# CS 447 : Networks and Data Communications

Instructor: Thoshitha Gamage, Ph.D.
Southern Illinois University at Edwardsville

Spring 2019 Syllabus

Course Information:

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|---|---|
| Title: | CS 447 : Networks and Data Communications (3 Credits) |
| Location: | EB 2160 |
| Time: | M & W 12:00 – 01:15 p.m. |
| Course Web site: | http://www.cs.siue.edu/~tgamage/S19/CS447 |

Contact Information:

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|---|---|
| Office: | EB 3053 |
| Phone ☎: | 650-2407 |
| Email 🖂: | tgamage@siue.edu |
| Web Site 🏠: | http://www.cs.siue.edu/~tgamage |
| Office Hours: | M & W 01:20 – 02:20 p.m. |
| | T 09:30 – 10:30 a.m. *or by appointment* |

This class is an undergraduate level introduction to computer networks with the following learning objectives:

1. to acquire a fundamental understanding and knowledge of modern communication networks and their underlying mechanisms through the TCP/IP stack;
2. to become proficient in applied communication networks and protocols – network programming, diagnosis, basic penetration testing, network engineering, performance analysis – through hands-on activities;
3. to kick-start cybersecurity education.
4. to facilitate a learning environment that strengthens participants' *theoretical* and *empirical* knowledge, and understanding through hand-on experiments; and
5. to improve participants' critical thinking, reading, and writing skills;

By the end of the semester, students are expected to be proficient in networking programming with an insight to the underlying network mechanisms. The content of this course is influenced by and was developed in accordance to the IEEE/ACM Computer Science Curriculum Guidelines (2013) http://www.acm.org/education/CS2013-final-report.pdf

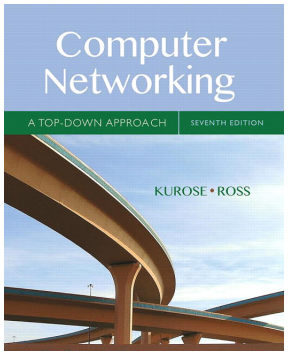
## 1 Course Prerequisites

CS340 – Data Structure and Algorithms (**graph theory**), and CS314 – Operating Systems (**system programming**). In addition, fluency and significant experience in structured or imperative programming (e.g. C, C++, Java, Python), and **Unix/Linux** is a **MUST** for the hand-on experiments. If you do not meet these prerequisites, talk to the instructor immediately within the first week of classes. I reserve the right to drop participants from the course that do not meet these minimum prerequisites.

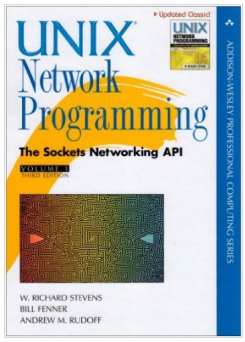
## 2 Textbook & Resources

[**Required**] [PR7e] Computer Networking: A Top-Down Approach $7^{th}$ ed., Kurose and Ross, Pearson, ISBN 0-13-359414-9 Online:http://www-net.cs.umass.edu/kurose-ross-ppt-7e/

**[Supplemental]** **[SFR3e]** Unix Network Programming, Volume 1: The Sockets Networking API, $3^{nd}$ ed., Stevens, Fenner & Rudoff, Prentice Hall, ISBN: 0131411551
**[Supplemental]** **[BH3e]** Beej's Guide to Network Programming, Online: http://beej.us/guide/bgnet/output/print/bgnet_USLetter.pdf




(a) **[PR7e]**




(b) **[SFR3e]**

My lecture notes are based on numerous textbooks from my personal library and recent literature. A complementary set of publisher provided lecture slides can be found on the course website. You can also find **PR7e** Authors' slides at http://www-net.cs.umass.edu/kurose-ross-ppt-7e/. Material I present in class typically have a **strong mathematical flavor** to them.
Students are **required** to regularly check the course website and the SIUE email account for any important course related updates.

# 3 Assigned Work and Tentative Grading Policy

The following grade allocation breakdown is ***tentative***, and may change during the semester. Unless the circumstances change, I am **NOT** planning on curving or rounding the final grade.

| **Grading Allocation** | | **BS** | **MS** |
|---|---|---|---|
| Exams | | 40% | 40% |
| Midterm | 15% / 15% | | |
| Final *(comprehensive!!)* | 25% / 25% | | |
| Attendance & Scribing | | 5% | 5% |
| Wireshark Labs | | 25% | 20% |
| Programing Projects | | 30% | 25% |
| Graduate Standing Project | | – | 10% |

| **Final Letter Grade** | |
|---|---|
| 90–100 | A |
| 80–89 | B |
| 70–79 | C |
| 60–69 | D |
| below 60 | F |

## 3.1 Exams

All exams and quizzes will be held in the lecture room.

