ECE 607 Advanced Network Algorithms Spring 2025

October 24, 2025

Instructor: Galen Sasaki. **Office:** Holmes 436. **Office Hours:** TBD.

Brief Course Description: The course will cover algorithms that are used in network research and implementation. These include graph algorithms, transmission scheduling, traffic management, control algorithms for certain switch/router architectures, optimization algorithms. There is an emphasis on TCP/IP as a case study.

Prerequisite: EE 367 (data structures) and knowledge of C programming, or consent of instructor. Knowledge of C programming is required of everyone. Knowledge of undergraduate probability (e.g., EE 342) will be helpful, but not necessary.

Textbooks:

- Fall and Stevens, TCP/IP Illustrated, Vol. 1: The Protocols, Second Edition, Addison-Wesley
- Cormen, Leiserson, Rivest, and Stein (4rd edition), Introduction to Algorithms, MacGraw Hill

Topics:

Overview of the networking	Computer communication and computer networks Examples: Ethernet (Link Layer): distributed control plane
Algorithms and applications in networking	Review of graph algorithms: shortest path, max flow, NP Completeness. Optimization and mathematical programming (e.g., linear programming, integer linear programming, and mixed integer linear programming), as well as heuristics such as simulated annealing and steepest descent.
Network layer	IP Packets, routing, ARP, DHCP, NAT IP table lookups: longest prefix match Distance vector routing (e.g., RIP, EIGRP) and link-state routing (e.g., OSPF) Virtual bandwidth splitting: weighted fair queueing and virtual clock service Software Defined Networks (Openflow): centralized control plane
Switching	Topologies: Crossbars, banyan, hypercube, shuffle, Clos, fat trees, rings, grids, torus Data center interconnection Upper and lower bounds on size and performance
Transport layer	TCP and UDP Closed-loop control Basic ARQ: go-back-N (sliding window), selective repeat TCP: Tahoe, Reno, New Reno Fairness: AIMD Open-loop control Leaky-bucket flow control, (σ, ρ)-traffic and queueing theory Other flow control mechanisms and concepts TCP Vegas, max min flow, link-by-link flow control, back-pressure (lossless) flow control and deadlock issues
MPLS	Basics MPLS Fast Reroute Other protection mechanisms and concepts (time permitting)
Time Permitting	SNMP P4

Assignments: Take-home midterm exam (10%)**, take-home final exam** (10%)**, homeworks and quizzes** (50%), **midterm project** (10%) (this will be an exercise on doing a research activity based on a past research paper, and then writing a paper about your results), and **final project** (20%) t(his includes an oral presentation and written report about a research paper/topic – you will be given a choice or you may propose one, though it must be approved).

Grading: The exams and the midterm and final projects will be graded: A= 90, A-=87, B+ =83, B=80, B-=77, C+=73, C=70, etc. The homeworks and quizzes will be graded more coarsely, e.g., 100% = correct or very nearly correct, 50% = good effort, and 0% = Little or no effort. For homeworks and quizzes, the total score is translated to letter grade as A =85, A-80, B+ 75, B = 70, B- = 65, C+ = 60, etc.