Georgia Institute of Technology

Course Syllabus: CS6250 Computer Networks

Fall 2020
Delivery: 100% Web-Based
Dates course will run: August 17 – Dec 12, 2020

Instructor Information

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Aja Woolworth, Head TA	*Please contact the instruction team through Piazza using a private post to 'Instructors'*
James Lohse, Head TA	

General Course Information

Description

This project-based course will explore research topics in computer networking from a computer scientist's perspective, primarily at the Internet Protocol (IP) layer and above. Students will gain exposure to burgeoning areas of computer networking and learn how to use the tools commonly used for networking research. The course begins with an overview of the history of the Internet and its current architecture, teaches how basic computer networking algorithms and protocols work, and explores router design and functionalities. Then the course takes a more in-depth look at Software Defined Networking technologies and how to achieve multiple tasks by applying various Internet measurements and analytics. The final part of the course explores current issues related to networking such as Content Delivery Network (CDN), overlay networks, cloud computing, wireless and mobile networks, and the Internet of Things. Hands-on projects exploring these topics will be completed in Python.

Pre-/Co-Requisites

A prior course in computer networking is not a prerequisite. However, this is an advanced course. Many things that would be covered in an introductory undergraduate course will not be covered in this course beyond a "review" level. Having a prior understanding of *basic* networking concepts is expected (such as IP addresses, subnets, TCP vs. UDP, OSI layer model and encapsulation, 3-way handshakes, basic operation of HTTP, client-server model vs. peer-to-peer model, etc.). Students will be expected to code in Python at an intermediate level (using object-oriented programming, data structures, control structures, etc. as well as testing and debugging strategies – see "programming skills" below).

Course Goals

By the end of this course, you will learn the principles and practice of computer networks, including signaling and framing, error control, medium access, routing, congestion control, end-to-end transport, and network APIs.

Course Learning Outcomes

By the end of the course, you will be able to:

- Understand, from an evolution perspective, why the Internet architecture has its current form
- Learn how basic algorithms and protocols work, such as link-state routing, distance vector routing
- Understand problems related to convergence, instability, configuration verification
- Understand router design and functionalities such as switching, queueing, packet classification
- Learn about Software Defined Networking technologies and applications
- Apply Internet Measurements and Analytics to achieve multiple tasks
- Evaluate issues related to Internet security, surveillance, and censorship
- Learn about CDN, overlay networks, cloud computing, and data centers
- Understand how modern Applications work: voice, video and web applications, wireless, mobile networks, optical networks, and the Internet of Things

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Course Materials

Course Text
There is no required textbook for this class. The exams will be based on the lectures and readings provided, rather than material outside of these. As an optional reference resource, we suggest:
Computer Networking: A Top-Down Approach by Kurose & Ross, ISBN-10: 0132856204 ISBN-13: 978-0132856201

Classroom Management Tools are located in Canvas:
- Content (Video Lectures and Reading Materials)
  - Material in Canvas -> Modules
  - Discussion in Piazza (various threads)
- Projects
  - Instructions, files and submission boxes in Canvas -> Assignments
  - Walkthroughs in Office Hours in Canvas->Piazza (separate threads for each project)
  - Discussion and student-generated resources in Canvas->Piazza (various threads)
- Exams
  - Delivery In Canvas/Quizzes (including proctoring via Honorlock in Canvas)
  - Logistics and study discussions in Piazza (various threads)
- Grades in Canvas -> Grades

NOTE: A previous iteration of this course had lecture videos hosted on Udacity. While these can be helpful and still teach useful concepts, the old lectures on Udacity do **not** cover the same material. Students are expected to study and use the content in Canvas.

Course Virtual Machine
Projects throughout the course will be released and graded on a VM. We recommend using VirtualBox to run your VM so that we can provide support for your VM configuration. If you are willing to self-support then you may use any virtualization system that supports importing .OVA files. *We do not recommend building your own* virtual machine due to specific software packages required. See Piazza for download links and instructions for downloading and setting up the course VM.

