

GATE Assignment 4

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Download all python codes from

<https://github.com/Adarsh541/EE3900/blob/main/Gate4/codes/Gate4.py>

Download latex-tikz codes from

<https://github.com/Adarsh541/EE3900/blob/main/Gate4/Gate4.tex>

1 PROBLEM(GATE 2001 EC Q.2.19)

The Nyquist sampling interval, for the signal

$$x(t) = \text{Sinc}(700t) + \text{Sinc}(500t) \quad (1.0.1)$$

is.

- 1) $\frac{1}{350}$ sec
- 2) $\frac{\pi}{350}$ sec
- 3) $\frac{1}{700}$ sec
- 4) $\frac{\pi}{175}$ sec

2 SOLUTION

Lemma 2.1. *Fourier transform of Sinc function*

$$\text{Sinc}(at) \xrightarrow{\mathcal{F}} \frac{1}{|a|} \text{rect}\left(\frac{f}{a}\right) \quad (2.0.1)$$

Since Fourier Transform is linear, and using (2.0.1)

$$X(f) = \frac{1}{700} \text{rect}\left(\frac{f}{700}\right) + \frac{1}{500} \text{rect}\left(\frac{f}{500}\right) \quad (2.0.2)$$

$$X(f) = 0 \text{ for } f > 350\text{Hz} \quad (2.0.3)$$

$$\text{Nyquist rate} = 2 \times \text{max frequency} \quad (2.0.4)$$

$$= 2 \times 350\text{Hz} \quad (2.0.5)$$

$$\text{Nyquist sampling interval} = \frac{1}{\text{Nyquist rate}} \quad (2.0.6)$$

$$= \frac{1}{700} \text{sec} \quad (2.0.7)$$

Sampling rate(Hz)	Observations
$f_s = 1k$	The signal is perfectly reconstructed. It is made up of frequencies $-350 < f < 350$.
$f_s = 2k$	The signal is perfectly reconstructed. It is made up of frequencies $-350 < f < 350$.
$f_s = 500$	$150 < f < 350$ are missing
$f_s = 600$	$250 < f < 350$ are missing

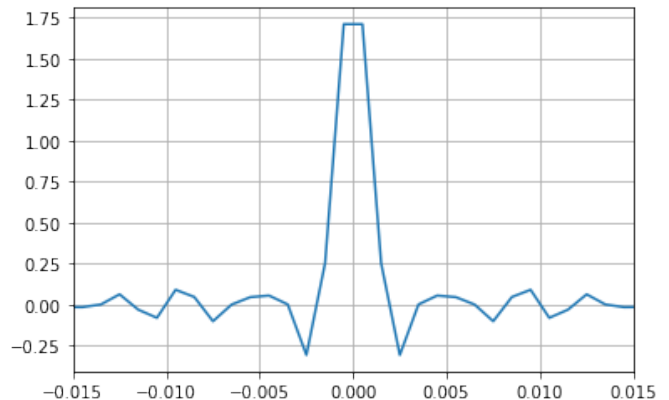


Fig. 4: Plot of $x(t)$ sampled at 1kHz.

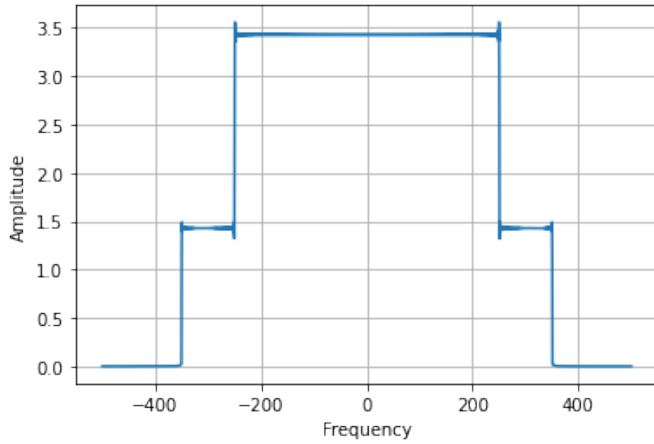


Fig. 4: DFT of $x(t)$ sampled at 1kHz

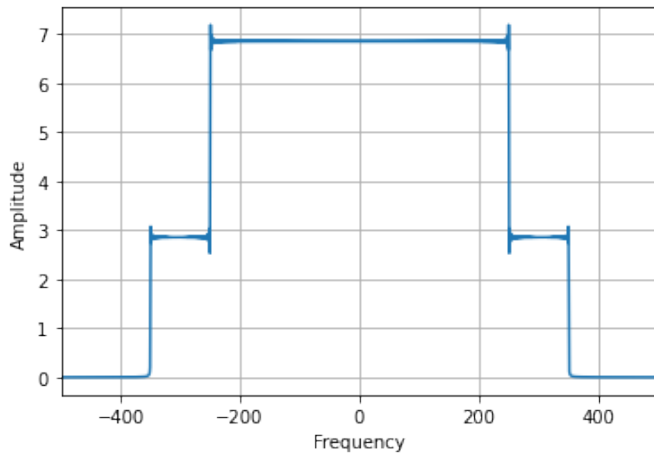


Fig. 4: DFT of $x(t)$ sampled at 2kHz

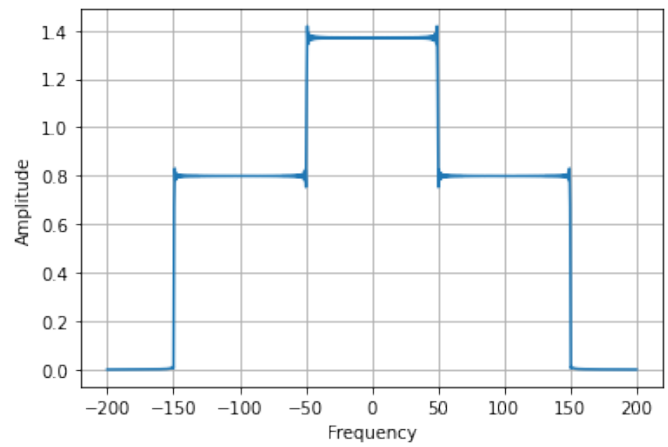


Fig. 4: DFT of $x(t)$ sampled at 500Hz. $f > 150$ are not present.

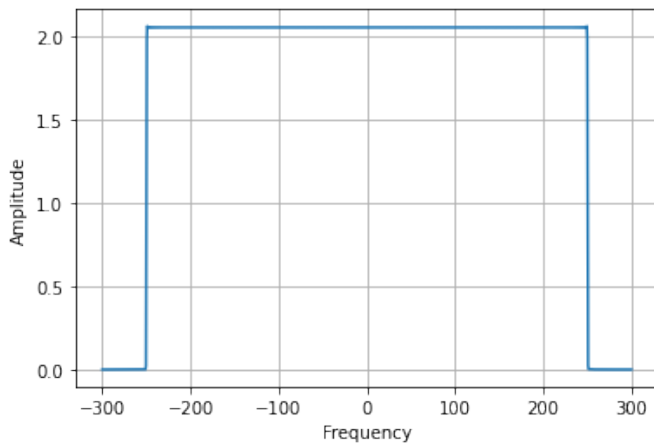


Fig. 4: DFT of $x(t)$ sampled at 600Hz. $f > 250$ are not present.