- **Midterm** : Wednesday March $06^{th}$ 12:00 – 01:15 p.m.
- **Final** : Tuesday May $07^{th}$ 10:00 – 11:40 a.m.

## 3.2 Class Participation

You are expected to **proactively** participate in in-class discussions. This aids your learning and that of your classmates, and provides valuable feedback on the lecture. Constructive and proactive participation in in-class discussions and scribing accounts for 5% of your final grade. I, therefore, expect you to attend each and every class.

In preparation for each lecture, you are expected to read the relevant sections from **PR7e** (*see Tentative Schedule below*). I will try my best to direct you to other relevant resources where applicable, but I fully expect you to **take the responsibility of your own learning** and come fully prepared to the class.
Each student is required to submit their scribe notes a **minimum of twice** for the semester, preferably once before the mid-term and once after. Scribe notes are due through *Moodle* within **48 hours** after the lecture. Only the top two scribe submissions (based on Moodle timestamp) will be counted as valid submissions. Scribe notes serve as a baseline set of complementary notes to you and to your colleagues, hence please pay your due diligence to make them legible.

## 3.3 Wireshark Labs

There will be roughly ~3-4 Wireshark Labs with a 1 week deadline from the day each is assigned. In preparation, each student is expected to download and install Wireshark from the official website https://www.wireshark.org/.

## 3.4 Programming Projects

You will be given roughly ~3 hands-on network programming experiments. These will be posted in the course website. I will give you the option to choose a language of your choice for programming (though C++, Java, or Python is recommended) but your programs **must** compile and run on a Unix/Linux machine. It is also advisable to set up a Linux virtual machine that can be used for your programming assignments. Additionally, EB1036 PCs will have a Linux dual-boot option.

## 3.5 Graduate Standing Project

Graduate students are required to conduct a mini-research project that is worth 10% of their final grade. Ideally, this would be a fairly comprehensive literature survey of a topic of your choosing with some empirical validation. Your topic should be relevant to the theme of this course. Important milestones for your project are listed below. All assignments are due at the beginning of class through Moodle.

- Wednesday January $30^{th}$, 2019 – **M1:** One page research proposal and a justification of your proposed research.
- Wednesday March $06^{th}$ 2019 – **M2:** ~3-4 page intermediate report of your research progress.
- Wednesday April $17^{th}$ 2019 – **M3:** Project presentation slides.
- Wednesday May $01^{st}$ 2019 – **M4:** Final report.

Places to look for a research topic includes (but not limited to) IEEE FOCS, ACM STOC, ISAAC, SODA, IEEE S&P, ACM CCS, SOCG, IEEE CCC, ACM PODC, IEEE IPDPS, CSF, DSN, IEEE ICDCS, USENIX, etc. Topics in Cybersecurity are **highly favorable**.
A typical graduate level research of this scope would include a bare-minimum 20-25 *highly cited* research papers. I reserve the right to decide which projects meet graduate standing and lower the grade for those who don't; hence, make sure to clearly exchange your research ideas with me, find out about my expectations, and set yourself up for success **early** in the semester.
You are to present your research to the class at the conclusion of your research during weeks 15 and 16. In addition, you are required to produce an IEEE conference style minimum 8-page paper of your research. A template can be found at http://www.ieee.org/conferences_events/conferences/publishing/templates.html. You are **highly encouraged** to produce your report using Latex.
In addition, graduate students may have additional mandatory questions in exams. Accordingly, graduate students will be graded on separate scale. Please refer Section 3 for the scale.

# 4 Course Requirements and Policies

## 4.1 Attendance Policy

I allow you to miss at most 2 classes for the semester without any penalties. Medical emergencies are outside this "absentee allowance", but should be accompanied by proper documented proof of medical services. For planned absences, assignments should be turned in before the absence rather than after. I reserve the right to lower the grade of any student who is markedly deficient in attendance and/or in in-class participation. If you miss a class, it is *your* responsibility to find out what happened and to collect any material that was handed out in the class.

## 4.2 Late Policy

Unless otherwise noted or announced in-class, all deadlines are hard deadlines and are due at the beginning of class on the due date. Programming assignments typically have a 2 week deadline. Wireshark labs have a 1 week deadline. Assignments may be turned within 48 hours *grace period* after the deadline (except PR03) with a 20% late penalty. No assignment is accepted beyond this grace period. Graduate project milestones do not have any grace periods.

