TO: The Faculty of the College of Engineering

FROM: Elmore Family School of Electrical and Computer Engineering

RE: New Graduate Course, ECE 60283 Epidemic Processes over Networks

The faculty of the School of Electrical and Computer Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

ECE 60283 Epidemic Processes over Networks
Sem. 1, Lecture 3, Cr. 1, 5 weeks.
Prerequisite: Introduction to Mathematical Fundamentals for Systems & Control Theory, (permanent number request for this course ECE 60281) and Epidemic Processes (permanent number request for this course ECE 60282) obtaining a grade of at least C-

Description: This course presents a class of epidemic models from a network science, control theoretic, and data science perspective. Networked epidemiological ideas will be explored combined with probability theory and systems theoretic ideas to be able to capture spread behavior, learn the behavior from data, and design mitigation techniques. Namely, the course consists of three modules: 1) Networked Virus Models, 2) Limiting Behavior of Networked Virus Models, and 3) Parameter Identification & Mitigation Algorithms

Reason: This course presents a class of epidemic models from a network science, control theoretic, and data science perspective. Networked epidemiological ideas will be explored combined with probability theory and systems theoretic ideas to be able to capture spread behavior, learn the behavior from data, and design mitigation techniques. Namely, the course consists of four modules: 1) Group Virus Models, 2) Solutions and Limiting Behavior, 3) Model Parameter Identification, and 4) Mitigation Algorithms. Given the impact of the COVID-19 pandemic and how the spread of the virus was accelerated by society's strong interconnectedness, these problems are of the utmost importance.

Course History: Spring 2022 – 2, Spring 2021 - 9

Milind Kulkarni,
Associate Head for Teaching and Learning
Elmore Family School of Electrical and Computer Engineering

ECE 60283: Epidemic Process Over Networks

Instructor

- Philip E. Paré, *Assistant Professor of Electrical and Computer Engineering, Purdue University*

Course Description

This course presents a class of epidemic models from a network science, control theoretic, and data science perspective. Networked epidemiological ideas will be explored combined with probability theory and systems theoretic ideas to be able to capture spread behavior, learn the behavior from data, and design mitigation techniques. Namely, the course consists of three modules: 1) Networked Virus Models, 2) Limiting Behavior of Networked Virus Models, and 3) Parameter Identification & Mitigation Algorithms.

Course Learning Outcomes

After completing this course, you will be able to:

- Differentiate between distinct networked compartmental models for epidemics (SI, SIS, SIR, etc.) in order to identify the best model for a given scenario.
- Analyze the limiting behavior of networked models for epidemic processes by identifying the different possible equilibria of the models and specifying conditions for converging to different equilibria.
- Estimate model parameters from data for the different networked epidemic models.
- Employ the estimated model parameters to forecast the spread of an outbreak.
- Choose the best networked model for a given scenario/dataset by employing their knowledge of the epidemic models and by comparing the fit from the estimated parameters and the forecast accuracy.
- Develop and implement mitigation algorithms for the different models of epidemic processes.
- Leverage the advantages and disadvantages of using networked models of epidemics processes versus group models in a given situation.

Required Software

You will need access to MATLAB® or an equivalent tool for this course.

- **MATLAB®** is the preferred tool for this course.
- **GNU Octave** is the recommended alternative to **MATLAB®**.

Options for Accessing MATLAB

1. Purchase a student version of MATLAB for $99.
2. Use MATLAB through Purdue Software Remote.

Notes:

- Additional information on Software Remote
- For assistance using Software Remote, contact Purdue ITAP.
- MATLAB is the preferred tool for this course. Students are welcome to use equivalent tools of their choice.
- ***Important:*** Purdue has a limited number of MATLAB licenses for Software Remote, and access may be unavailable during busy times.

Accessing GNU Octave (version 5.2.0)

1. Go to the GNU Octave website.
2. Click the *Download* button on the right of the screen for download information for your specific system.

Notes:

- Download information for specific systems
- GNU Octave Support/Help
- Octave is the recommended tool for this course. Students are welcome to use equivalent tools of their choice.
- ***Important:*** Octave is a free software under the GNU General Public License.

Recommended Reading

- *Epidemics and Rumours in Complex Networks*, M. Draief and L. Massoulie, The London Mathematical Society, 2010, ISBN: 9780511806018
- *Networks, Crowds and Markets*, D. Easley and J. Kleinberg, Cambridge Univ. Press, 2010, ISBN: 9780521195331

Prerequisites

- ECE_695_IMF, Introduction to Mathematical Fundamentals for Systems & Control Theory, obtaining a grade of at least C-
- ECE_695_EP, Epidemic Processes, obtaining a grade of at least C-

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s course will be graded based on the following criteria:

Assessment Type	Description	% of Final Grade
Homework	There will be two (2) homework assignments. Homework will be based on the content of the module in which it is located, but each module builds on the previous. Each assignment will be worth 15 points and will consist of five questions.	30%

