School of Mathematics and Statistics
MAST90026 Computational Differential Equations
2026

Homework 2
Due: 11:59PM Friday, 20th March.

This homework is worth 5% of the total assessment in this subject. Submit your hand working and published MATLAB code* as a combined PDF file through Canvas.

*Use the `publish` command (or use the GUI) to run your script and save it as a PDF.

Late submissions will not be marked and a grade of 0 will be awarded. If there are extenuating circumstances apply for an extension or special consideration (more information available in the assessment adjustments page in the student support module).

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1. Write a code to solve the mixed BC problem

$$u'' + pu' + qu = r;\ u(a) - u'(a) = \alpha,\ u(b) = \beta,$$

where $p, q, r, a, b, \alpha, \beta$ are constants.

Use

(i) a first order FD formula
(ii) a 2nd order method

to handle the Robin BC at $x = a$.

Test your code on problem

$$u'' - u = 0;\ \ u(0) - u'(0) = 0, u(1) = \exp(1),$$

whose exact solution is $u(x) = \exp(x)$ and plot the maximum grid error $\max |e_j|$ versus N as a log-log plot, for each method.

2. Write code to use collocation at Legendre Gaussian Lobatto points to solve the constant coefficient Dirichlet BVP:

$$u'' + pu' + qu = r;\ \ u(-1) = \alpha, u(1) = \beta,$$

where p, q, r, α, β are constants. You may use the file '`cheb.m`'.

(a) Test your code on problem A:

$$u'' - u = 0;\ \ u(-1) = 1, u(1) = 3,$$

whose exact solution is $\hat{u}(x) = 2\cosh(x)/\cosh(1) + \sinh(x)/\sinh(1)$. Inspect the solution visually by plotting both the numerical and exact solution on the same axes.

(b) Approximate the error using $\|E\|_2 = \sqrt{\int_{-1}^{1}(u - \hat{u})^2 dx}$ and an appropriate quadrature rule. Plot the error vs N.

(b) What change would you have to make to handle the problem with $u(a) = \alpha, u(b) = \beta$.