

# E9 213 Time-Frequency Analysis - Assignment 3

**Submission Deadline:** October 19, 2025, 11:59 PM

## Instructions

- Give concise answers.
- Use either **MATLAB** or **Python** to solve the programming problems. Comment your code appropriately to enhance readability.
- Plots must be clearly labelled with titles, scale, and axes labels.
- For Python Coders: Submit a single Jupyter Notebook named `E9_213_A3_FirstNameLastName_Code.ipynb` and delineate the code for each question in separate, clearly labeled cells. Upload only the the Notebook (`.ipynb`) and report (`.pdf`) via Teams before the deadline.
- For Matlab Coders: For each problem, create a corresponding file named `run_Problem1.mat`, `run_Problem2.mat`, etc. Submit a single zipped folder named `E9_213_A3_FirstNameLastName.zip`, containing all scripts and the report (`.pdf`), via Teams before the deadline.
- Submit the report with all the results, such as images or numerical outputs, along with your assumptions, analytical computations, observations and conclusions.
- Name your report as `E9_213_A3_FirstNameLastName_Report.pdf`.
- Use of AI tools such as ChatGPT to solve this assignment will result in zero marks.
- Resorting to unfair means such as copying will result in zero marks.

1. Consider the following time-domain signals:

$$f_1(t) = \sin(\omega_0 t),$$

$$f_2(t) = e^{-(t-5)^2/\sigma^2},$$

$$f_3(t) = \sin(2\pi\gamma(t)t), \text{ where } \gamma(t) \text{ varies linearly between 5 Hz and 50 Hz,}$$

$$f_4(t) = e^{-(t-5)^2/\sigma^2} \sin(\omega_0 t), \quad 0 \leq t < 10.$$

- (a) Write a program to compute the short-time Fourier transform (STFT) and display the spectrogram of the signals using a Bartlett window and a Gaussian window. Provide observations on time and frequency resolution, based on the window length, overlap between consecutive frames and spread of the window. In which case is the STFT invertible? **(5 pts)**
  - b) Write a program to compute and display the Wigner-Ville distribution of prototype signals. Compare the resolution of WVD with that of STFT. When is the Wigner-Ville distribution invertible? **(5 pts)**
2. Write a program to compute and display the Spectrogram and pseudo Wigner-Ville distribution for the files provided in the ZIP file.