	Your answers to the homework assignments should be typed in LaTeX and will be submitted via Gradescope.	
Project	The project will provide an opportunity to implement the principles you have learned on a real dataset of your choosing. For this project, you will select a dataset, write a project proposal; complete a project progress report; present your final results; share feedback with your peers; and complete a final report. • **Project Proposal -** You will submit a project proposal in Week 1. The project proposal will constitute 5% of your overall grade (5 points, 5/70 of the project grade) and will explain your application, the motivation of this project (citing at least 2 papers), the general goals of the project, and an outline of the plan of action in 1-2 pages (not including citations). Your proposal will be submitted via Gradescope. • **Project Progress Report -** You will submit a progress report in Week 3. The progress report will constitute 15% of your overall grade (15 points, 15/70 of the project grade) and will give updates on your progress, including the motivation (citing at least 5 papers), plots of clean data, simulations of the appropriate model(s), and concrete plans for accomplishing the rest of the project goals. The progress report should be 2-4 pages long (not including citations). Your progress report will be submitted via Gradescope. • **Project Presentation -** You will record or present-live a brief (7-10 min) presentation. Presentations will be due in Week 5. The presentation will constitute 19% of your overall grade (19 points, 19/70 of the project grade). An ideal sample presentation outline would include a background and motivation section, data depiction that expounds on challenges faced, selected model and reasoning behind choice, simulation/prediction results with accuracy discussion, and a depiction of implemented control strategies. Best practices for recording the video will be included in the course. Specific directions for submitting your presentation will be included in the course. • **Project Peer Feedback -** You will review at least 5 peer presentations, providing feedback and/or questions for each presentation. The project peer feedback will constitute 1% of your overall grade (1 point, 1/70 of the project grade). This feedback could include clarification questions, positive feedback on the results (i.e. something you found especially interesting), ideas for extensions, etc. or a combination of the aforementioned examples. This feedback should be constructive and professional. Specific directions for submitting your feedback will be included in the course. • **Project Final Report -** You will submit a final project report at the end of the course. The final project report will constitute 30% of your overall grade (30 points, 30/70 of the project grade) and will include an abstract, an Introduction, a Methods/Results Section, a Simulations Section, a Data Processing and Analysis Section, a Conclusion, a Bibliography (with at least 10 citations), and an Appendix. The final report should be 5-8 pages long (not including the Bibliography and Appendix). Your final report will be	70%

	submitted via Gradescope. Refer to the specific project directions in the course for the final report rubric.	

Grading Scale

98% - 100%	A+
90% - 98%	A
84% - 90%	A-
78% - 84%	B+
72% - 78%	B
68% - 72%	B-
63% - 68%	C+
58% - 63%	C
53% - 58%	C-
48% - 53%	D+
45% - 48%	D
40% - 45%	D-
<40%	F

Course Schedule

Week	Module	Dates	Assignments
1 - 2	**1 – Networked Virus Models**	10/23 – 11/5	• Homework 1 Assigned: ○ Available in course: 10/23 • Project Assigned: ○ Available in course: 10/23 • Project Proposal Due: ○ Due Date: **Wednesday, 11/1 at 11:59 PM ET** *(11/2 at 03:59 UTC)*
3	**2 – Limiting Behavior of Networked Virus Models**	11/6 – 11/12	• Homework 2 Assigned: ○ Available in course: 11/6 • Homework 1 Due: ○ Due Date: **Wednesday, 11/8 at 11:59 PM ET** *(11/9 at 03:59 UTC)* • Project Progress Report Due: ○ Due Date: **Friday, 11/10 at 11:59 PM ET** *(11/11 at 03:59 UTC)*
4 - 5	**3 - Parameter Identification & Mitigation Algorithms**	11/13 – 12/10	• Homework 2 Due: ○ Due Date: **Wednesday, 12/6 at 11:59 PM ET** *(4/29 at 03:59 UTC)* • Project Presentation Due: ○ Due Date: **Thursday, 12/7 at 1:00 PM ET** *(4/29 at 17:00 UTC)* • Project Peer Feedback Due: ○ Due Date: **Saturday, 12/9 at 1:00 PM ET** *(5/1 at 17:00 UTC)*
	Project Final Report Due		• Project Final Report Due: ○ Due Date: **Wednesday, 12/13 at 11:59 PM ET** *(12/14 at 03:59 UTC)*

Course Help

To get help with course content, comment in the discussion forums located in each unit. By commenting in the unit discussion forums, the course team will be able to respond to your question more quickly. During the work week, the course team will respond to your question within 36 hours.

Discussion Guidelines

Please follow the Discussion Guidelines when contributing to discussions in this course. Here are a few of the key points you should remember:

- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular or slang language. This could possibly lead to misinterpretation.
- Do not hesitate to ask for feedback.
- Be concise and to the point.
- Think and edit before you push the "Send" button.

Technical Help

If you experience technical difficulties with the edX platform, contact edX Support using:

- The email address: support-masters@edx.org
- edX's Contact Us form

Accessibility Information

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

The **Office of Institutional Equity**, which is responsible for ensuring Americans with Disability Act compliance, can be contacted with any accessibility concerns at:

Phone: (765) 494-7253
Email: equity@purdue.edu
TTY: (765) 496-1343
Website

- Purdue's Disability Resource Center Website
- Purdue's Web Accessibility Policy
- edX's Website Accessibility Policy
- MATLAB's Accessibility Policy
- GNU Accessibility Policy

Academic Integrity

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing or by calling 765-494-8778. While information may be submitted anonymously, the more information that is submitted provides the greatest opportunity for the university to investigate the concern.

The Purdue Honor Pledge

> *"As a Boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."*

Nondiscrimination Statement

Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Link to Purdue's nondiscrimination policy statement.