Math 606 in Summer 2023: Introduction to Random Matrices

Class number 054–39482R
Class meetings: MW, 9:30am-12:30pm, KAP 166.

Information on this and related pages changes frequently.

Instructor: **Sergey Lototsky**.

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Office Hours: MW before and after the class. Appointments at other time are welcome.

Course objective: To learn main terminology and results related to random matrices, such as

- Gaussian ensembles (GOE, GUE, GSE) and some of the fundamental math behind them (Lie groups, Lie Algebras, Quaternions, etc.);
- Circle, semi-circle, and other laws, and the names behind them;
- Saddle point method, Method of moment, Stieltjes trasnform, Dyson Brownian motion, and other technical tools.

Course work: Class participation, homework assignments, final presentation.

Official grading scheme: 20% class participation, 40% homework assignments, 40% final presentation.

Main reference: G. Livan, M. Novaes, P. Vivo. Introduction to random matrices. Theory and practice. SpringerBriefs in Mathematical Physics, 26. *Springer, Cham,* 2018, **ix+124 pp.**

The book is available in electronic form from USC libraries.

A longer list of references.

An example of a book review from *Math reviews* [Edition 1, Edition 2] **and from** the Bulletin of the AMS

Homework problems and more.

Our progress.

May 17. An overview of the class, the book, and some foundational material from [Linear Algebra](#) and [Probability](#).

May 22. Random eigenvalues vs. iid random variables; circle/semi-circle/quarter-circle laws; an overview of [quaternions](#).

May 24. [Asymptotic Integration](#); more about the circle laws.

May 29. No class: Memorial Day.

May 31. From the joint pdf of matrix entries to the joint pdf of eigenvalues and eigenvectors; [Vandermonde and his determinant](#).

June 5. Proving the circle laws: [weak convergence of probability measures](#), method of moments, Stieltjes transform, and more.

June 7. [Orthogonal polynomials](#); determinant processes; examples of bulk vs edge asymptotics for eigenvalues.

June 12. Wishart-Laguerre ensembles; Marchenko-Pastur theorem.

June 14. Free probability and its connections to random matrices.

June 19. No class: Federal holiday/USC non-instructional day.

June 21. [Painleve equations](#) and related topics; Dyson's Brownian motion.

June 26. More on Dyson's Brownian motion, matrix norms, and kernels/determinant processes.

June 28. [A concluding discussion](#).