ECE 592-XXX
Advanced Computer Networks for Distributed Computing Systems

(Note: For ECE courses, 700-level courses have a 500-level course as a prerequisite)
(If no section number, contact Elizabeth New to create one.)

Instructor(s): Dr. Ruozhou Yu (ryu5@ncsu.edu)

Objective or Description:
This course explores the design and implementation principles of advanced computer networks that support modern distributed computing systems. In particular, the course will emphasize on recent networking techniques developed and used for cloud computing, edge computing, and peer-to-peer systems, which have enabled high-performance and reliable applications such as MapReduce, search engines, stream analysis, mobile AR/VR, etc. Multiple aspects of each of these types of networks will be explored, including architectures, protocols and tools, metrics and performance, and applications. The students will be encouraged to read research papers in related areas. In addition, the students will learn and practice using network simulation/emulation tools to model and improve the performance of network architectures and protocols, through homework assignments and the course project.

By the end of this course, students should be able to:
- Understand the principles for network design and implementation in cloud computing, edge computing and P2P networks
- Understand how network protocols and architectures support modern cloud, edge and P2P applications
- Understand the role and concept of network simulation and emulation tools
- Model and analyze the performance of network architectures and protocols using network simulation/emulation tools
- Identify research problems and trends in related areas by doing literature review
- Make oral presentation of literature review and/or research/reproduction results

Prerequisites:
- A networking course at the undergraduate level (CSC/ECE 400+)
- Programming using C/C++
- Basics on using Matlab/Python/other tools to visualize data statistics

Textbook: No textbook required. Students are encouraged to read:
- "Cloud Networking: Understanding Cloud-based Data Center Networks," by Gary Lee.
- "Handbook of Peer-to-Peer Networking," by Xuemin Shen, Heather Yu, John Buford, and Mursalin Akon.

Topics:
- Review of Internet Architecture and Introduction to Cloud Networking
- Network Simulation and Emulation
- Data Center Networks: Architecture
- Data Center Networks: Protocols and Tools (Layer 2/3/4)
- Data Center Networks: Protocols and Tools (Virtualization & SDN)
- Data Center Networks: Application Layer and Cross-Layer Design
- Beyond Data Centers: Cloud Networking over the Internet
- Edge Computing: Architecture
- Edge Computing: Algorithms

- P2P Overlay: Basics and Architecture
- P2P Overlay: Protocols

Grading: For ECE students, the final project can be chosen from a Literature Review (report + oral presentation) and a Research/Reproduction Project using NS3 (report + oral presentation)
- 50% Homework Assignments
- 20% Exam
- 15% Report for Final Project (Literature Review or Research/Reproduction)
- 15% Oral Presentation for Final Project (Literature Review or Research/Reproduction)

Cross-listing in other departments: cross-listed with CSC 591/791-023

Include anything else that is unique to the course - this information will be posted on the ECE Current Graduate/Undergraduate Student Portals for all students to view
This course features a combination of theory and implementations of networking advances in distributed systems. Theory is learnt from lectures, while implementation is learnt from homework assignments and/or project that aim to use NS-3 to validate and reproduce results from the state-of-the-art networking solutions. The covered topics either have been applied in production environments such as Google Data Centers and Amazon EC2, or have inspired extensive research opportunities.

For more information about Dr. Yu and his research, please see his homepage:
https://people.engr.ncsu.edu/ryu5/