Course Requirements, Assignments & Grading

Assignment Distribution and Grading Scale
Grading will be based on seven projects and three exams completed throughout the course, with some extra credit opportunities. The grade breakdown is as follows:

Assignments	Weight	Points
Project 1 Simulating Networks	5%	50
Project 2 Spanning Tree Protocol	15%	150
Project 3 TCP Fast Open	5%	50
Project 4 Distance Vector Routing	15%	150
Project 5 Congestion Control	5%	50
Project 6 SDN Firewall	10%	100
Project 7 BGP Hijacking	15%	150

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Assignments	Weight	Points
Projects Total:	**70%**	**700**
Exam 1 (lessons 1-4)	10%	100
Exam 2 (lessons 5-8)	10%	100
Exam 3 (lessons 9-12)	10%	100
Exams Total:	**30%**	**300**
Extra credit portion for Project 7		
Extra Credit Discussion Threads	1%	10
(Other Extra Credit opportunities – see announcements in Piazza for details)		
Extra Credit Total:	**6%**	**60**

Grading Scale
***There is no curve in CS6250*:** letter grades are calculated from a total of 1,000 points as follows:

- **A** ≥ 90% (900 points)
- **B** ≥ 80% (800 points) and < 90% (900 points)
- **C** ≥70% (700 points) and < 80% (800 points)
- **D** ≥ 65% (650 points) and < 70% (700 points)
- **F** < 65% (650 points)

Course Components

- **Lectures & Readings:** The lectures and accompanying readings for each week. Students are responsible for watching and reading this material.
- **Projects:** Project start and end dates are provided on the schedule. Note that instructions are provided in Canvas.
- **Exams:** Exams will be administered via Honorlock. Please check the class schedule for open/close dates of the exam window.
    - Late exam submissions, after the window has closed, are not allowed – except in case of emergency. Not taking the exam, or late exam submission, defaults to score 0 for that exam. Honorlock will allow you to start your exam any time during the exam window but will stop your exam when the window closes. This means if you are allotted 2 hours to complete an exam, but if you start your exam one hour before the exam window closes, you will only have one hour to complete your exam. Give yourself plenty of time prior to the end of the exam window to complete your exam.
    - You must take all exams by yourself, and all answers must be provided entirely by you. You may not give (or ask for) direct answers to exam questions to classmates, online forums, chats, websites, etc. (Asking about concepts presented in class is acceptable, so long as the question is not soliciting a response that would answer a specific exam question, and provided it is not done during a proctored exam period where such materials or websites may be disallowed.)
    - **Exams in this course do not allow supplemental materials, e.g. notes, scratch paper, books or digital reference material.** All proctored exams will have specific instructions regarding what materials are and are not allowed to be used during the exam – usually only a calculator app is allowed, and earbuds or headphones or headsets are not permitted.

Using any disallowed materials during a proctored exam will be considered an academic integrity violation.
    - While preparing for the exam, it is entirely up to you to evaluate the relevance and accuracy of any information you find outside of the official class materials. If you use information you found on the Internet to answer a question, and it is wrong because the information was either inaccurate or was actually answering a slightly different question than the one on the exam, then that question is wrong and will be graded as such.
    - Invalid Honorlock sessions (such as the student's face leaving the frame of the camera, the student using headphones, etc.) will result in a score of 0 for the exam. Please ensure that you understand what is permitted and not permitted for each exam.
- **Piazza extra credit discussions:** We will be having several discussion threads (minimum of 3 discussions across the semester) on topics that are in focus for a given week. To receive extra credit, students are asked to post at least one post per discussion thread about their thoughts on open research problems, a recent publication they came across, or challenges of existing approaches. The Instructor and TAs will be reviewing students' participation on the weekly discussion threads. To receive the extra credit for participation, a student needs to participate with posts that reflect her/his thoughts/understanding/ideas and effort to be involved in a discussion. Posts such as "I agree" or "+1" do not count as valid posts. The Instructor/TAs will not be reviewing the posts to "grade" them for correctness or length, but rather to identify valid participation.

