ECE 50863: Computer Network Systems

Course Information

Course name: Computer Network Systems
Credit: 3 credits
Offered: Fall 2021
Website: Brightspace (lecture videos, notes, assignments, submissions, etc.)

Instructor

- Sanjay Rao, *Professor of Electrical and Computer Engineering, Purdue University*
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Teaching Assistants:

- Chandan Bothra, Graduate TA (1/4 time TA)
  - Email: cbothra@purdue.edu
- Xin (Wyatt) Du, Undergraduate TA

Course Description

The goal of this course is to provide students with a proper grounding in the basic concepts and seminal work in computer network protocols and systems, and to introduce students to research in the field. The course will cover classical concepts such as network architecture, switching, routing, congestion control, and quality-of-service, and discuss recent developments in these areas. The course will also cover new developments in networking such as algorithms for Internet video delivery, network management, network security, and new network architectures such as Software Defined Networking. The course will emphasize a system-oriented and empirical view of Internet architecture.

Course Learning Outcomes

By the end of this course, you should be able to:

1. Describe the architectural principles underlying the Internet design
   a. Method of evaluation: Satisfactory performance in homeworks and examinations
2. Explain and summarize key elements of Internet design such as LAN interconnects, routing algorithms and congestion control algorithms
   a. Method of evaluation: Satisfactory performance in homeworks and examinations
3. Implement networking systems, address challenges encountered in their design, and rigorously evaluate them using systematic empirical methods
   a. Method of evaluation: Satisfactory performance in the projects
4. Read and critique cutting edge scientific publications related to computer networking
   a. Method of evaluation: Satisfactory performance in the projects, homeworks (especially discussion assignment), and examinations

Prerequisites

- ECE 264 (Advanced C Programming) or equivalent (hard requirement)
- ECE 368 (Data Structures) or equivalent with a grade of B or higher (hard requirement)
- Strong proficiency in programming and data structures (must have received a grade of B or higher) is required given the heavy programming requirements. Students should be strongly independent when it comes to coding/debugging. The course has limited TA support
- A broad and strong foundation in undergraduate computer engineering courses and good programming skills are essential. A prior course in operating systems or networking will be useful but not essential.
- Undergraduate students are strongly encouraged to talk to the instructor to make sure the course is appropriate for them.

Course Materials (Learning Resources, Technology and Text)

Text

- There is **no required text**, but the following text is strongly recommended:
    - *Computer Networks - A Systems Approach*, 5th Edition by Larry L. Peterson and Bruce S. Davie, Morgan Kaufmann, 2011. ISBN: 978-0-12-385059-1
        - Available through Purdue Libraries
- The course will involve the reading of research papers that cover historical perspective, case studies and more in-depth coverage of recent topics which is required.
    - Provided for free within the course materials

Required Software

- **Python**
    - In order to complete the lab exercises and projects in this course, you will need to access and use ***Python***, which is free to install. Refer to the "Required Materials" page in the *Start Here* section in Brightspace for details about installing Python.
- **GitHub Classroom**
    - Additionally, the labs are assigned and graded through ***GitHub Classroom***. In order to complete the lab exercises and projects in this course, you will need a GitHub account, which is free to create. Refer to the "Required Materials" page in the *Start Here* section in Brightspace for details about accessing GitHub classroom.

Grading (Assignments)

This course will be graded based on the following criteria:

Assessment Type	Description	% of Final Grade
Homework	Homework will be in the format of quizzes located throughout your course modules in Brightspace, or discussions of research publications. For each quiz, you will have an unlimited number of attempts, and only your highest score will be recorded. Refer to your course schedule in Brightspace for specific due dates.	15%
Lab Projects	There will be a small warm-up lab exercise and three projects in this course, to be done individually. The warm-up exercise carries only a small amount of credit (at most 5% of the total project grade for the course) but is essential for you to complete to prepare you for the projects. Each project will be roughly 4-5 weeks in duration, and each will carry between 30-35% of the total project grade. The projects will involve (i) building a simple centralized routing system using socket programming; (ii) designing and optimizing a reliable transport protocol; and (iii) designing and implementing Adaptive BitRate algorithms for video streaming. Some of the projects will not only involve implementation, but also open-ended components, reading of scientific papers, detailed evaluations of trade-offs between designs, and will require a written report documenting findings. Projects will be based heavily on Python, and will be submitted on GitHub Classroom. Students are required to have a GitHub account.	45%
Exams	There will be two exams in this course, a midterm and a final. Both exams will be open book and timed. They will be weighted as roughly equal. Online students will complete and submit both exams in Gradescope. We are finalizing the details for in campus students. You must complete an Honor Code quiz in order to take both exams. Tentatively, the Mid Term will be held the week of October 4th, and the Finals during Finals week.	40%

Grading Policy

The exact breakpoints for letter grades will be decided by the instructor at the end of the semester adjusting for the difficulty level of the examinations.

