Network Science (NETS)

NETS 1990. Elective. (1-4 Hours)
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

NETS 2990. Elective. (1-4 Hours)
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

NETS 3990. Elective. (1-4 Hours)
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

NETS 4990. Elective. (1-4 Hours)
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

NETS 5116. Network Science 1. (4 Hours)
Introduces network science and the set of analytical, numerical, and modeling tools used to understand complex networks emerging in nature and technology. Focuses on the empirical study of real networks, with examples coming from biology (metabolic, protein interaction networks), computer science (World Wide Web, Internet), or social systems (e-mail, friendship networks). Shows the organizing principles that govern the emergence of networks and the set of tools necessary to characterize and model them. Covers elements of graph theory, statistical physics, biology, and social science as they pertain to the understanding of complex systems.

Prerequisite(s): PHYS 2303 with a minimum grade of D- or graduate program admission
Attribute(s): NUpath Natural/Designed World

NETS 6108. Complex Network Analysis Capstone. (2 Hours)
Offers students an opportunity to apply network analytic tools and network science concepts to a project that further develops skills and expands understanding of how to approach problems using network analytics and principles. Students may propose a topic or choose projects presented by a sponsoring organization or agency. Topics must be approved by the instructor, and students are expected to provide regular updates and present their final project. May be repeated once.

Prerequisite(s): INSH 5301 with a minimum grade of C ; NETS 5001 with a minimum grade of C ; NETS 5002 with a minimum grade of C ; NETS 5103 with a minimum grade of C

NETS 6116. Network Science 2. (4 Hours)
Continues an exploration of network science and the set of analytical, numerical, and modeling tools used to understand complex networks emerging in nature and technology. Focuses on the empirical study of real networks. Investigates the organizing principles that govern the emergence of networks and the set of tools necessary to characterize and model them. Offers students an opportunity to obtain a deeper understanding of complex systems.

Prerequisite(s): PHYS 5116 with a minimum grade of C or NETS 5116 with a minimum grade of C

NETS 6962. Elective. (1-4 Hours)
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

NETS 7332. Machine Learning with Graphs. (4 Hours)
Covers a number of advanced topics in machine learning and data mining on graphs, including vertex classification, graph clustering, link prediction and analysis, graph distance functions, graph embedding and representation learning, deep learning for graphs, anomaly detection, graph summarization, network inference, adversarial learning on networks, and notions of fairness in social networks. Seeks to familiarize students with state-of-the-art descriptive and predictive algorithms on graphs. Requires a foundational understanding of calculus and linear algebra, probability, machine learning or data mining, algorithms, and programming skills.

Prerequisite(s): PHYS 5116 with a minimum grade of C

NETS 7334. Social Networks. (4 Hours)
Offers an overview of the literature on social networks, with literature from political science, sociology, economics, and physics. Analyzes the underlying topology of networks and how we visualize and analyze network data. Key topics include small-world literature and the spread of information and disease. Students who do not meet course prerequisites may seek permission of instructor.

NETS 7335. Dynamical Processes in Complex Networks. (4 Hours)
Immerses students in the modeling of dynamical processes (contagion, diffusion, routing, consensus formation, etc.) in complex networks. Includes guest lectures from local and national experts working in process modeling on networks. Dynamical processes in complex networks provide a rationale for understanding the emerging tipping points and nonlinear properties that often underpin the most interesting characteristics of sociotechnical systems. Reviews the recent progress in modeling dynamical processes that integrates the complex features and heterogeneities of real-world systems.