Assignment Due Dates
All quizzes, exams, and projects are due at 11:59:00pm AOE, unless otherwise noted. All assignments are due relative to the "Anywhere on Earth" Time Zone (AOE). We will not make exceptions due to time zone issues.

Grading and Feedback
Feedback to each exam will be given once all students complete the assignment, and grading has been finished.

For Projects, your last submission on Canvas will be used for grading. Be sure to include ALL files in the last submission. We will not release full solutions to any assignment.

Technology Requirements and Skills

Minimum Technical Requirements
- **Browser and connection speed:** An up-to-date version of Chrome or Firefox is strongly recommended. 2+ Mbps recommended; at minimum 0.768 Mbps download speed
- **Operating system:** Note – these technical requirements are for project completion only.
    - PC: Windows 7, 8, or higher with latest updates installed
    - Mac: OSX Yosemite 10.10.5 or higher with latest updates installed
    - Linux: Any recent distribution that has the supported browsers installed
- **Hardware:** Georgia Tech's Office of Student Computer Ownership issues the following Minimum Hardware Requirements to incoming undergraduates (https://sco.gatech.edu/hardware-requirements/). We recommend that you meet or exceed these guidelines to ensure you have sufficient computing power to complete all coursework and projects.
- **Software:** Virtualbox 5. See Piazza for discussions and VM support.

Technical Support
For any technical questions, problems or concerns with lecture videos, Piazza, Canvas, or other Georgia Tech IT resources please find email contacts below. The instructor/TAs will likely not be able to assist you with this.

- For OIT (Georgia Tech IT dept.) support, please email support@oit.gatech.edu
- For technical support with Canvas please email: support@instructure.com
- For technical support with Piazza, please email team@piazza.com

Programming Skills
We will be completing the project assignments in Python (many of the tools we're using like Mininet and Pyretic are language-dependent on Python 2.7). An intermediate level of skill with Python is adequate for the projects in this course. If you have a beginner level of skill, but have programmed something more complex than "Hello World" in Python before, then you should be able to learn what you need to about the language as you go through the course — it may just take you a little more time, and a willingness to search the Python documentation and other Internet sources to teach yourself how to do some things.

If you have never programmed in Python before (or have only written "Hello World" or only completed a basic tutorial on that level), then you may find it better to take some time to learn Python prior to the start of the course. If you have experience learning new computer languages and feel comfortable teaching yourself a new language from scratch in a short period of time, then you may find extra time and effort will be enough to be successful.

Canvas & Kaltura
This class will use Canvas and Kaltura to deliver course materials to online students. ALL course materials, assignments, and exams will take place on Canvas.

Proctoring Information
All course exams will be proctored. A proctored exam is similar to the one you would take in the classroom. This means no open textbooks, notebooks, notes, and other like resources are allowed unless any or all of these materials are allowed. These exams are delivered via a tool called Honorlock.

Honorlock uses multi-factor biometric authentication to verify the identity of students, upon entry. Each student will provide a face and ID scans, which will be measured against the student's baseline biometric profile, stored on file. You will also be asked to scan the room around you – see Piazza for a pinned post for details.

You will have the opportunity to take an onboarding quiz to become familiar with how it all works and to ensure that your system meets all hardware and software requirements. The onboarding quiz will be a practice quiz that will not affect your grades in the course. You can take the onboarding quiz as many times as you want. All potential violations are reviewed by a human - **a violation can result in a grade of 0 for an exam**. If you have any issues with Honorlock while taking the graded exam, reach out to Honorlock 24/7. Support: https://honorlock.com/support/.