Typically, the cut-offs for an A, B and C grade are 90, 80, and 70 respectively. In addition, there will be +/- grading. The exact cutoffs for all grades will be based on the overall distribution of scores at the end of the course.

In deciding borderline cases, performance and regularity in homeworks, projects, and discussion assignments will be given significant consideration and greater weightage. Particular emphasis will be given to the quality of projects and especially the associated reports. A score of at least 40% is needed for each project in order to achieve a passing grade in the course.

Course Modules

- Module 1: Introduction & Internet Architecture (1 week)
- Module 2: Ethernet and Interconnects (2 weeks)
- Module 3: Network Performance (1 week)
- Module 4: IP (Network) Layer (3 weeks)
- Module 5: Transport Layer and TCP (3 weeks)
- Module 6: Video Rate Adaptation and Router Mechanisms (3 weeks)
- Module 7: Miscellaneous (DNS, Security and SDNs) (3 weeks)

NOTE: Refer to the Brightspace course for specific start and end dates for each module.

Estimated Effort

- 10 hours/week
- 16 weeks total

Course Communication and Help

Course announcements will be sent either via email or using Piazza (an intuitive platform designed to simulate real class discussion). It is your responsibility to monitor both your email and Piazza to track any announcements (e.g., changes to the projects, reminders, etc.). You will access Piazza through the link provided in Brightspace. Owing to limited TA support, the help that the course staff can provide with course content is limited. We encourage you to post questions on Piazza and to primarily resolve them through interactions with your peers. We strongly encourage students to respond to each other's questions. The course staff may only be able to respond to a selected subset of questions that it deems relevant to many students. In such cases responses may take up to 48 hours or two business days, whichever is later. Please start projects early and do not expect instantaneous responses on the day of a deadline.

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.

Class Policies

IMPORTANT: Please also refer to the *University Policies* section in Brightspace for more detailed university policies applicable to this course. Other policies specific to this course are described below.

Programming Projects:

1) As there is limited TA support for the class, you will be mostly on your own with regard to programming projects. We will provide starting points, and necessary background information. Questions of a generic and conceptual nature will be answered. However, we will be unable to debug your code or provide detailed feedback on why your code does not work. All programming projects require the use of Python.
2) It is your responsibility to keep track of any announcements related to the project in the appropriate class forum.
3) Late submissions will require that you obtain approval from me at least two days in advance and will incur stiff penalties based on the lateness of the submission. Approval is not guaranteed and will depend on the discretion of the instructor and the student's track record of prior on-time submissions. Submissions more than three days late will be assigned a score of zero. No exceptions will be made to this policy unless there are extraordinary circumstances (e.g., family emergency involving an immediate family member, medical illness) supported by appropriate documentation.
4) Some of the projects support auto-grading with GitHub classroom. Please note this is only provided as a convenience on a best-effort basis, and students should not rely on it, but do their own extensive testing. Assignments may get queued up at the grade server taking several hours for grading, and the grade server could be down. It is highly unlikely that submissions a few hours prior to the deadline will receive feedback in time, and this will not be grounds for any extension request. Students are advised to finish a couple of days in advance to have a better chance of getting the auto-grader results prior to the deadline. Please also note that for some of the projects the auto-grader only gives minimal feedback with a bulk of the grade depending on the design and documentation.

Homeworks: No extensions will be given for homeworks barring medical or family emergencies supported by appropriate documentation.

Examinations: Any conflict with the exam schedule needs to be brought to the instructor's attention at least one week prior to the examination date. Beyond this date, exceptions will only be considered if you present documentation confirming exceptional reasons beyond your control. You must also contact the instructor as soon as you become aware of the cause. The following are examples of insufficient reasons: non-emergency doctor visits, emergencies of

persons other than immediate family members, job interviews scheduled after the exam schedule is announced, etc.

