Kadi Sarva Vishwavidyalaya

Faculty of Engineering & Technology

Third Year Bachelor of Engineering (CE/IT)

(In Effect From Academic Year 2019-20)

Subject Code: CT605B-N	**Subject Title:** Information Theory and Coding
Pre-requisite	

Teaching Scheme (Credits and Hours)

Teaching scheme				Total Credit	Evaluation Scheme					
L	T	P	Total		Theory		Mid Sem Exam	CIA	Pract.	Total
Hrs	Hrs	Hrs	Hrs		Hrs	Marks	Marks	Marks	Marks	Marks
03	00	02	05	04	03	70	30	20	30	150

Course Objective:

- Introduce the principles and applications of information theory.
- To teach study how information is measured in terms of probability and entropy, and the relationships among conditional and joint entropies.
- To teach coding schemes, including error correcting codes.
- Explain how this quantitative measure of information may be used in order to build efficient solutions to multitudinous engineering problems.

Outline of the Course:

Sr. No	Title of the Unit	Minimum Hours
1	Introduction to Information Theory and Coding	8
2	Source Coding	10
3	Channel Capacity	8
4	Linear Binary Block Codes	10
5	Error-correcting Code	4
6	Convolutional Codes	4
7	Differential Entropy	4

Total hours (Theory): 48
Total hours (Lab): 32
Total hours: 80

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Detailed Syllabus

Sr. No	Topic	Lecture Hours	Weightage(%)
1	**Introduction to Information Theory and Coding:** Information, Entropy, Information Rate, Information source, Symbols, and Entropy, Entropy of sources and their extension, Lossless image compression, Mutual Information.	8	15
2	**Source Coding:** The source coding theorem, Kraft inequality, Shannon-Fano codes, Huffman codes, Arithmetic Codes, Lempel-Ziv-Welch algorithm.	10	20
3	**Channel Capacity:** Symmetric Channels, Properties of Channel Capacity, Jointly Typical Sequences, Channel Coding Theorem,Continuous and Gaussian channels.	8	15
4	**Linear Binary Block Codes:** Introduction, Generator and Parity-Check Matrices, Single-Parity-Check Codes, Binary Hamming Codes, Error Detection with Linear Block Codes.	10	20
5	**Error-correcting Code:**Cyclic Code,Burst errors, BCH Code, Reed Solomon (RH)Codes.	4	10
6	**Convolutional Codes:** Convolution codes, MLSD and Viterbi decoding algorithm.	4	10
7	**Differential Entropy:** Relation of Differential Entropy to Discrete Entropy, Relative Entropy and Mutual Information, Properties of Differential Entropy and Related Amounts.	4	10
	Total	48	100

Instructional Method and Pedagogy:

- At the start of course, the course delivery information, prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector, blackboard, OHP etc.
- Attendance is compulsory in lecture and laboratory which carries 10 marks in overall evaluation.
- One internal exam will be conducted as a part of internal theory evaluation.
- Assignments based on the course content will be given to the students for each unit and will be evaluated at regular interval evaluation.
- Surprise tests/Quizzes/Seminar/tutorial will be conducted having a share of five marks in the overall internal evaluation.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Experiments shall be performed in the laboratory related to course contents.

Learning Outcome:

On successful completion of this course, the student should be able to:

- Apply information theory and linear algebra in source coding and channel coding
- Understand various error control encoding and decoding techniques
- Analyze the performance of error control codes

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e-Resources:

- https://nptel.ac.in/courses/117101053/
- https://nptel.ac.in/courses/117108097/
- http://web.ntpu.edu.tw/~phwang/teaching/2012s/IT/00index.html

Reference Books:

1. Reza, "An Introduction to Information Theory", Dover 1994
2. R.B.Ash, Information Theory, Prentice Hall,1970
3. David Saloman, Data Compression : The Complete Reference, Springer
4. Khalid Sayood, Introduction to Data Compression, Morgan Kaufmann Publishers
5. R. Hill, "A First Course in Coding Theory", Oxford University Press, 1986
6. R. Bose, "Information Theory, Coding and Cryptography", TMH, 2002
7. Jiri Adamek, Foundation of coding, John Wiley and sons.
8. N. Abramson, Information and Coding, McGraw Hill,1963

List of experiments

No	Name of Experiment
1	Verify Kraft's inequality for binary and ternary codes and generate instantaneous codes.
2	A) Simulate binary Huffman code in SCILAB. B) Find average length, entropy and coding efficiency of the code.
3	Write a SCILAB program that takes in channel transition probability matrix and compute Mutual Information & channel capacity of the discrete memory-less channel.
4	Write a SCILAB program to encode messages for a forward error correction system with a given Linear block code .
5	Write a SCILAB program to encode messages for a system with given Cyclic Polynomial code.
6	Decoding the messages for a system with a given cyclic polynomial code and verifying through simulation.
7	Understanding the concept of loss less data compression technique using Huffman coding
8	Write a SCILAB program to perform BCH encoding and decoding.
9	Write a SCILAB program to perform RS encoding and decoding.
10	Encoding the data bits using a Binary Cyclic block encoder in Simulink/SCILAB.
11	Decoding the code words using a Binary Cyclic block decoder in Simulink/SCILAB.
12	Encoding the data bits using a Binary Linear block encoder in Simulink/SCILAB.
13	Decoding the code words using Binary Linear block decoder in Simulink/SCILAB.
14	Encoding and decoding of convolutional codes in SCILAB.