Course Policies, Expectations & Guidelines

Communication Policy
All communications for the class will take place within Piazza. This includes, but is not limited to the following:

- **Student Questions:** Students are strongly encouraged to post their questions on Piazza related to the lectures, readings, weekly discussions, exam preparation, or projects. Due to the large volume of this class, we do not recommend directly emailing the instructor or the TAs.
- **Private Posts:** Students are able to post privately to the teaching staff on Piazza. This is appropriate when a student needs to ask a question about a personal matter or request a regrade. Students may also post privately to ask questions about material when the question would violate academic integrity rules if posted publicly. An example of this would be asking a question about

their code submission for a project that requires posting the code. Posts should be addressed to "Instructors" in order to ensure that they are seen and addressed.

- **Volume of posts:** Please try to avoid posting duplicate questions. Posting duplicate questions can lower the turnaround time of responses significantly. You can use the search bar (to the right of the "New Post" button) and the folders listed across the top of the page to look for related posts where your question may have already been asked & answered.
- **Instructor/TA Announcements:** Announcements within Piazza will be used to communicate updates to projects, grades being posted, and other administrative information. Students should be active on the Piazza forums, and are responsible for reading announcements within 24 hours, as the information typically will be time sensitive. While the teaching staff will make every effort to update resources/descriptions on Canvas in the event of a policy or project change, it is ultimately the responsibility of the student to obtain updates on Piazza. This includes all posts, whether they have been pinned by the teaching staff or not.
- **Email announcements through Piazza:** Particularly important announcements may occasionally be sent by email. We will use Piazza to do this, so you will receive these announcement emails at whatever email address you have in your Piazza account. This may be your Georgia Tech email address, or some other email address if you prefer. However, whichever you use, you are responsible for checking it daily in case of such announcements.
- **Piazza code of conduct:** Please review the anti-harassment policy, located within this document.
- **Emailing the Instructor:** Students may directly email the instructor, if there is an issue that has not been resolved through communication on Piazza. Due to the large volume of students, direct emails may take longer to be answered. Students are strongly encouraged to post on Piazza first and seek resolution from the TA team.
- **Other Official emails:** Under certain circumstances, the TA team may send you direct emails to your official Georgia Tech email address (you may not request a different email address for these messages). Examples include resolving academic integrity violation incidents, notification of incomplete onboarding with proctoring software, etc. Students are expected to check their Georgia Tech email at least twice a week and to respond in a timely manner.

Anti-harassment policy:
Please follow these guidelines to ensure that everyone has a beneficial, positive and harassment-free experience:

- Any type of hostile behavior will not be accepted. Abusive/degrading/hostile/intimidating language, language that creates discomfort, or interferes with a person's participation or opportunity for participation will not be tolerated. Excuses such as "It was obvious" or "I was just joking" will not be accepted.
- Students that are violating this policy may be excluded from participation at Piazza. If you believe that you or a classmate has been harassed, please contact the Instructor/TAs immediately.
- Please remember that on the other end of a posted question, follow up, or comment there is a real person - like you - who will react not only to the content of your response, but also to the tone. Please remember that students in this class have a wide variety of backgrounds and prior experience. Students with more experience or background in a topic are strongly encouraged to share - through useful and practical responses – in a supportive way so that others can learn as well. When you answer a question, please remember that your primary purpose is to help the student who asked.
- You are encouraged to suggest ways to improve questions that are posted, so that students will receive faster and better answers. You are expected to do so using positive and supportive language and tone. For example, if a question does not have all the information you need to provide an answer you may politely ask for what you specifically need in order to help (e.g. "Could you please provide an example of some code that produces that error message?").

Office Hours
The tentative office hours schedule for Fall 2020 is as follows:

- **Office Hours with Professor Maria Konte:** These office hours are mostly focused on lectures, readings, discussion threads and exam preparations questions. We will announce the dates and times of Professor Konte's regular office hours in the first weeks of class.
- **Weekly Office Hours with Head TAs:** These sessions are mostly focused on project questions and will generally include a discussion of that week's coursework.
- **Chat Sessions:** In addition to the above, the class TAs will hold 30 min chat sessions, 1 to 5 times per week, to help students with project questions. We will be announcing the schedule of the chat sessions every week, depending on TA availability.

