# MTH5315 Midterm II (Due 04/14/2025)

April 5, 2025

(1) Please submit a printed report about the project.
(2) In the report, please include basic introduction of the methods, all related computer code and plots, as well as all the necessary analysis.

Consider 1D Poisson's Equation $-\Delta u = sin(\pi x)$, over the region $(0, \pi/2)$, with boundary conditions $u(0) = 0$ and $u(\pi/2) = 1$. Using centered difference scheme and a mesh of 128, obtain a linear system $Au = f$ for the problem, then solve the linear system using the following methods until a relative residual of $10^{-4}$ is reached. For all the methods listed below, plot the analytical solution, numerical solution and the error distribution. Use zero vectors as your initial guess.

(a) Gauss-Seidel Method. Plot the rate of convergence and compare it with analysis.
(b) Conjugate Gradient Method. Compare the rate of convergence with that obtained in (a). Do not use the CG solver provided by Matlab.
(c) Conjugate Gradient Method preconditioned by Incomplete Cholesky Decomposition. Compare the rate of convergence with that obtained in (b).