

# Syllabus

Villanova University

**Course:** CSC 5930/9010 - Network Science

**Term:** Spring 2025

**Instructor:** Dr. Maurício Gruppi

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**Office:** Mendel Hall, 292A

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## Quick links

- Textbook - Network Science by Albert-László Barabási
  - Course Schedule
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## Meeting times and locations

- **Section 005:** Tue/Thu 2:30-3:45 PM, Mendel Hall G90
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## Office hours

- **Dr. Gruppi:**
  - Mon/Tue/Wed 1:00 PM - 1:45 PM, Mendel 292A (292 CS Flex Space)
  - *Possibly available at other times or via Zoom upon request.*

*\*All office hours subject to change. Updates will be posted.*

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# Contents

- (1) Main references
  - (2) Course content
  - (3) Course structure
  - (4) Course objectives
  - (5) Assessment
  - (6) Attendance
  - (7) Technology
  - (8) Late work
  - (9) Student conduct
  - (10) Office of Disabilities and Learning Support Services
  - (11) Academic Integrity
  - (12) Absence for Religious Holidays
  - (13) Lecture recording
  - (14) Copyright notice
- 



## Main references

[Back to top]

- The textbook for this course is available for free in digital format and available for purchase in print: **Network Science by Albert-László Barabási**
- Some of the content may also be taken from the textbook **Networks, Crowds, and Markets by Easley and Kleinberg**.
- Lecture notes and assignments will be available on the course Blackboard page.



## Course content

[Back to top]

The following topics are covered in this course:

1. Tools for network analysis and visualization: Gephi and NetworkX.
2. Graph theory: degree, adjacency matrix, paths and distances, clustering coefficient.
3. Centrality: closeness, betweenness and eigenvector centrality.
4. Random networks: The Erdős-Rényi model, degree distribution, expected degree, critical point and connectedness regime, the Small World Phenomenon and Six-Degrees of Separation.
5. Scale-free networks: Power laws, hubs, the Ultra-small property, degree exponent, growth, preferential attachment and the Barabasi-Albert model.
6. Evolving networks: fitness, deletion, aging.
7. Degree correlations: measuring correlations, degree assortativity.
8. Network robustness: attack tolerance, cascading failures.
9. Communities: clustering, modularity, overlap, testing communities.
10. Spreading phenomena: epidemic modeling, immunization.



## Course structure

[Back to top]

- Classes will take place in person at the designated time and location. The schedule will be available on Blackboard describing the contents of each class, including homework due dates, quizzes and exams. *Lecture recordings will be available upon request.*
- Evaluation will be based on homework assignments, projects, quizzes, and participation. **Assessment.**
- Office hours will be held to provide additional guidance to students. See section **Office hours** for details.

## Course goals

[Back to top]

The goal of this course is to provide the students with the fundamental knowledge in network science. Upon successful completion of the course, the student will be able to:

- Model networks from real-world data across multiple disciplines.
- Identify and characterize network structures using degree distribution and connectedness.
- Perform centrality analysis in networks.
- Understand the creation communities and clusters in networks.
- Understand the spreading phenomena and epidemic networks.
- Produce meaningful visualizations of network structures.

## Assessment

[Back to top]

Assessment of the learning goals in the class will be performed across various activities. Grades will be distributed with the following activities:

Assignment	Points
Quizzes	24%
Labs	36%
Final project	40%
<b>Total</b>	<b>100%</b>

A description of each assessment module as well as their related goals is shown in Table 1. The final grade cutoff points are displayed in Table 2.

Assessment	Description	Goals assessed
<b>Quizzes</b>	Quizzes will assess the theoretical and problem-solving skills. These will take place in class and are open notes.	Fundamental understanding, interpretation
<b>Lab sessions</b>	Practical exercises to be done in class. Students will need a laptop capable of running Python and Gephi (Java).	Application, problem solving.
<b>Final project</b>	This network science project will span several weeks and will draw upon the entire course material. Students will produce a network analysis on real data and create a report describing the work.	Application, fundamental understanding, interpretation.
<b>Active participation</b>	Points given for students who demonstrate active participation during the course, such as asking/answering questions during class and attending office hours. Not included in the 100% tally. Will count as extra.	Human aspect of learning, care for the topic.

