Principles of Complex Systems
CSYS/MATH 300; Instructor: Prof. Peter Dodds
Tuesday and Thursday, 11:30 am to 12:45 pm in 102 Perkins
Level: Graduate/Advanced Undergraduate

Synopsis: Many of the problems we face in the modern world revolve around comprehending, controlling, and designing multi-scale, interconnected systems. Networked systems, for example, facilitate the diffusion and creation of ideas, the physical transportation of people and goods, and the distribution and redistribution of energy. Complex systems such as the human body and ecological systems are typically highly balanced, flexible, and robust, but are also susceptible to systemic collapse. These complex problems almost always have economic, social, and technological aspects.

So what do we know about complex systems? My basic aim in this introductory, interdisciplinary course is to impart knowledge of a suite of theories and ideas and tools that have been evolved over the last century in the pursuit of understanding complex systems. We’ll touch on everything from physics to sociology, from randomness to cities to language. Throughout the course, we’ll maintain a focus on (1) real small-scale mechanisms that give rise to observed macro phenomena, (2) scaling phenomena, and (3) complex networks, allowing us to explore how seemingly disparate systems connect to each other—the phenomenon of universality—and, just as importantly, where tempting analogies break down.

Potential topics:
Emergence and Universality
Scaling Phenomena
Complex Networks
Hierarchies and Modularity
Complexity from Simple Rules
Robustness & Fragility
Statistical Mechanics
Inevitability and Path Dependence

Complex Sociotechnical Phenomena
Social & Biological Contagion
Network Analysis and Visualization
Collective behavior
Information & Search
Language and knowledge
Stories
The Theory of Anything

http://www.uvm.edu/~pdodds/teaching/courses/2013-01UVM-300