Course: Networks: Friends, Terrorists and Epidemics	**Professor:** *Ahmet Ay*
Lecture: *MWF 10:20am-11:10am*	**Office:** *Olin 206*
Location: *McGregory 210*	**E-mail:** *aay@colgate.edu*
Office Hours: *Tue 9am-10:30am, Thu 3pm-4:30pm*	**Phone:** *(315) 228-6176*
(Other times: By appointment)	**Zoom ID:** *315 228 6176*
Help Session via Zoom: *Sun at 8pm-9pm*	**Website:** *http://math.colgate.edu/~aay*

COURSE DESCRIPTION:

We now live in a small world where everything is connected to everything else. Indeed, networks are all around us, from the human brain to the internet to our circle of friends. All networks have an underlying order and adhere to basic laws. Understanding the structure and behavior of these networks will allow us to achieve amazing things, such as finding terrorists and halting a disease epidemic before it spreads. This course provides a broad overview of network science-addressing the computational techniques of network science as well as their applications and implications in biology, sociology, technology, and other fields. Across this course, we will build networks in a variety of fields, demonstrating that social networks, the internet, and cells are more alike than they are distinct-revealing crucial new insights into the linked world around us. Aside from the simple structural properties of real-world networks, the course will also cover topics such as dynamic network activities, including epidemics, network robustness, and communities in networks. We will also discuss the societal effects and implications of network analysis. Students will have the opportunity to apply what they've learned about network science to real-world network data sets of their own choice. The course will present an exciting glimpse of the future century in science, in an inherently and increasingly interconnected world.

COURSE OBJECTIVES:

On completion of this course, students should be able to do the following:

- Understand and apply basic network science techniques.
- Know how to execute network analysis in Python.
- Know how to use network science on real life datasets, and properly interpret results

CLASS FORMAT:

The class itself will be lecture format. These lectures will focus on the network theory and definitions that underpin their applications. We will frequently work through examples by hand to illustrate applied techniques. And, we will sometimes have discussions based on the primary literature.

The in-class practice sessions are designed to help you learn the course material and become proficient in network analysis using Python. The practice session will consist of group work. During these sessions, we will manage and analyze real life data using Python's NetworkX package. This software are freely available and can be installed on your personal computer. You will need to set these up on your machine or use a Colgate computer adequately configured. We will ensure that everyone is set up with proper hardware and software tools during the first week.

COURSE RESOURCES:

Recommended Textbooks:

- Network Science, Albert-László Barabási, Cambridge University Press (2016)
- Networks – 2nd Edition, Mark Newman, Oxford University Press (2018)

- Complex Network Analysis in Python, Dmitriy Zinoviev, Pragmatic Bookshelf (2018)

Popular Science Books:

I will assign readings from the following popular science books throughout the semester. I encourage you to read the text assignments before coming to the lecture.

- Linked, Albert-László Barabási. Basic Books (2014)
- The Human Network: How Your Social Position Determines Your Power Beliefs and Behaviors, Matthew O. Jackson. Penguin Random House (2020)

Scientific Papers and News Articles:

We will also read scientific papers and news articles to supplement the material covered in class. Here are a few of the articles that you will read this semester (subject to change).

- DiMaggio, Paul, and Filiz Garip. "Network effects and social inequality." Annual review of sociology 38 (2012): 93-118.
- Guney, Emre, Jörg Menche, Marc Vidal, and Albert-László Barábasi. "Network-based in silico drug efficacy screening." Nature communications 7, no. 1 (2016): 1-13.
- News Article 1: Social Networks and Inequality: How Facebook contributes to economic (and other) inequality.
  https://www.psychologytoday.com/us/blog/understanding-social-networks/201203/social-networks-and-inequality
- News Article 2: Use Your Social Network as a Tool for Social Justice
  https://hbr.org/2020/07/use-your-social-network-as-a-tool-for-social-justice?utm_medium=email&utm_source=newsletter_daily&utm_campaign=mtod&referral=00203

Python Software: For students that are particularly keen to learn all that you can about the software program that we will be using (Python), you might consult the following book.

- Learning Python – 5th Edition, Mark Lutz, O'Reilly Books (2013)

Moodle: The syllabus, homework assignments and other important communications will be conveyed via Moodle (http://moodle.colgate.edu/). Materials that I expect you to have reviewed will be referred to and/or placed at the Moodle website for this course. Please see that site regularly so that you can keep up with things.

Gradescope: I will use the Gradescope website to collect some of the graded assignments. Please upload the assignments to this website as directed.

COURSE POLICIES:

Classroom Policy: To ensure an atmosphere conducive to learning, students must be considerate of one another in the classroom. The following rules should be observed during class.

- Every student is expected to be in class on time.
- No chatting during the lecture.
- *Usage of cell phones during the class is STRICTLY forbidden.* Please put your cellphone on silent mode before the class starts.
- Usage of computers during the lecture is STRICTLY forbidden unless you have my permission.
- *No leaving classroom without prior notification and approval from me.*

- *If you are attending the lecture through Zoom (will be only allowed due to coronavirus quarantine), you should turn your camera on (and be presentable!) If you don't want people to see your (real) background, you can set a simulated background. Keep your audio muted, and unmute yourself to ask your questions.*

Calculator Policy: You will need a scientific calculator for this class. A cell phone, or other electronic device is prohibited on the exams or quizzes.

GRADING:

Participation (10%): You are expected to attend the class and urged to ask questions in class whenever you believe this will enhance your understanding. Class attendance/participation will be noted and will contribute to your overall assessment in the course.

Homework Assignments (25%): You will learn how to do network analysis by doing network analysis, day in and day out. Assignments will involve questions, homework problems, reading assignments (see the daily schedule at the last page), and short writing assignments. They will be due on Monday each week except for break and take-home exam weeks.

