Computational Études

A Spectral Approach

A Tentative Teaching Plan

Course Information

Course: MATH 794 – 01 (CRN 21296)
Semester: Spring 2026
Schedule: Mon & Wed, 16:30 – 17:45
Location: G-G02013

Instructor

Name: Dr. Denys Dutykh
Department: Mathematics
Institution: Khalifa University
Location: Abu Dhabi, UAE

Legend: Completed Current Planned

Week	Dates	Monday Lecture	Wednesday Lecture
1	Jan 12–14	Course introduction Syllabus & overview	**Ch. 2:** Classical PDEs Heat equation – separation of variables
2	Jan 19–21	**Ch. 3:** Mise en bouche Method of weighted residuals, collocation example, collocation vs Galerkin	**Ch. 4:** The Geometry of Nodes Lagrange interpolation, Runge phenomenon, potential theory
3	Jan 26–28	**Ch. 5:** Differentiation Matrices FD stencils, spectral matrices, Fornberg algorithm	**Ch. 6:** Smoothness and Spectral Accuracy Smoothness, spectral convergence, exponential accuracy
4	Feb 2–4	**Ch. 7:** Chebyshev Differentiation Matrices Chebyshev nodes, D_N matrix, negative sum trick	**Ch. 8:** Boundary Value Problems 1D/2D BVPs, matrix stripping, Newton iteration – Project II assigned
5	Feb 9–11	**Project I:** Students Presentations Oral presentations and discussions of Project I results	Project I
6	Feb 16–18	TBA	TBA
7	Feb 23–25	TBA	TBA
8	Mar 2–4	TBA	TBA
9	Mar 9–11	TBA	TBA
–	Mar 16–27	*Spring Break & Eid Al Fitr – No classes*	
10	Mar 30–Apr 1	TBA	TBA
11	Apr 6–8	TBA	TBA
12	Apr 13–15	TBA	TBA
13	Apr 20–22	TBA	TBA
14	Apr 27–29	TBA	TBA
–	May 4–14	**Final Examinations Period**	

Table 1: Teaching schedule for MATH 794 – Spring 2026

Notes

- This schedule is tentative and may be adjusted based on class progress.
- Chapter numbers refer to *Computational Études: A Spectral Approach*.
- Office hours are available by appointment.

- All course materials are available in the course repository.

Course Projects

Project I: Spectral Methods for Boundary Value Problems (Based on Chapter 3 – Assigned: Jan 19, 2026)

Implement spectral methods (collocation and/or Galerkin) to solve a boundary value problem of your choice. Requirements:

1. Find a linear BVP of at least second order with **non-homogeneous** boundary conditions.
2. Construct an exact solution to this problem (or design the problem around a known exact solution).
3. Choose appropriate basis functions that satisfy the boundary conditions identically.
4. Apply the **Collocation** method, **Galerkin** method, or both to obtain a numerical solution.
   - If using **only** the Collocation method, the BVP must have **non-constant coefficients**.
   - If applying **both** methods, the problem may have constant coefficients (though non-constant coefficients are also welcome).
5. Present results in a table that includes the error at the collocation points.
6. Provide graphical representations showing: the exact solution, the numerical approximation, and the difference (error) between them.

Project II: Spectral Collocation for BVPs (Based on Chapters 6–7 – Assigned: Feb 2, 2026)

Implement Chebyshev spectral collocation to solve boundary value problems. Requirements:

1. Implement the Chebyshev differentiation matrix D_N using the negative sum trick.
2. Choose a second-order BVP (linear or nonlinear) with known exact solution.
3. Solve the BVP using spectral collocation with matrix stripping for boundary conditions.
4. Present a convergence study: error vs. N on a semilog plot.
5. For bonus: solve a 2D problem using tensor products.

Project III

To be announced

Project IV

To be announced

Last updated: January 29, 2026