Student participation in office hours: We expect that students will be leading/driving these sessions through their participation. If the students are not able to participate at the time of the office hours, they are strongly encouraged to post their questions in advance.

Format: We will be holding office hours online using Bluejeans. Instructions for accessing each session will be posted on Piazza in advance, and students are encouraged to post their questions as follow ups to the office hours announcement both before office hours begins and during the live broadcast. After office hours have completed, a recording of the office hours will be made available. By entering questions in advance and viewing the recording afterwards, students may participate in office hours even if they are not able to attend live.

University Use of Electronic Email
A university-assigned student e-mail account is the official university means of communication with all students at Georgia Institute of Technology. Students are responsible for all information sent to them via their university-assigned e-mail account. If a student chooses to forward information in their university e-mail account, he or she is responsible for all information, including attachments, sent to any other e-mail account. To stay current with university information, students are expected to check their official university e-mail account and other electronic communications on a frequent and consistent basis. Recognizing that some communications may be time-critical, the university recommends that electronic communications be checked minimally twice a week.

Plagiarism & Academic Integrity
Students are expected to follow the Georgia Tech Honor Code (https://osi.gatech.edu/content/honor-code), including the Graduate Addendum. All incidents of suspected dishonesty will be reported to and handled by the Office of Student Integrity. In addition, the following specific policies apply to this course. If in doubt as to whether an action is allowed in this course, please ask the Instructor/TAs.

- **Collaboration:** You are to complete all projects yourself. You may discuss the projects with your classmates, but you may not share code/data/solutions with other students. For specific projects, we provide explicit instructions about what pieces of information can or cannot be shared with the entire class. Should a classmate send you their code (such as in a direct message on Slack), it is your responsibility to warn them and/or inform the TA team.
- **Plagiarism:** You may not copy or reference solutions (fully or in part) from any source. (This includes solutions from previous classes or solutions in other programming languages.) Each file you turn in must be written entirely by yourself. If it is a file provided with the project, the modifications to the file must be made entirely by yourself. For written reports, all quotes must be clearly cited.
    - See https://libguides.gatech.edu/c.php?g=54271&p=350397 for some resources on how to avoid plagiarism, and contact the TAs if you have any questions.
- **Publishing exam/project material or solutions:** You may not publish or provide project solutions on any medium at any time, even if the solution is not working/did not earn full credit (with the exception of private messages to the TA team). You may not publish or provide exam questions OR answers on any medium at any time (with the exception of in the clearly designated thread on Piazza after the TA team announces grades). These restriction include

public git repos, sites such as CourseHero, and private messages to others. ***These restrictions apply even after completing the course and/or graduating from the program***.

Accommodations for Students with Disabilities
If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or http://disabilityservices.gatech.edu/, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also send a private message to "Instructors" on Piazza as soon as possible. Note: the TA team cannot provide any accommodations or extensions without an accommodations letter, nor are accommodations provided retroactively.

Late and Make-up Work Policy
All deadlines are 11:59pm AOE, on the date specified, unless otherwise noted. Misunderstanding of the deadline and late policy is NOT a valid justification for an extension or reduction in penalties. It is the student's responsibility to accommodate for technical issues, such as a slow connection to Canvas.

- Late project submissions will be penalized 5% per hour late. Submissions will be accepted up until 24 hours after the posted due date. If there are multiple submissions, the last submission is used for grading, ***with the late penalty applied if applicable.***
- Exams are only available and accepted during the posted exam window.
- Extra credit submissions are NOT accepted past the posted deadlines.

Extensions to Deadlines
Extensions to deadlines will be allowed only in the case of a medical or personal emergency, or in the case of military exercises/deployments for service members. These situations must be approved by the office of Dean of Students. Please contact the Office of the Dean of Students, (see the Division of Student Life [studentlife.gatech.edu] and the "Get Help Now" link), and send a private message to the TA team on Piazza as soon as possible.

