EMORY UNIVERSITY

College of Arts and Sciences
Department of Mathematics

MATH 789 – Approximation Theory (Fall 2024)

(as of April 16, 2024)

Land Acknowledgement

Emory University acknowledges the Muscogee (Creek) people who lived, worked, produced knowledge on, and nurtured the land where Emory's Oxford and Atlanta campuses are now located. In 1821, fifteen years before Emory's founding, the Muscogee were forced to relinquish this land. We recognize the sustained oppression, land dispossession, and involuntary removals of the Muscogee and Cherokee peoples from Georgia and the Southeast. Emory seeks to honor the Muscogee Nation and other Indigenous caretakers of this land by humbly seeking knowledge of their histories and committing to respectful stewardship of the land.

Instructor: Dr. Manuela Girotti

Office: Math & Science Center, room N416

Email: `manuela.girotti@emory.edu`

Lectures: *Tuesdays and Thursdays, 11:30am–12:45pm*
Math & Science Center, room E408

Office hours: – *Ask-Me-Anything* hours –

TBD

Prerequisites: Linear Algebra (Determinants, eigenvalues, eigenvectors, permutation group etc.), Analysis (Lebesgue integration, differentiation in several real variables), Complex analysis (analyticity of functions, contour integration, Cauchy theorem), Elementary measure theory (definition and basics of L^p spaces).

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Overview: This course is a first exploration into the world of approximation theory for integrable systems.

Tentative topics–to be updated as we go along

- Padé approximants.
- Orthogonal polynomials and generalizations, Connections to Padé approximants.
- Laplace steepest descent methods.
- Determinantal Point Processes.
- Random Matrix Theory.
- Riemann–Hilbert problems.
- The Deift–Zhou nonlinear steepest descent method. Essentials of potential theory: equilibrium measures, one-cut cases.
- Applications: spectral theory of large random matrices, large time asymptotics of nonlinear wave equations.

Evaluations: There will be ≥ 1 home-assignment. At the end each student will deliver an oral presentation of either a chapter/section of a book or of a research paper (to be indicated later on).
The final course mark will be calculated as follows :

presentation: 45%
homework: 35%
scribing: 15%
class participation: 5%

The scribbles/course notes will be redacted using a Latex template that will be distributed in a timely manner.
They will then be uploaded on the course's repository Overleaf.

Final letter grades are assigned according to the ECAS Catalog:

Grade	F	D	D+	C-	C	C+	B-	B	B+	A-	A
Percentage	0-62	63-66	67-69	70-72	73-76	77-79	80-82	83-86	87-89	90-92	93-100

Extensive class bibliography:

This is a non-exhaustive list of books which the course will be based on:

- G. A. Baker Jr., "Essentials of Padé approximants", Elsevier, 1975.
- P. Deift, "Orthogonal Polynomials and Random Matrices: a Riemann–Hilbert approach", Courant Lecture Notes, Volume: 3, American Mathematical Society, 2000.
- T. S. Chihara, "An introduction to Orthogonal Polynomials", Dover Publications, 2011.
- A. R. Its, "Large N asymptotics in Random Matrices. The Riemann–Hilbert approach", in: Harnad, J. (eds) Random Matrices, Random Processes and Integrable Systems. CRM Series in Mathematical Physics. Springer, New York, NY, 2011.
- E. B. Saff, V. Totik, "Logarithmic potentials with external fields", Grundlehren der mathematischen Wissenschaften, Volume 316, Springer, 1997.
- M. J. Ablowitz, A. S. Fokas, "Complex Variables: introduction and applications", Cambridge Texts in Applied Mathematics, Series Number 35, Cambridge University Press, 2003.
- J. Baik, P. Deift, T. Suidan, "Combinatorics and Random Matrix Theory", Graduate Studies in Mathematics, Volume 172, American Mathematical Society, 2016.
- P. Miller, "Applied Asymptotic Analysis", Graduate Studies in Mathematics, Volume 75, American Mathematical Society, 2006.

Academic Integrity:

This course will adhere to the Emory University Academic Honor Code
http://catalog.college.emory.edu/policies/honor-code.html

Accommodation:

Emory University is committed to providing reasonable accommodations for all persons with disabilities. Students with disabilities who need accommodations shall contact the Department of Accessibility Services to learn more about the registration process and steps for requesting accommodations. Students who have accommodations in place are encouraged to coordinate with the instructor during the first week of the semester to communicate your specific needs for the course.