MA639 – Matrix Analysis
(2026 Spring semester)

Instructor: Projesh Nath Choudhury **Office:** AB-6/356
Email: projeshnc@iitgn.ac.in **Office hours:** Mon 4–5 pm

Google classroom code: qnmiwmor

Course website: https://projesh.people.iitgn.ac.in/Teaching/MA639/MA639_2026.html

Course goals: This course is an introduction to matrix analysis, developing essential tools. The emphasis will be more on analytic aspects of matrix theory (things like variational principles, norms, inequalities, and Perron–Frobenius theory).

PRE-REQUISITES

Basic knowledge of linear algebra.

LIST OF TOPICS

(The selection of topics is variable depending on time constraints.)

(1) Review: Spectral theorem, singular value decomposition, Moore-Penrose inverse, least squares solutions.
(2) Variational principles of spectrum: The Minmax principle for spectrum of Hermitian matrices, Rayleigh–Ritz theorem, Courant–Fischer theorem, Weyl's monotonicity theorem, Cauchy interlacing theorem, inertia and congruence, Sylvester's law of inertia.
(3) Matrix norms: Definition and examples of matrix norms, Gelfand formula, location of eigenvalues, Geršgorin theorem. Applications to sensitivity of linear systems.
(4) Positive semidefinite and Positive definite matrices: Properties and characterizations, the Loewner partial order relation, operator monotone and operator convex functions, Hadamard's inequality, Fischer's inequality. Applications to dynamical systems.
(5) Perron–Frobenius theory: Matrices with positive and non-negative entries. Applications to Page rank algorithm and steady state of a stationary finite Markov chain.

SUGGESTED BOOKS AND REFERENCES

(1) R.A. Horn and C.R. Johnson. *Matrix analysis.* Cambridge University Press, 2012.
(2) R. Bhatia. *Matrix analysis.* vol. 169 of Graduate Texts in Mathematics, Springer, 1997.
(3) C.D. Meyer. *Matrix analysis and applied linear algebra.* SIAM, 2001.
(4) F. Zhang. *Matrix theory. Basic results and techniques.* Springer, 1999.

LECTURES AND TUTORIALS

- **Lectures:** Wed, Fri 3.30–4.50 pm (Room AB 7/208)
- **Tutorials:** TBA

ASSIGNMENT

Assignment problems will not be discussed in class. Students are expected to work out these problems and submit them by the appropriate deadline. Solutions to assignments will be provided after deadline. Discussing in a group is allowed and encouraged; however, each student should hand

in their independently written solutions, written in their own words. Mere copying of others' work is strictly prohibited.

POLICY FOR EVALUATION

- **Quiz:** 15%
- **Examination I:** 30%
- **Examination II:** 35%
- **Assignment:** 10%
- **Attendance:** 10%

ATTENDANCE POLICY

Class participation will help you in staying on track and developing a deeper understanding and interest in the subject. As a result, attendance at lectures will be recorded. The following is the policy for the marks based on the percentage in attendance:

% in Attendance	Marks
Above or equal to 80	10
60 to less than 80	5
Below 60	0

*If you miss a class due to medical reasons and want to record attendance for that day, you need to provide a medical certificate from the institute health center doctor stating that you are not fit to appear for the class on that day.

HONOR CODE

Students are expected to follow the Institute Honor Code at all times. Any suspected/alleged violations of the Honor Code will be investigated and may lead to disciplinary action, as per Institute policy.

GRADING POLICY

Relative grading policy will be followed.