Jordan University of Science and Technology

Faculty of Engineering

Electrical Engineering Department

EE752 Error Control Coding - JNQF Level: 9

First Semester 2023-2024

Course Catalog
3 Credit Hours. Fundamentals of coding theory in digital communications. Topics include introduction to abstract algebra field theory, linear block codes, soft and hard decision decoding, correction of random errors, cyclic codes, BCH and Reed-Solomon codes, LDPC, convolutional codes, maximum likelihood decoding, and sequential decoding of convolutional codes, and parallel concatenated codes. Design and implementation for a digital communication system
Teaching Method: On Campus

Text Book	
Title	Error Control Coding
Author(s)	S. Lin and D. Costello, Jr.
Edition	2nd Edition
Short Name	Required Textbook
Other Information	Pearson Prentice Hall, Englewood Cliffs, N.J., 2004.

Course References

Short name	Book name	Author(s)	Edition	Other Information
Ref. 1	Error Control Systems for Digital communication and Storage	S. Wicker	2nd Edition	Prentice-Hall, Inc., Simon & Schuster, N.J., 1995
Ref. 2	Algebraic Codes for Data Transmission	R. Blahut	1st Edition	Cambridge University Press 2003.
Ref. 3	Applied Coding and Information Theory for Engineers	R. Wells	1st Edition	Prentice-Hall, Inc., Englewood Cliffs, N.J., 1999.
Ref. 4	Error Correction Coding: Mathematical Methods and Algorithms	Moon Todd K.	1st Edition	John Wiley & Sons, Inc, 2005
Ref. 5	Iterative Error Correction	S. J. Johnson	1st Edition	Cambridge, 2010.

Ref. 6	The Theory of Error-Correcting Codes	F. J. MacWilliams and N. J.A.Sloane,	1st Edition	North Holland, 1977

Instructor	
Name	**Dr. Ibrahim Ghareeb**
Office Location	E1L3
Office Hours	Sun : 08:00 - 08:30 Sun : 13:00 - 14:00 Mon : 08:00 - 09:00 Tue : 08:00 - 08:30 Tue : 11:30 - 14:30 Thu : 08:00 - 08:30
Email	ghareeb@just.edu.jo

Class Schedule & Room
Section 1: Lecture Time: Sun, Tue, Thu : 10:30 - 11:30 Room: LAB

Tentative List of Topics Covered

Weeks	Topic	References
Week 1	Introduction to Error Control Systems	**Chapter 1** From **Required Textbook**
Weeks 2, 3	introduction to abstract algebra and field theory	**Chapter 2** From **Required Textbook**
Week 4	Linear Block Codes, Encoding and Decoding	**Chapter 3** From **Required Textbook**
Week 5	Performance Analysis of linear block codes; Repetition and Hamming Codes	**Chapters 3, 4** From **Required Textbook**
Week 6	Cyclic Codes: Encoding of Cyclic Codes	**Chapter 5** From **Required Textbook**
Week 7	Cyclic Codes: Decoding of Cyclic Codes	**Chapter 5** From **Required Textbook**
Week 8	BCH Codes: Encoding and Decoding of BCH Codes	**Chapter 6** From **Required Textbook**
Week 9	Non-binary BCH Codes and Reed-Solomon Codes	**Chapter 7** From **Required Textbook**
Week 10	Convolutional Codes: Encoding, Catastrophic Codes	**Chapter 11** From **Required Textbook**

Week 11	Convolutional Codes: State Diagrams, Trellises	**Chapter 11** From **Required Textbook**
Week 12	Maximum-Likelihood Decoding, the Viterbi Algorithm	**Chapter 12** From **Required Textbook**
Weeks 13, 14	Performance Bounds , Soft-Decision Decoding: Maximum A Posteriori (MAP) Decoding	**Chapter 12** From **Required Textbook**
Week 15	Low-Density Parity Check (LDPC) codes: Sum-Product Decoding LDPC Encoding and Code Design, Min-Sum Decoding	**Chapter 17** From **Required Textbook**

Mapping of Course Outcomes to Program Outcomes and NQF Outcomes	**Course Outcome Weight (Out of 100%)**	**Assessment method**
Explain the need for error correction in data communication and storage systems. [1SO1] [1L9K1]	10%	
Apply mathematical tools from group and finite field theory in the design of codes and sequences. [1SO1] [1L9K2]	10%	
Design an error correcting code for a given application. [1SO2] [1L9S3]	20%	
Describe the fundamental limits of error correction. [1SO2] [1L9S1]	10%	
Demonstrate the decoding of block codes including cyclic codes BCH and Reed-Solomon codes. [1SO1] [1L9K2]	20%	
Explain the operation of a convolutional encoder. [1SO1] [1L9S2]	10%	
Apply the Viterbi algorithm to decode a convolutional code [1SO2] [1L9K2]	20%	

Relationship to Program Student Outcomes (Out of 100%)						
SO1	SO2	SO3	SO4	SO5	SO6	SO7
50	50					

Relationship to NQF Outcomes (Out of 100%)				
L9K1	L9K2	L9S1	L9S2	L9S3
10	50	10	10	20

Evaluation	
Assessment Tool	**Weight**
Midterm exam	20%
Assignments and Participation	15%
Project	15%
Final Exam	50%

Policy	
Exams and Assignments Policy:	Midterm exam during exam period, one and half hours, problem solving, closed book (covers Weeks 1-7). Final exam, during exam period, two hours, and closed-book (covers all chapters). . There will be some assignment problems for each chapter. However, students are expected to solve all assignment problems. Information about these assignments will be posted on the course homepage. Attendance Policy: Policies for student attendance is as of university regulations.
Project Description:	A research project is a part of the course. The goal of the project is to help you get exposed to some interesting research topics in Coding Theory and its applications not covered in the class. It is your choice to select the topic, but you can also pick up a topic from a list of suggested projects and readings included below. Certainly, original research work is preferred. But an in depth literature survey on a relevant topic, or a review of some papers, is also acceptable. You are encouraged to select a topic that is closely related to your area of expertise. Each of student is required to submit and 1-page proposal outlining the project (with some key references), a project report (of about 8-10 pages) and to provide an oral presentation (no more than 20 minutes) at the end of the semester. The (tentative) time line is as follows: - Project proposal must be turned in by the first week of semester. You should meet with the instructor well in advance for a discussion about the chosen topic. - Project report is due on the last week of the semester. - The project presentations shall be organized in the last week of the semester.

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