Table 1: Assessment modules

Grade	Cutoff	Grade	Cutoff
A	95	C	73
A-	90	C-	70
B+	87	D+	67
B	83	D	63
B-	80	D-	60
C+	77	F	<60

Table 2: Letter grade cutoff points

## Attendance

[Back to top]

Attendance is expected for a successful completion of this course. The instructor will register the attendance at the beginning of every class.

As per university guidelines, if the number of unexcused absences for first year students exceeds twice the number of weekly classes (four absences for a course that meets twice

a week), then such student will receive a failing grade “Y”.

## Personal Days

In addition to the attendance policy stated above, students are entitled to one excused absence for any reason that may contribute to their personal wellness. Students must advise the instructor by email before class of their intent to utilize a Personal Day as the reason for their absence. A Personal Day will not be approved retroactively. Students may, but are not required, to provide additional information regarding their absence. Additionally, a Personal Day may not:

- a. be used immediately preceding or following a University holiday or break period;
- b. be used on days when exams, presentations or other major assignments are scheduled.

A Personal Day does not grant an automatic extension for items due. Students remain responsible for all assignments, exams, presentations, etc. due on that date. It is in the instructor’s discretion to determine whether any extension is appropriate given individual circumstances.



## Technology

[Back to top]

- Students are allowed to make use of technology to assist them in the process of learning. Laptops, tablets and similar devices are permitted for uses related to the class and **should not cause distractions to anyone present**.
- All homework assignments **must be typeset**, unless otherwise stated. Students should make use of a computer and a text editor to write reports and homework solutions and export them in PDF format.
- Poll Everywhere is an online polling platform that we will use throughout the semester to engage you in the course and with your peers. Participation points can be obtained through responding to polls in class. Please bring a web-enabled device (phone, tablet, laptop) to every class so you can participate
- Use of **Artificial Intelligence**: all submissions made by a student should be a result of their own work or, in the case of group work, their peers. The use of AI or Large Language Models such as ChatGPT, Microsoft Co-pilot, Llama 2 and Google Bard should be made with caution to ensure it will be beneficial to the student’s learning outcomes. Answers generated by such models will **not be accepted** and will configure an **academic integrity violation**.



## **Late work**

[\[Back to top\]](#)

Late work will not be accepted unless there is an excused absence. Make sure to notify the instructor as soon as possible to discuss the submission.



## **Student conduct**

[\[Back to top\]](#)

As it is every member's responsibility to contribute to the creation of a healthy and safe community, students are required to comply with University health and safety directives, guidelines, rules, regulations and protocols in times of emergency and/or public health concern. Violations may be referred for action under the Code of Student Conduct.

## **Office of Disabilities and Learning Support Services**

[\[Back to top\]](#)

It is the policy of Villanova to make reasonable academic accommodations for qualified individuals with disabilities. All students who need accommodations should go to Clockwork for Students via myNOVA to complete the Online Intake or to send accommodation letters to professors. Go to the LSS website or the ODS website for registration guidelines and instructions. If you have any questions please contact LSS at 610-519-5176 or [learning.support.services@villanova.edu](mailto:learning.support.services@villanova.edu), or ODS at 610-519-3209 or [ods@villanova.edu](mailto:ods@villanova.edu).

## **Academic Integrity**

[\[Back to top\]](#)

All students are expected to uphold Villanova's Academic Integrity Policy and Code. Any incident of academic dishonesty will be reported to the Dean of the College of Liberal Arts and Sciences for disciplinary action. You may view the University's Academic Integrity Policy and Code for a detailed description.

## **Absence for Religious Holidays**

[\[Back to top\]](#)

Villanova University makes every reasonable effort to allow members of the community to observe their religious holidays, consistent with the University's obligations, responsibilities, and policies. Students who expect to miss a class or assignment due to the observance of a religious holiday should discuss the matter with their professors as soon

as possible, normally at least two weeks in advance. Absence from classes or examinations for religious reasons does not relieve students from responsibility for any part of the course work required during the absence. For more information, see Religious Holidays.

## **Lecture recording**

[Back to top]

This course, including your participation, will be recorded on video and may be made available to students in the course for viewing remotely. Course videos and materials belong to your instructor, the University, and/or other sources depending on the specific facts of each situation, and are protected by copyright. Do not download, copy, or share any course or student materials or videos without the explicit permission of the instructor. For questions about recording and use of videos in which you appear please contact your instructor.

## **Copyright notice**

[Back to top]

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