Academic Honesty: Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, Student Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]

Cases of cheating or academic dishonesty may result in a lower grade, failure, a report filed with the Dean of Students and/or other action as per Purdue policies. You must take an Honor Code Quiz prior to the examinations - a prerequisite for your examinations to be graded. You may discuss homework problems and project assignments with other students. Helping a fellow student debug a program, or providing tips and suggestions on programming assignments and homeworks is perfectly fine and is in fact encouraged. However, the actual homework solution, program or code must be written individually by each student, and not copied from another student.

Reusing (or adapting) material (e.g., reusing code) from a student who took the course in a previous year will also be considered a form of academic dishonesty. Please note that we have solutions submitted by students for many of the past years and will be checking for code similarity with submissions from prior years.

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 integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace table of contents, under University Policies.

Use of Copyrighted Materials: All material, including lecture material and notes, homeworks, project descriptions, examinations, and solutions are subject to Purdue's policies regarding commercial note taking. ***Please do not post any material on an online web site without checking with the instructor.*** More details about Purdue's policies may be found in the *University Policies* section in Brightspace.

Attendance Policy:

On campus students only: Students are expected to attend all classes and participate actively in class discussions. While formal attendance will not be taken, and there is no formal grade for attendance and class participation, the instructor will consider attendance and class participation as a factor in borderline cases, and in any course accommodations requested by a student.

All students: Students are expected to participate actively and constructively in Piazza, and participate actively in any reading/discussion assignment conducted online. Regularity of turning in homeworks, and projects will be considered a form of active class participation.

Academic Guidance in the Event a Student is Quarantined/Isolated:
If you find yourself too sick to progress in the course, notify your adviser and notify me via email. We will make arrangements based on your particular situation. Barring major sickness, on-campus students are expected to use material available online to progress in the class. Note that this material will not include video recordings of in-class discussions and activities, but will include pre-recorded video content available for all online students.

Classroom Guidance Regarding Protect Purdue:
Any student who has substantial reason to believe that another person is threatening the safety of others by not complying with Protect Purdue protocols is encouraged to report the behavior to and discuss the next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights and the Violent Behavior Policy under University Resources in Brightspace.

Accessibility:
Purdue University is committed to making learning experiences accessible. 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.

Mental Health/Wellness Statement:
If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack. Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Another resource is TaskHuman, which offers private, real-time, on-demand, 1-on-1 video calls with wellness coaches covering over 800+ topics such as anxiety, mindfulness, reducing stress, clean eating, time management, in-home workouts, relationship tensions, financial issues, spiritual guidance and many more. You can access these wellness coaches from around the world 24/7. The College of Engineering has an exclusive agreement with TaskHuman which gives you free and unlimited access to these resources. Over 3,200 calls have been made by College of Engineering students, staff, and faculty so far with an average satisfaction rating of 4.89/5. Learn more here: https://engineering.purdue.edu/ECE/TaskHuman

Nondiscrimination Statement:
A hyperlink to Purdue's full Nondiscrimination Policy Statement is included in our course Brightspace under University Policies.

Basic Needs Security:
Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday. Considering the significant disruptions caused by the current global crisis as it related to COVID-19, students may submit requests for emergency assistance from the Critical Needs Fund

Emergency Preparation:
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.

To report an emergency, call 911. To obtain updates regarding an ongoing emergency, sign up for Purdue Alert text messages, view www.purdue.edu/ea.

There are nearly 300 Emergency Telephones outdoors across campus and in parking garages that connect directly to the PUPD. If you feel threatened or need help, push the button and you will be connected immediately.

If we hear a fire alarm during class we will immediately suspend class, evacuate the building, and proceed outdoors. Do not use the elevator.

If we are notified during class of a Shelter in Place requirement for a tornado warning, we will suspend class and shelter in [the basement].

If we are notified during class of a Shelter in Place requirement for a hazardous materials release, or a civil disturbance, including a shooting or other use of weapons, we will suspend class and shelter in the classroom, shutting the door and turning off the lights.

Please review the Emergency Preparedness website for additional information.___
http://www.purdue.edu/ehps/emergency_preparedness/index.html