# Round 1

# Experiment Design for Communication Systems Laboratory

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**Department**: ECE

**Discipline**: ECE

**Name of the Lab**: Communication Systems Laboratory (C.S.L)

**Name of experiment**: Pulse Code Modulation (PCM)

**Focus Area**: Experimental Analysis Method

**About the experiment:**

The goal of this experiment is to understand the basic principle of pulse code modulation (PCM) and demodulation and how the analog signal at the transmitter is converted into n-bit binary (digital) using sampler, quantizer and encoder. At the receiver, the baseband signal is retrieved from the encoded binary data by using decoder and reconstruction filter. The required transmission bandwidth, signalling rate and signal to quantization ratio (SQNR) are examined to analyse the performance of PCM system.

**Learning Objectives and Cognitive Level:**

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| --- | --- | --- | --- |
| **S.No.** | **Learning Objectives** | **Cognitive level** | **Action Verb** |
| 1 | Students will be able to define pulse code modulation. | Remember | Define |
| 2 | Students will be able to define the process of sampling, quantization, encoding and decoding for pulse code modulation and demodulation. | Remember | Define |
| 3 | Students will be able to calculate the required transmission bandwidth and signalling rate of PCM signal. | Apply | Calculate |
| 4 | Students will be able to analyse the performance of PCM by varying the frequency and amplitude of the input baseband signal. | Analyse | Analyse |
| 5 | Students will be able to evaluate the signal to quantization ratio (SQNR) of n-bit binary at the PCM output. | Evaluate | Evaluate |

2. **Instructional Strategy**:

**2. 1 Instructional Strategy**: Experiential Learning

**2.2 Assessment Method**: Formative Assessment, Pretest and Posttest (Multiple choice questions)

**2.3 Description of section:**

• Theory aspects for the proposed PCM experiment will be provided for better understanding.

• Step by step procedure to perform the simulation will be given.

• Pretest questions (based on the concept of PCM) & post test questions (based on the observations carried out) will be provided to evaluate the students understanding level.

• Additional reference materials related to PCM modulation and demodulation will be provided.

3. **Task & Assessment Questions**

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Instructions given by the Teacher** | **Tasks to be done by the Students** | **Assessment questions aligned to the task** |
| 1) | State the principle of Pulse code modulation and demodulation. | Click on the theory button to understand the basic principle of pulse code modulation and demodulation. | **Q3** |
| 2) | State the basic elements of PCM and its process. | Click on the procedure button and see the blocks present in the simulator to understand the basic elements of PCM. | **Q1** |
| 3) | Choose the appropriate values of frequency and amplitude of input sine wave and sampling signal and calculate the theoretical values of transmission bandwidth and signalling rate of PCM. | Click on the Sine wave generator and Sampler blocks to set the suitable values of input sine wave and sampling frequency to perform PCM experiment and compute the parameters. | **Q2** |
| 4) | Examine the performance of PCM system by repeating the experiment using different set of frequency and amplitude values. | Click on the blocks to reconstruct the PCM circuit for a new set of values and execute the simulator to analyse the output waveforms of the respective blocks and compute the PCM parameters. | **Q5** |
| 5) | Calculate the output signal to quantization noise ratio (SQNR) for the n-bit binary at the PCM output and verify it with the simulated result. | Click on the Evaluate block at the modulator to obtain the values of SQNR, transmission bandwidth and signalling rate of n-bit PCM for the message bandwidth of “w” Hz. | **Q4** |

**Additional Assessment Questions:**

1. Arrange the sequence of operations performed in transmitter part of a PCM system
2. Decoder, Sampler, Quantizer
3. Quantizer, Filter, Sampler
4. Encoder, quantizer, Sampler
5. Sampler, Quantizer, Encoder

Answer: d

1. What is the transmission bandwidth of n- bit PCM for the message bandwidth of “w” Hz?
2. BT=4nw
3. BT=nw/2
4. BT=2nw
5. BT=nw

Answer : d

1. Define PCM.
2. Each message sample is converted into n-bit binary.
3. Each message sample is converted into analog.
4. Each message sample is converted into discrete.
5. Each message sample is converted into sinewave.

Answer: a

1. Calculate the signal to quantization noise ratio in dB for a 10-bit PCM system.

* 1. 23.8 dB
  2. 61.8 dB
  3. 72.6 dB
  4. 56.3 dB

Answer: b

1. Obtain the codeword length of a sample which is quantized into one of 16 levels in PCM.
2. 5
3. 4
4. 3
5. 7

Answer: b

4. **Simulator Interactions:**

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No** | **What students will do?** | **What Simulator will do?** | **Purpose of the task** |
| 1 | Click on the theory and procedure blocks in the home page to carry out the PCM modulation and demodulation experiment. | Display the theory and procedure to be followed for PCM simulation. | Recall the functionality and objectives of PCM experiment. |
| 2 | Understand the blocks required to construct a PCM circuit in the workspace and the use case of every block. | Display the blocks that can be placed in the workspace as per user need. | To provide the space to realize the theoretical concepts of pulse code modulation and demodulation in the simulation environment. |
| 3. | Click on the sine wave generator and sampler blocks to choose the appropriate frequency and amplitude of sine waveform and sampling frequency. | Display the blocks with the required values of frequency and amplitude. | To produce the baseband signal for sampling process and identify the values of message bandwidth to calculate the PCM parameters. |
| 4. | Click on the quantizer and encoder blocks for PCM modulation and then click on decoder and reconstruction filter blocks for demodulation. | Display the modulated and demodulated signals of PCM system. | To observe and analyse PCM waveform for the specified values of amplitude and frequency of input sine wave. |
| 5. | Click on the Evaluate block at the PCM modulation to note down the PCM parameters. | Display the value of bandwidth, signaling rate and SQNR of the simulated PCM system. | To check the theoretical values of PCM parameters with the simulated results. |