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| **Course Name:** | **Analogue Digital Systems** | **Semester:** | **IV** |
| **Date of Performance:** | **30 / 01 / 2024** | **Batch no.:** | **A - 2** |
| **Faculty Name:** | **Prof. Amrita Naiksatam** | **Roll no.:** | **16014022050** |
| **Faculty Sign & Date:** |  | **Grade / Marks:** | **\_\_\_ / 25** |

**Experiment no.: 3**

**Title: To Verify Sampling Theorem**

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| **Aim and Objective of the Experiment:** |
| * To verify sampling theorem. * To check analyze signal reconstruction for different sampling frequency. |

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| **COs to be achieved:** |
| CO3: Learn Pulse modulation schemes and multiplexing techniques. |

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| **Theory:** |
| In analogue communication system like AM & FM the instantaneous value of the information is used to change certain parameters of carrier wave.  Pulse modulation systems differ from the analogue system in a way that they transmit a limited number of discrete states of signals at the pre-determined rate. Sampling can be defined as measuring the value of signal at a pre-determined time interval. The rate at which the signal is sampled is known as sampling rate or sampling frequency. It determines the quality of reproduced signal.  Nyquist Criterion: The lowest sampling frequency that can be used without sideband overlapping is twice the highest frequency component present in the information signal. If we reduce the frequency, we cannot get the original signal simply by low pass filtering. This phenomenon is called aliasing in which the low frequency components merge with the high frequency components of adjacent bands.  Sampling Theorem: A continuous signal of bandwidth Fm can be completely represented & reconstructed from samples taken at a rate greater than or equal to 2Fm samples/sec,  i.e. FS > 2FM. |

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| **Stepwise Procedure:** |
| 1. Apply sampling frequency & sinusoidal (1 KHz) signal mentioned on the kit. 2. Select the duty cycle knob (5). 3. Display waveform (pin 12) & sampling output (pin 37) on CRO. 4. Link the sampled output to II & IV order filter successively & observe the reconstructed waveforms. 5. Change sampling frequency from maximum to minimum. 6. Draw the waveforms on graph sheet. |

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| **Circuit Diagram:** |
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| **Observation Table / Graphs / Calculations:** |
| **Observation Table:**   |  |  |  | | --- | --- | --- | | **FS (khz)** | **Fm (khz)** | **Remarks about Nyquist Rate** | | 400 | 1 | Nyquist-Shannon sampling theorem is satisfied. | | 100 | 1 | Nyquist-Shannon sampling theorem is satisfied. | | 50 | 1 | Nyquist-Shannon sampling theorem is satisfied. | | 10 | 1 | Nyquist-Shannon sampling theorem is satisfied. |   **Calculations:**    **Graphs:** |

Note: Draw corresponding waveforms on graph paper.

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| **Post Lab Subjective / Objective type Questions:** |
| 1. **State the difference between natural and flat top sampling.**   Natural Sampling: In natural sampling, the impulse used for sampling has a duration equal to zero and infinite amplitude. It is essentially an ideal impulse. This type of sampling is theoretical and not practically realizable.  Flat Top Sampling: In flat top sampling, the impulse used for sampling has a finite duration. This duration is typically longer than the duration of the natural sampling impulse. The amplitude of the pulse is constant over this finite duration. Flat top sampling is more practical and achievable in real-world systems compared to natural sampling.   1. **Sampling frequency should be**     1. **less than or equal to maximum frequency of message signal.**    2. **more than or equal to maximum frequency of message signal**    3. **equal to average frequency of message signal.**    4. **more than or equal to twice the maximum frequency of message signal.** |

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| **Conclusion:** |
| In this experiment utilizing a digital communication trainer and a digital storage oscilloscope, we successfully verified the Sampling Theorem by observing that the signal was accurately reconstructed when the sampling frequency exceeded twice the maximum frequency of the message signal. Additionally, by varying the sampling frequency, we analysed the effect on signal reconstruction, highlighting the critical role of sampling frequency in accurately recreating the original signal. |

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