Regrade Requests

- **Format:** All requests for a regrade on any assignment (project, exam, etc.) or other questions regarding your grade must be made in writing via private post to all instructors on Piazza. Please use the provided regrade request tag in Piazza. For general questions about the answer key / model answers not specific to your submission, please make a public post on Piazza.
- **Deadline for regrade requests:** Regrade requests must be made no later than one week from the grade release date for that assignment. Due to the volume of this class, there will be no exceptions.
- **Valid requests:** Please submit a request if you think there has been an error in grading or applying the rubric (such as the number of points not adding up correctly). Other requests for regrading will not be considered: e.g. you need a higher grade for Institute/program requirements or reimbursement, your grade is close to the cutoff for the next grade level, you disagree with the rubric, etc.
- **Volume of regrade requests:** Please submit a regrade request only if there has been an error. Please refrain from submitting multiple requests, as they consume significant amounts of TA time, and this can result in slower turnaround time, that may affect the entire class.

Student-Faculty Expectations Agreement
At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See http://www.catalog.gatech.edu/rules/22/ for an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Subject to Change Statement

The syllabus and course schedule may be subject to change. Changes will be communicated via email, Piazza, and/or the Canvas announcement tool. It is the responsibility of students to check email messages and course announcements to stay current in their online courses.

Course Schedule

See https://registrar.gatech.edu/calendar for GATech's academic calendar.
All deadlines are 11:59 pm AOE on the date specified.

Week/Dates	Topic	Assignments
Week 1 **Aug 17 – Aug 23**	Lesson 1: Introduction. Internet History, and Architecture	Project 1 Assigned Project 2 Assigned
Week 2 **Aug 24 – Aug 30**	Lesson 2: Transport Layer	Project 1 Due (Aug 30)
Week 3 **Aug 31 – Sept 6**	Lesson 3: Intradomain Routing	Project 2 Due (Sept 6)
Week 4 **Sept 7 – Sept 13**	Lesson 4: AS Relationships and Interdomain Routing	Project 3 Assigned
Week 5 **Sept 14 – Sept 20**		Exam 1 (Sept 14 – Sept 20) Project 3 Due (Sept 20) Extra Credit Discussion Thread 1
Week 6 **Sept 21 – Sept 27**	Lesson 5: Router Design and Algorithms: Part 1	Project 4 Assigned
Week 7 **Sept 28 – Oct 4**	Lesson 6: Router Design and Algorithms: Part 2	Project 4 Due (Oct 4)
Week 8 **Oct 5 – Oct 11**	Lesson 7: SDN Part 1	Project 5 Assigned
Week 9 **Oct 12 – Oct 18**	Lesson 8: SDN Part 2	Project 5 Due (Oct 18)
Week 10 **Oct 19 – Oct 25**		Exam 2 (Oct 19 – Oct 25) Extra Credit Discussion Thread 2
Week 11 **Oct 26 – Nov 1**	Lesson 9: Internet Security	Project 6 Assigned
Week 12 **Nov 2 – Nov 8**	Lesson 10: Internet Surveillance and Censorship	Project 6 Due (Nov 8)
Week 13 **Nov 9 – Nov 15**	Lesson 11: Applications Part 1: Video	Project 7 Assigned
Week 14 **Nov 16 – Nov 22**	Lesson 12: Applications Part 2: CDNs	
Week 15 **Nov 23 – Nov 29**	(Thanksgiving Week)	Project 7 Due (Nov 29)
Week 16 **Nov 30 – Dec 6**	Optional Readings Lesson 13: The Future of the Internet	Exam 3 (Nov 30 – Dec 6) Extra Credit Discussion Thread 3
Week 17 **Dec 7 – Dec 13**	(Dec 12 – end of term)	