Techno India NJR Institute of Technology

Course File

Information Theory &Coding

(6EC 4-05)

For Techno India NJR Institute of Technology
पंकज पोरवाल
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(Principal)

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6EC4-05: Information Theory and Coding

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	Basics of information theory, entropy for discrete ensembles; Shannon's noiseless coding theorem; Encoding of discrete sources.	15
3	Markov sources; Shannon's noisy coding theorem and converse for discrete channels; Calculation of channel capacity and bounds for discrete channels; Application to continuous channels.	15
4	Techniques of coding and decoding; Huffman codes and uniquely detectable codes; Cyclic codes, convolutional arithmetic codes.	10
	Total	41

Course Overview:

Students undergoing this course are expected to: • Understand the basics of information theory and coding theories. decoding algorithm. Understand and explain the basic concepts of information theory, source coding, channel and channel capacity, channel coding and relation among them. Understand basic concepts of Error detection and correction code.

Course Outcomes:

CO.NO.	Cognitive Level	Course Outcome
1	Knowledge	Students will define and describe of entropy & Source coding.
2	Comprehension	Students able to distinguish and classify various source coding schemes for data compaction and compare source coding schemes on the basis of code efficiency.
3	Application	Students will apply concepts of block code on transmitting message compute number errors in receiving message.
4	Synthesis	Students will be able to design and develop encoder and decoder for cyclic code, linear block code, convolution code.
5	Evaluation	Students will be able interpret and predict correct receiving message using block codes.

Prerequisites:

1. Fundamentals knowledge of probability.
2. Fundamentals knowledge of sequential and combinational circuit.
3. Fundamentals knowledge of digital communication.

Course Outcome Mapping with Program Outcome:

Course Outcome	Program Outcomes (PO's)											
CO. NO.	Domain Specific					Domain Independent						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	1	1	0	0	0	0	0
CO2	3	3	1	3	1	1	1	0	0	0	0	0
CO3	3	3	1	2	1	1	1	0	0	0	0	0
CO4	3	3	1	2	1	1	1	0	0	0	0	0
CO5	3	3	1	3	1	1	1	0	0	0	0	0
1: Slight (Low) , 2: Moderate (Medium), 3: Substantial (High)												

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	**1**	**INTRODUCTION:** Objective, scope and outcome of the course.
2	**2**	**BASICS OF INFORMATION THEORY**
3	2	Uncertainty and Information
4	2	Average information, Entropy
5	2	Properties of Entropy
6	2	Numerical on Entropy
7	2	Information Rate
8	2	Numerical onInformation Rate
9	2	Conditional And Joint Entropy
10	2	Numerical onConditional And Joint Entropy
11	2	Mutual Information
12	2	Numerical onMutual Information
13	2	Shannon'snoiseless coding theorem: Huffman coding
14	2	Numerical onHuffman coding
15		Shannon'snoiseless coding theorem: Shannon Fano coding
16	2	Numerical onShannon Fano coding
17	**3**	**DISCRETE MEMORY LESS CHANNEL**
18	3	Numerical onmemory less channel
19	3	Numerical onmemory less channel
20	3	Binary Symmetric channel
21	3	Numerical onBinary Symmetric channel
22	3	Numerical onBinary Symmetric channel
23	3	Shannon's noisy coding theorem
24	3	Numerical onShannon's noisy coding theorem
25	3	Numerical onShannon's noisy coding theorem
26	3	Capacity of Gaussion Channel
27	3	Numerical onCapacity of Gaussion Channel

28	3	Numerical onCapacity of Gaussion Channel
29	3	Trade off between signal to noise ratio and bandwidth of channel
30	3	Numerical on Trade off between signal to noise ratio and bandwidth of channel
31	3	Numerical on Trade off between signal to noise ratio and bandwidth of channel
32	**4**	**TECHNIQUES OF CODING AND DECODING**
33	4	Introduction of Huffman codes
34	4	Introduction of uniquelydetectable codes or Variable length codes
35	4	Introduction of prefix coding and Numerical
36	4	Introduction of Linear Block codes
37	4	Numerical on Linear Block codes
38	4	Introduction of Cyclic codes
39	4	Numerical on Cyclic codes
40	4	Introduction of Convolution arithmetic codes
41	4	Numerical on Convolution arithmetic codes

TEXT/REFERENCE BOOKS

1. Digital Communication, Simon Haykin, Wiley.
2. Information Theory & Coding, J.S.Chitode, Technical Publications.
3. InformationTheory,Coding&Cryptography,RanjanBose,McgraHill, Education.

NPTEL COUSES LINK

1. https://nptel.ac.in/courses/108/108/108108168/
2. https://nptel.ac.in/courses/108/102/108102117/
3. https://nptel.ac.in/courses/117/108/117108097/
4. https://nptel.ac.in/courses/117/101/117101053/

Faculty Notes Link

1. https://drive.google.com/drive/folders/1YebO09xgninbiTxUrfLeHZdo2ep4wk9U?usp=sharing

QUIZ Link

1. https://myandroid.site/information-theory-and-coding-multiple-choice-questions/
2. https://www.careerride.com/mcq-tag-wise.aspx?Key=Information%2520Theory&Id=21
3. https://edurev.in/course/quiz/attempt/-1_Test-Information-Theory-Coding/54f0f9c8-0a8d-4f85-9992-229e920ebe27

Assessment Methodology:

1. Two Midterm exams where student have to showcase subjective learning.
2. Final Exam (subjective paper) at the end of the semester.

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Instructions to Candidates:

Attempt all five questions from Part A, four questions out of six questions from Part B and one questions out of three from Part C.

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used /calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL

2. NIL

PART – A

(Answer should be given up to 25 words only) **[5×2=10]**

All questions are compulsory

Q.1 State the channel coding theorem for a discrete memoryless channel.

Q.2 What is prefix coding?

Q.3 Explain channel capacity theorem.

Q.4 Define efficiency of the source encoder.

Q.5 Define mutual information.

PART – B

(Analytical/Problem solving questions) **[4×10=40]**

Attempt any four questions

Q.1 An alphabet set contains 3 letters A, B, C transmitted with probabilities of 1/3, 1/4, 1/4. Find entropy.

Q.2 What is the difference between block codes and convolutional codes?

Q.3 Show that for a discrete binding channel –

$H(x, y) = H(x/y) + H(y)$

$H(x, y) = H(x) + H(y)$

Q.4 Write short note on Noise free channel and Shannon's theorem.

Q.5 Consider a source $S = [S_1, S_2]$ with probabilities 3/4 and 1/4 respectively. Obtain Shannon – Fane code for source S its 2^{nd} and 3^{rd} extensions. Calculate efficiency for each case.

Q.6 What is coding efficiency? Show that coding efficiency is maximum when $P(0) = P(1)$.

PART – C

(Descriptive/Analytical/Problem Solving/Design Questions) **[1×15=15]**

Attempt any one questions

Q.1 The intersection of cyclic codes is cyclic. Find the generator polynomial of $C_1 \cap C_2$.

Q.2 Explain the need of error correcting codes. How its Encoding/Decoding take place? Explain with help of parity example.

Q.3 Write short notes (any two) –

(a) Hamming code and their applications

(b) Fading channel

(c) Huffman coding

(d) Advantages and disadvantages of convolutional codes