- Homework assignments will be posted on Moodle/Gradescope and are due at the end of the day on the scheduled date.
- You must pay close attention to the formatting of homework responses. Assignments should be presented in a clear, professional, and precise manner.
- *Please do not submit your assignments by email.*
- You may work together on the homework assignments, but the submitted work should be yours and yours alone.
- If you have questions concerning the grading, please let me know.
- *Please keep in mind that some of the questions may be graded based on their completion. Answers will be provided to these questions.*

Exams (20% each): There are two midterm exams in this course. Midterm exams will include in-class and take-home portions. Take-home exams are "open book" and "open note". *You should do your own independent work on all exams.*

Final Project (25%): Students will collect data reflecting a real network of their choice for the final project and analyze it using the network measures and computational tools given in class. The goal is to provide a complete story: what does network science teach us about the organization and function of the system?

Late or Missed Work: Missed activities can only be made up or omitted from consideration in cases of verifiable hardship (e.g., serious illness). This applies to deadlines for assignments as well. Late work will be penalized at 10% per calendar day up to a maximum of 30%. No work will be accepted after four days.

Letter Grade: Your course grade will be determined by a subjective curve based upon the accumulation of your points. Comparing your grades with the class averages will give an indication of your tentative letter grade for the course. Note that the course grade is directly dependent upon your performance on each of the assignments and exams.

KEY POINTS FOR SUCCESS:

Attendance: You are required to attend all lectures and are responsible for all of the material covered. Any changes in this syllabus or the scheduling of exams, assignments, etc., will be announced during class meetings. Students who miss a class meeting should copy a classmate's notes for that meeting.
Class Participation: You are urged to ask questions during our class meetings whenever you believe this will enhance your understanding.

Study Groups: I encourage you to study with others in the same course. Meet regularly to go over the concepts. Many students have reported phenomenal success in their mathematics courses after they have joined a study group.

STUDENTS WITH DISABILITIES:

Any student who feels s/he may need an accommodation based on the impact of a disability should contact me privately to discuss her/his specific needs. Please provide a letter from Disability Services in your earliest convenience.

HONOR CODE POLICY:

You are reminded of the Academic Honor Code in place at Colgate University. All tests and other graded assignments fall under the auspices of this policy. Unless otherwise indicated, all graded materials must contain only work that you have completed yourself. Appropriate citation of the work or ideas of others is expected in all writing assignments. Cases of plagiarism will be referred to the Colgate Student Conduct Board. Students are reminded that convictions of violations of Colgate's Academic Honesty Policy result in a grade of F for the entire course, not for the individual assignment.

Contrary to what you have probably been told up to this point in your life, your integrity is more valuable than your intelligence or good grades. So, (1) don't cheat on the assignments, and (2) don't represent the writing or ideas of someone else as your own in your written work. Do not work with others in the class to "feed" materials from one lab section to the other; do not work with one another on exams and quizzes or collaborate in other nefarious ways. If you have any questions about what might be an appropriate collaboration or use of previous knowledge, ask.

This is a course in which we have had previous experiences with cheating. So, from experience, we know that if you cheat, it will be embarrassing for everyone, it will destroy your grade, it may have life-changing effects on your academic career, and simply be awful in every way.

TENTATIVE LECTURE SCHEDULE (FALL 2022)

Date		Topic	Assignment	Reading Assignment
AUG	25	1/2-day Introductory Period		
	26	Introduction to Network Science		Linked: Introduction
	29	Technological/Information Networks		
	31	Social Networks		
SEP	2	Biological Networks		Linked: The Map of Life
	5	Network Measures and Metrics	HW 1	
	7	Network Measures and Metrics		
	9	Power and Influence: Centrality		The Human Network: Chapter 2
	12	Network Measures and Metrics	HW 2	
	14	Network Measures and Metrics		
	16	Too Connected to Fail?		The Human Network: Chapter 4
	19	Computer Algorithms	HW 3	
	21	Computer Algorithms		
	23	Computer Algorithms		
	26	**EXAM 1(IN CLASS)**	HW 4	
	28	The Structure of Real-World Networks		
	30	The Structure of Real-World Networks		Linked: Chapters 3-6
OCT	3	The Structure of Real-World Networks	**EXAM 1 (TH)**	
	5	The Structure of Real-World Networks		
	7	Random Networks		Linked: The Random Universe
	10	**MIDTERM RECESS**		
	12	Random Networks		
	14	Random Networks		
	17	Models of Network Formation	HW 5	
	19	Models of Network Formation		
	21	Models of Network Formation		Linked: Rich Get Richer
	24	Evolving Networks	HW 6	
	26	Evolving Networks		
	28	Globalization: Our Changing Networks		The Human Network: Chapter 9
	31	Network Robustness	HW 7	
NOV	2	Network Robustness		
	4	Network Robustness		Linked: Achilles' Heel
	7	**EXAM 2(IN CLASS)**	HW 8	
	9	Network Communities		
	11	Network Communities		Dimaggio and Garip (2012)
	14	Network Communities	**EXAM 2 (TH)**	
	16	Network Effects & Social Inequality		
	18	Network Effects & Social Inequality		News Articles 1&2
	21	**THANKSGIVING BREAK**		
	23	**THANKSGIVING BREAK**		
	25	**THANKSGIVING BREAK**		
	28	Epidemics on Networks	HW 9	Linked: Viruses and Fads
	30	Epidemics on Networks		
DEC	2	Drug Repurposing for Rare Diseases		Guney et al. (2016)
	5	**FINAL PRESENTATIONS**		
	7	**FINAL PRESENTATIONS**		
	9	**FINAL PRESENTATIONS**		