new problems. Exhibits a high capacity for devising logically consistent and rigorous solutions with clear justifications for each step, going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in applying key coding concepts in problem-solving. Displays high motivation to learn and the ability to devise logically consistent and well-justified solutions.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar coding problems, and some capacity for devising logically consistent solutions. Shows persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to understand key coding concepts, and the ability to identify solution to familiar coding problems. 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 skills to understand key coding concepts. Shows limited ability to solve familiar coding problems and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for development in the discipline.

Course AI Policy

Students are encouraged to use Generative AI tools to assist learning. However, for assessment tasks, you are prohibited from directly copying answers from AI without working out and writing up your own answers.

Communication and Feedback

- Homeworks, term exam, and project tasks assessment marks will be communicated via Canvas within two weeks of submission
- Students who have further questions about the feedback, including raising an appeal on marks, should consult the instructor/teaching team within one week of receiving the feedback.

Late Submission Policy

To ensure fairness for students who submit assignments on time, the following penalty arrangement for late submission of homeworks and project reports will be applied.

- Late submission within 24 hours, 10% penalty will be applied
- Late submission between 24 to 48 hours, 20% penalty will be applied
- Late submission for more than 48 hours will not be accepted.

Required Texts and Materials

There is no required textbook, but there are many useful reference books, including but not limited to the following.

1. H. Charles Lee, "Error-Control Block Codes for Communications Engineers," Artech House, 2000. (readable, available via HKUST library)
2. C. Moreira and P. G. Farrel, "Essentials of Error-Control Coding," Wiley, 2006. (Also readable, available in HKUST library)
3. Ranjan Bose, "Information Theory, Coding and Cryptography," Tata McGraw-Hill, 2nd Edition, 2008. (Contains many examples)
4. Bernard Sklar, "Digital Communications: Fundamentals and Applications," Prentice Hall, 2nd Edition, 2001. (Very readable)
5. William E. Ryan and Shu Lin, "Channel codes: Classical and Modern," Cambridge University Press, 2009. (Authoritative, extensive coverage of advanced coding like Turbo & LDPC codes)
6. Roger E. Ziemer and Roger L. Peterson, "Introduction to Digital Communication", 2nd Edition, 2001. (With 2 quick-to-read chapters on the topic)

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.