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| **Course Name:** | **Information Theory and Coding Techniques** | **Semester:** | **V** |
| **Date of Performance:** | **20 / 09 / 24** | **Batch No:** | **B - 1** |
| **Faculty Name:** | **Prof Makarand Kulkarni** | **Roll No:** | **16014022050** |
| **Faculty Sign & Date:** |  | **Grade/Marks:** | **\_\_\_ / 25** |

**Experiment No: -6**

**Title:** **Linear Block Code**

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| **Aim and Objective of the Experiment:** |
| 1. To design Encoder and Decoder using Linear Block Code. |

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| **COs to be achieved:** |
| CO3 Students will be able to apply error control coding scheme for reliable transmission of digital data. |

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| **Theory:** | |
| Problem Statement:  Design theoretically a (6, 3) linear block encoder for given the generator matrix and implement the circuit of the encoder and decoder | |
| **Stepwise-Procedure:** |
| **Steps of algorithm:**  Design a digital circuit to implement the above encoder.  **Use open source simulator software: Circuit Verse (Just signup once or login with Google). (You may use LTpsice)**  **Step 1**: Click on the option of “Launch Simulator”, the untitled project window appears.    **Step 2**: Select the project tab of the toolbar and create a new project. Save the project in online mode.    **Step 3**: Select the appropriate input, logic gate and output option from the circuit element palette. Drag and drop the selected option on the project screen.    **Step 4**: Interconnect the placed elements by clicking on the two end-points. The output changes can be visualised in real-time. Note down the corresponding input-output logic    **Step 5:** Observe the code words for all the inputs. Verify using ‘encode’ function of MATLAB.  **Step 6:** Design a circuit (decoder) to evaluate the syndrome from the received code word  **Step 7**: Implement circuit, using software.  import numpy as np  from itertools import product  def encode\_message(message, G):  message\_vector = np.array([int(bit) for bit in message])  codeword = np.dot(message\_vector, G) % 2  return codeword  def print\_codewords(messages, G):  print("Generated Hamming Codes:")  for message in messages:  codeword = encode\_message(message, G)  print(f"Message: {message} -> Codeword: {''.join(map(str, codeword))}")  G = np.array([  [1, 0, 0, 0, 1, 1, 0],  [0, 1, 0, 0, 0, 1, 0],  [0, 0, 1, 0, 0, 1, 1],  ])  n = 3  messages = [''.join(bits) for bits in product('01', repeat=n)]  print\_codewords(messages, G)    G = np.array([  [1, 0, 0, 0, 1, 1, 0],  [0, 1, 0, 0, 0, 1, 0],  [0, 0, 1, 0, 0, 1, 1],  [0, 0, 0, 1, 1, 1, 1]  ])  n = 4    \  C:\Users\Admin\Downloads\unnamed.png  C:\Users\Admin\Downloads\unnamed (1).png  **Input-000**    **Input-001**    **Input-010**    **Input-011**    **Input-100**    **Input-101**    **Input-110**    **Input-111** |

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| **Observations:** |
| The implementation of a (6, 3) linear block code encoder and decoder showcased the efficiency of error control coding in digital communication. By designing the encoder using the specified generator matrix, various input messages were transformed into corresponding codewords, confirming the proper functionality of the circuit. Real-time visualization of input-output relationships facilitated an understanding of how bits are encoded, revealing the redundancy introduced for error detection and correction. The MATLAB encoding function provided a benchmark to validate the manually constructed circuit. The decoder's design effectively evaluated the syndrome from received codewords, highlighting any discrepancies. Overall, the experiment reinforced the concepts of linear block codes, demonstrating their practical applications in reliable data transmission. |

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| **Post Lab Subjective/Objective type Questions:** |
| 1. How does the linear block coding scheme enhance data transmission reliability?   Linear block coding enhances data transmission reliability by introducing redundancy in the transmitted messages, which allows for error detection and correction. In a linear block code, a fixed number of data bits is transformed into a larger set of code bits using a generator matrix, ensuring that specific patterns are followed. This structure means that even if some bits are altered during transmission—due to noise or other interferences—the receiver can identify and correct these errors by analyzing the received code word against known valid patterns. Thus, linear block codes provide a systematic approach to ensuring that digital data remains accurate and reliable over potentially noisy channels, making them crucial in communication systems. |

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| **Conclusion:** |
| By performing this experiment, I understood the design and implementation of a (6, 3) linear block code encoder and decoder. It highlighted how redundancy improves data reliability in digital communication by enabling error detection and correction, reinforcing the practical significance of linear block codes in ensuring accurate data transmission. |

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| **Signature of faculty in-charge with Date:** |