Prerequisite(s): NETS 5116 with a minimum grade of C- or PHYS 5116 with a minimum grade of C-

NETS 7341. Network Economics. (4 Hours)
Covers seminal works in the economics of information and networks, including Akerlof, Arrow, Spence, Stiglitz, and von Hayek. Proceeds through concepts of information, its value, and measurement; search and choice under uncertainty; signaling, screening, and how rational actors use information for private advantage; strategy-given network effects; two-sided (or multisided) network effects, organizational information processing, learning, and social networks; and other micro- and macroeconomic effects such as matching markets. Although primarily a theory course, it may be of interest to any student applying information economics and network economics in academic, commercial, or government policy contexts. Expects students to produce a major paper suitable for publication or inclusion in a thesis. Requires prior completion of graduate coursework in microeconomics and mathematics at the level of introductory calculus and statistics.

NETS 7350. Bayesian and Network Statistics. (4 Hours)
Introduces advanced quantitative methods including maximum likelihood, hierarchical models, sampling, and network modeling. Offers students an opportunity to engage in estimating and developing models from the probabilistic and Bayesian perspective and to pursue their own research project, focusing on methodological challenges. Reviews probability and examines maximum likelihood methods for estimating regression models with continuous and categorical dependent variables. Examines a variety of procedures for sampling from posterior distributions including grid, quadratic, Gibbs, and Metropolis sampling. Applies these methods to hierarchical modeling and other simple probabilistic models and then takes a closer look at the statistical modeling of networks as it has been developed in the social sciences (e.g., exponential random graph models, temporal models such as TERGM and SIENA, spatial network models, and stochastic block models).

NETS 7360. Research Design for Social Networks. (4 Hours)
Analyzes the architecture of research—how to design ethical research projects that empower the researcher to make useful and interesting claims about the world. Topics include design research about social networks and how to measure such varied relational concepts such as friendship, love, and proximity; the effective study of "recycled" data—data not collected for research—such as Twitter, cell phone, or email data, and the ethical constraints in using this data; and how to design data collection so as to make robust causal claims.

NETS 7370. Computational Urban Science. (4 Hours)
Introduces the field of computational urban science, focusing on methods to collect and analyze urban data. Covers techniques such as geographic information systems, network science, machine learning, spatial models, and causal inference to examine city dynamics and inform urban planning, policy, and research. Explores the application of these methods to real-world urban datasets, including mobile phone data, social media, and transactional data, enabling critical insights into the complexities of urban systems.

Prerequisite(s): INSH 5301 with a minimum grade of B or NETS 5116 with a minimum grade of B or PHYS 5116 with a minimum grade of B

NETS 7976. Directed Study. (1-4 Hours)
Offers independent work under the direction of a member of the program on a chosen topic. Course content depends on instructor. May be repeated without limit.

NETS 7983. Topics. (4 Hours)
Covers various topics in network science. May be repeated up to two times for up to 12 total credits.

NETS 8941. Network Science Literature Review Seminar. (2 Hours)
Critically evaluates recent articles in the academic literature surrounding topics and applied research in network science. May be repeated up to three times.

NETS 8984. Research. (1-4 Hours)
Offers advanced students an opportunity to work with an individual instructor on a topic related to current research. Instructor and student negotiate a written agreement as to what topic(s) are covered and what written or laboratory work forms the basis for the grade. Viewed as a lead-in to dissertation research. May be repeated without limit.

NETS 8986. Research. (0 Hours)
Offers an opportunity to conduct full-time research under faculty supervision. May be repeated without limit.

NETS 9000. PhD Candidacy Achieved. (0 Hours)
Indicates successful completion of the doctoral comprehensive exam.

NETS 9990. Dissertation Term 1. (0 Hours)
Offers experimental and theoretical work for PhD candidates. Requires written dissertation and final oral exam.

Prerequisite(s): NETS 9000 with a minimum grade of S

NETS 9991. Dissertation Term 2. (0 Hours)
Offers dissertation supervision by members of the department.

Prerequisite(s): NETS 9990 with a minimum grade of S

NETS 9996. Dissertation Continuation. (0 Hours)
Offers experimental and theoretical work for PhD candidates. Requires written dissertation and final oral exam.

Prerequisite(s): NETS 9991 with a minimum grade of S or Dissertation Check with a score of REQ