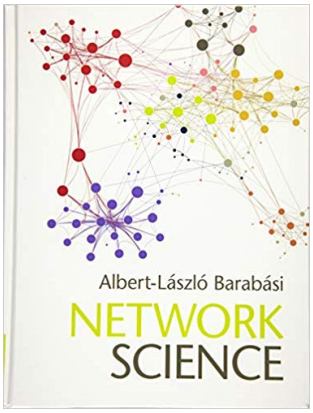
ECE-GY 9293 NETWORK SCIENCE AND OPTIMIZATION

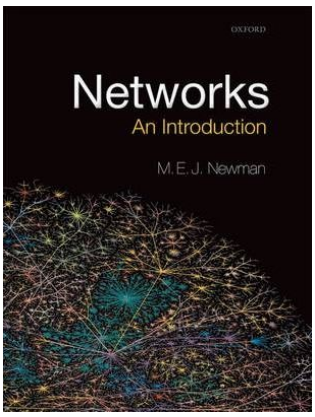
(SELECTED TOPICS)

INSTRUCTOR: Prof. Yury Dvorkin (dvorkin@nyu.edu)
LECTURE: 9:50-11:20 AM on Thursdays
OFFICE HOURS: TBA (on a weekly basis), or by email

INTRO: This is an introductory graduate-level class that will develop foundational knowledge in the **mathematical theory of networks and decision-making in complex network environments**, with applications to network-driven phenomena and cyber-physical and social networks. Although the course will start with a **review of related engineering concepts** that will be necessary to successfully complete all course requirements, the students are expected to complete undergraduate calculus and linear algebra. **Students outside of ECE and NYU Tandon are encouraged to register**. Please email the instructor if you have any questions or concerns.



COURSE DESCRIPTION: The course teaches foundational knowledge from emerging science of complex networks and their applications. Topics to be covered include the mathematics of networks (derived from graph theory), data analysis, and decision-making under uncertainty and their applications to biology, citizen science, cyber security, cyber-physical systems and other fields. Motivated by these applications with complex network structures, the course will cover algorithms for solving them and the complexity/difficulty of these algorithms from an operations research point of view. Students will learn about the ongoing research in the field, and ultimately apply their knowledge to conduct their own analysis of a real network data sets of their choosing as part of the final project.



BOOKS: The course will closely follow the following two books, which strongly complement each other:
[BAR] L. Barabasi, "Network Science," Cambridge University Press, 2016. (available for free online: http://networksciencebook.com/)
[NEW] M. Newman, "Networks: An Introduction," Oxford University Press, 2010. (available for free online: https://www.oxfordscholarship.com/view/10.1093/acprof:oso)

Note that homework assignments will be based on **[BAR]** and, in some rare cases, on **[NEW]**. Both books are available through NYU Libraries. If you have any difficult getting access (e.g. affordability, availability, etc) to either **[BAR]** or **[NEW]**, you can use borrow a copy from my office.

ALTERNATIVE/EXTRA MATERIALS: There is a number of alternative resources that could support learning in this course. The most relevant ones are listed below:

[ZHU] L. Zhukov, Networks: Theory and Algorithms, 2014. Link: http://leonidzhukov.net/hse/2014/socialnetworks/ (note that it is a bilingual web-page; all course materials are in both Russian and English, but all video lectures are in English)
[DOR] S. Dorogovtsev, Lectures on Complex Network Systems, Oxford University Press (2010).
[**EAS**] D. Easley and J. Kleinberg, "Networks, Crowds, and Markets", Cambridge University Press, (2010)
[**AHU**] R. K. Ahuja, T. L. Magnanti, and J. B. Orlin, Network Flows: Theory, Algorithms, and Applications, Prentice Hall, Upper Saddle River, NJ (1993)
[**DATA**] We will use network sets from **[BAR]**, which can be downloaded here: http://networksciencebook.com/translations/en/resources/data.html

HOMEWORK ASSIGNMENTS: Homework will be assigned bi-weekly and will include theoretical questions and practice problems. In some cases, there will be a programming assignment that will require manipulations with **[DATA]**. Homework assignments can be done in groups, but everyone must submit an individual homework report.

TOPICS TO BE COVERED:

Topic 1:	Course Introduction & Introduction to networks
Topic 2:	Review of prerequisies as applicable to network sciences
Topic 3:	Mathematics of networks
Topic 4:	Centrality
Topic 5:	Network and agent properties
Topic 6:	Degree distributions
Topic 7:	Complexity
Topic 8:	Algorithms for network science
Topic 9:	Percolation in networks
Topic 10:	Network robustness and resiliency
Topic 11:	Spreading in networks
Topic 12:	Optimization over networks
Topic 13:	Algorithm for resilient network design

GRADING:

- Attendance – 10 %
- Homework (biweekly assignments) – 50%
- Midterm (related to homework problems; 1-page cheat sheet is allowed) – 20%
- Final exam (related to homework problems; 1-page cheat sheet is allowed) – 20%

DISSEMENTATION OF MATERIALS:

- All class materials are posted on NYU Classes
- Homework is posted biweekly after the lecture

QUESTIONS: Please email me at dvorkin@nyu.edu

OTHER (IMPORTANT) RESOURCES:

- NYU Tandon Policy on Academic Integrity: http://engineering.nyu.edu/online-asynchronous-orientation/academic-integrity.php
- If you require reasonable accommodation due to documented disability, please email me and check the following NYU resource: http://www.nyu.edu/students/communities-and-groups/students-with-disabilities.html