MA203 Numerical Methods

Winter Semester 2026

09.04.2026

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Assigment 4

Tutorial(Problem 4) must be completed individually and submitted via Google Classroom by 17.04.2026 at 23:59. Ensure that the name and enrollment number is clearly written on the submission. Late submissions will not be accepted.

Question 1: [**Integration**]

a) Find the degree of precision of the quadrature formula

$$\int_{-1}^{1} f(x)\,dx = f\left(-\frac{1}{\sqrt{3}}\right) + f\left(\frac{1}{\sqrt{3}}\right).$$

b) The quadrature formula

$$\int_{-1}^{1} f(x)\,dx = c_0 f(-1) + c_1 f(0) + c_2 f(1)$$

is exact for all polynomials of degree less than or equal to two. Determine $\{c_i\}_{i=0}^{2}$.

Question 2: [**Eigenvalue**]

Find the first two iterations obtained by the Power method and the inverse power method applied to

$$\mathbf{A} = \begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix},$$

using $\mathbf{x}^{(0)} = (1, -1, 2)$.
Choose the linear functional

$$\varphi(\mathbf{x}) = \|\mathbf{x}\|_\infty.$$

Question 3: [**Euler Method**]

In a circuit with impressed voltage $\mathcal{E}$ having resistance $\mathcal{R}$, inductance $\mathcal{L}$, and capacitance $\mathcal{C}$ in parallel, the current i satisfies

$$\frac{di}{dt} = \mathcal{C}\frac{d^2\mathcal{E}}{dt^2} + \frac{1}{\mathcal{R}}\frac{d\mathcal{E}}{dt} + \frac{\mathcal{E}}{\mathcal{L}}.$$

Suppose $\mathcal{C} = 0.3$ Farads, $\mathcal{R} = 1.4$ Ohms, $\mathcal{L} = 1.7$ Henries, and

$$\mathcal{E}(t) = \sin(2t - \pi).$$

If $i(0) = 0$, approximate the current at $t_j = 0.1j$ for $j = 0, 1, 2$ using the Euler method.

Question 4: [**Programming Exercise**]

Write a Python code to implement the Trapezoidal rule to evaluate

$$\int_{-2}^{2} x^2 e^x \, dx.$$

The exact value of the integral is

$$2e^2 - 10e^{-2} \approx 13.4226.$$

Divide the interval of integration into n equal subintervals and apply the Trapezoidal rule on each subinterval. Combine the results to obtain the final approximation.
Compute the numerical error for

$$n = 4,\ 8,\ 16.$$

Recall that if

$$a = x_0 < x_1 < \cdots < x_n = b,$$

then

$$\int_a^b f(x)\, dx = \sum_{i=0}^{n-1} \int_{x_i}^{x_{i+1}} f(x)\, dx.$$