**Course Description Format**

**TITLE : Introduction to Coding Theory**

**Course Code :**

**Note: Please use course code for previously existing course**

**CREDITS : 3-1-0-2**

**TYPE-WHEN : Spring 2021**

**FACULTY NAME : Lalitha Vadlamani**

**PRE-REQUISITE :** Linear Algebra

**OBJECTIVE :** This course aims to introduce students to the idea that coding theory is a fundamental block of communications systems, whether in the form of real-time communication or in the form of storage. The course will be taught top-down – various current communication systems and storage systems will be shown and the error correcting codes used in those systems will be enunciated upon starting from the basics. The theory required in each will be concurrently covered to a limited extent.

**COURSE TOPICS :**

**(please list the order in which they will be covered)**

* *Introductory Concepts*: Noisy channels, block codes, encoding and decoding, maximum-likelihood decoding, minimum-distance decoding, error detection and correction. Shannon's noisy-channel coding theorem.
* *Linear codes*: Minimum distance, generator and parity-check matrices, dual codes, standard array decoding, syndrome decoding. Repetition codes, Hamming codes.
* *Bounds on Code Parameters*: Hamming bound, Singleton bound, Gilbert-Varshamov bound, Plotkin bound.
* *Basic Finite Field Theory*: Definitions, prime fields, construction of prime power fields via irreducible polynomials, existence of primitive elements, minimal polynomials.
* *Algebraic Codes*: Bose-Choudhury-Hocquenghem (BCH) codes, Reed-Solomon codes. Applications of Reed-Solomon codes in digital communications and storage.
* *Channel Codes in Communication Systems:* Cyclic Codes, Convolutional Codes, LDPC Codes
* *State of the Art and the Future :* Codes for Data Storage Applications, Codes for Distributed Computation, DNA Data Storage

**PREFERRED TEXT BOOKS:**

Lectures will be based on the following reference books in addition to important technical papers.

* R. Roth, Introduction to Coding Theory, Cambridge University Press, 2007
* W.E. Ryan and S. Lin, Channel Codes: Classical and Modern, Cambridge University Press, 2009.
* S. Lin and D.J. Costello, Error Control Coding, Pearson, 2011
* R.E. Blahut, Algebraic Codes for Data Transmission, Cambridge University Press, 2003

**\*REFERENCE BOOKS:**

* F.J. MacWilliams and N.J.A. Sloane, The Theory of Error-Correcting Codes, North-Holland Publishing Company, 1977
* W.C. Huffman and V. Pless, Fundamentals of Error Correcting Codes, Cambridge University Press, 2003

**\*PROJECT:** There will be a paper implementation/presentation as part of this course, based on each student’s capabilities and interests in theory/application. A list of plausible papers will be released mid way through the course, from which the students can select.

**GRADING PLAN:**

|  |  |
| --- | --- |
| **Type of Evaluation** | **Weightage (in %)** |
| Quizzes |  |
| Assignments |  |
| Term paper |  |
| Project |  |
| Open book exam or 30 minute quiz |  |
| Other Evaluation \_\_\_\_\_\_\_\_\_ |  |

**OUTCOME:** At the end of the course, the student is expected to appreciate how coding theory has been and will be instrumental in applications like storage and communications. The student should also be ready to read introductory papers on research topics related to coding theory.

**REMARKS:**