

# Algebraic Graph Theory

Algebraic graph theory is a branch of Mathematics that studies graphs by using algebraic properties. There are two main connections between graph theory and algebra. These arise from two algebraic objects associated with a graph: its adjacency matrix and its automorphism group. In this course, more in particular, we focus on the spectral graph theory that studies the relation between graph properties and the spectrum of the adjacency matrix and the Laplacian matrix.

This is a graduate course. Students are expected to be familiar with basic aspects of graph theory, linear algebra and group theory. The course will mostly be taught in the lecture format, although questions are always welcome and all students are supposed to have a seminar during the semester. There will be homework assigned in each session, two exams during the semester and a final project.

**Time:**??.

**Instructor:** Behnaz Omoomi

**Grade:** 20% Homework + 80% Exams + Class Activities

**References:**

- [An Introduction to the Theory of Graph Spectra](#); D. Cvetkovic, P. Rowlinson and S. Simic, 2010.
- [Topics in Algebraic Graph Theory](#); W. Beineke and R.J. Wilson, 2004.
- [Algebraic Graph Theory](#); [C. Godsil](#) and G. Royle, 2001.
- [Algebraic Graph Theory](#); N. Biggs, 1993.
- [Spectra of Graphs](#); D. Cvetkovic, M. Doob and Sachs, 1995.
- [Eigenspace of Graphs](#), D. Cvetkovic and R. J. Wilson, 1997.
- [Spectra of Graphs](#); Brouwer and Haemers.
- [Spectral Graph Theory](#), Chung, 1994.

## Syllabus:

- Matrices associated to a graph
- The spectrum of a graph
- The spectrum of some graphs
  - The complete graph
  - The complete bipartite graph
  - The cycle
  - The path
  - Line graphs
  - Cartesian products
  - Strongly regular graphs
- The spectrum of an undirected graph
  - Regular graphs
  - Complements
  - Walks
  - Diameter
  - Spanning trees
- Characterization by spectra
  - Cospectral graphs
- Structure and one eigenvalue
  - Star complements
  - Graphs with least eigenvalue  $-2$
- Spectral techniques
- Spectrum and graph structure
  - Automorphisms and eigenspaces
  - Distance regular graphs
- Laplacian
  - Laplacian spectrum
  - The matrix-tree theorem
  - Algebraic connectivity
  - Laplacian eigenvalues and graph structure
  - Expansion
- Graph automorphism

## Useful Links

- [Home page for- Algebraic Graph Theory](#)
- [Algebraic graph theory - Wikipedia, the free encyclopedia](#)
- [Lectures on Spectral Graph Theory Fan rk Chung](#)
- [Spectral Graph Theory and its Applications](#)
- [Spectral graph theory - Wikipedia, the free encyclopedia](#)
- [Spectral graph theory](#)
- [Spectral graph theory and its applications](#)
- [Spectral Graph Theory](#)
- [Spectral graph theory – 32leaves](#)