E9 213 Time-Frequency Analysis

Assignment 2

Maximum Marks: 20
Due Date: 13/09/24, 11:59pm

General Instructions

- Use either **MATLAB** or **Python** to solve the programming problems. Be sure to include comments within your code to enhance readability.
- Develop your own functions for all questions.
- If you're coding in Python, organize your work within a single Jupyter Notebook (`.ipynb`). Clearly separate the code for each question into different cells and label them accordingly.
- In addition to your code, submit a PDF document that includes all the results (such as images or numerical outputs), along with your observations and conclusions.
- Name your code file as `A2_FirstNameLastName_code` and your report as `A2_FirstNameLastName_report.pdf`.
- Submit both files via email to oindrilah@iisc.ac.in with the subject line **TFA Assignment 2 Submission** before the deadline. Please note that late submissions will be penalised.

Problem 1. *Discrete Sinusoid* *2 points*

Generate a discrete-time sinusoid and compute its discrete Fourier spectrum.

$$s[n] = \cos(w_0 n), \quad n = -N \text{ to } N, \quad w_0 = \frac{20\pi}{2N}, \quad N = 512$$

Problem 2. *Gaussian signal* *4 points*

Generate a Gaussian signal with variance σ^2 and compute its spectrum. Estimate σ_t and σ_ω from the discrete Gaussian and its spectrum. Compare $\sigma_t \sigma_\omega$ with the theoretical lower limit.
Consider $\sigma = 1$.

Problem 3. *Gabor functions* *4 points*

Generate Gabor functions and determine their spectra for varying $\langle t \rangle$, $\langle \omega \rangle$ and σ^2.

Problem 4. *Gaussian modulated chirp* *5 points*

Generate a discrete-time Gaussian modulated chirp signal.

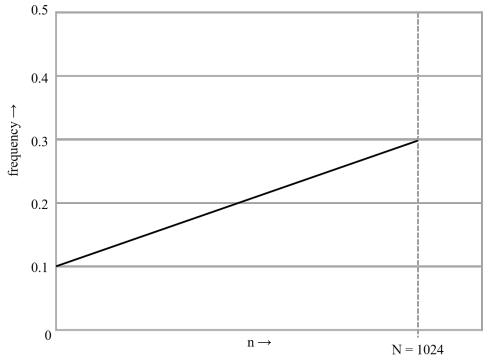

Figure 1: Custom Signal

Plot its spectrum.

Problem 5. *Chirp signal* *5 points*

Generate

$$f(t) = \left(\frac{\alpha}{\pi}\right)^{1/4} \exp\left\{\left(-\frac{\alpha t^2}{2} + \frac{j\beta t^2}{2} + jw_0 t\right)\right\}, \alpha > 0$$

for different choices of α, β and w_0. Plot the corresponding spectra.