## 4.3 Responsible Learning Policy

I expect *you* to *own* your degree of success in this class *and*, I expect you to contribute to the success of others. Examples:

- Read outside the class on your own in preparation for each lecture, jot down any questions your encounter on your reading (strongly encouraged), and bring those to the class as discussion points;
- Be respectful of the learning environment. Refrain from activities that may disturb the flow of the lecture or the environment;
  - Refrain from engaging in disruptive *"little talk"* while I am conducting the lecture; if you have a concern, raise your hand and grab my attention. be respective of your colleagues time and desire to learn.
  - Put your cell phones to vibrate mode and refrain from using your computers for casual web browsing. Take full advantage of the opportunity to learn.
- Cooperate with other students and to share your knowledge during in-class discussions. Respect the differences in learning and understanding of each other. Seek ways of taking advantage of those differences;
- If another student is confused, help him or her out without disturbing the class;
- I enjoy engaging in technical conversations with students with the goal of helping them create an accurate understanding of course material. Participating in such conversations is very favorable for your class participation grade;
- If I am systematically doing something that inhibits your learning, tell me;
- Engage in *proactive learning*: speak up when you don't understand, question assumptions, relate course material to your experience outside class, seek out additional experience and reading related to the class. You must *construct* your understanding of the material;
- If a lecture point is unclear, ask questions and ask me to repeat what I said, preferably in class, during office hours, or by e-mail. You are probably not alone in your confusion;
- Promptly review feedback you receive from me or other students to actively clarify the feedback if the material is still unclear and to incorporate the feedback in your future work;
- Spend adequate time on the course. Adequate time includes getting enough rest so that time you spend on course tasks is well-spent time. Adequate time includes proofreading and reviewing your assignments before you hand them in;
- Have high expectations of yourself: set goals for yourself and try to do your very best. Consciously think about the balance between what you do to earn a grade and what you do to learn (If I'm doing something that puts these in opposition to each other, please let me know.); and,
- Check your SIUE assigned student email and the course website regularly for important class announcements.

**IMPORTANT**: I strongly discourage you from getting into discussions with me about grades and how you can get a better one. This includes emailing me about possible ways to "bump" your grade. Such requests only mean one thing; that you have already fallen behind on your own expectations.
Do your own work. Your exams, homeworks, and programming projects are subject to the academic honor code. **DO NOT CHEAT IN ANY WAY: DO YOUR OWN WORK!**. Following activities will be considered academic dishonesty:

- Submitting work (such as assigned work, projects, and code) done by somebody else (this includes any human/electronic sources (such as web sites));
- Watching and copying your neighbors' solutions during quizzes and/or exams;
- Using materials not allowed during quizzes and exams;
- Using materials not allowed for the programming projects.

It is quite acceptable to ask others things like "Have you come across this particular issue/error/exception before?," and even having them briefly look briefly at your stack trace and/or its code. To have them spend hours helping develop or seriously rearrange your program's logic, on the other hand, is not acceptable. And, of course, it is unacceptable for two or more people to collaboratively develop the solutions to assignments. If you are tempted to collaborate on such assignments, **DON'T!!**.
I expect you to know and observe the SIUE Student Conduct Code (3C1) and Student Academic Code (3C2). Copying of other students' work, working together on individual assignments, plagiarism of published sources and other forms of academic dishonesty will result in zero credit on the assignment for all students involved and a lower grade in the class. A second offense (across the University) will result in an automatic **F** in the course and exposes the violator to University sanctions up to and including expulsion. All offenses will be reported to Student Affairs.

#### 4.3.1 Online Repositories

If you indent to keep any project source code in online repositories, ensure those repositories are **private** and **only accessible to you**. By making source code publicly available to others, you might be involuntarily participating in plagiarism.

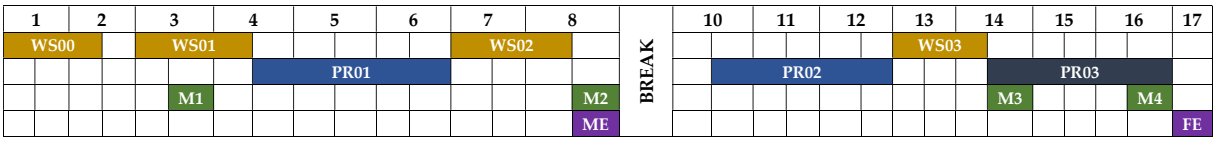
#### 4.3.2 Advice

a Don't wait until the last minute to do homework or projects. Labs get busy, computers break down, and people get sick. These are not sufficient excuses for an extension.
b Save early; save often!
c Contact me if you are confused. Don't wait for office hours; send an email.

### 4.4 Accessible Campus Community & Equitable Student Support: http://www.siue.edu/access

Students needing accommodations because of medical diagnosis or major life impairment will need to register with Accessible Campus Community & Equitable Student Support (ACCESS) and complete an intake process before accommodations will be given. Students who believe they have a diagnosis but do not have documentation should contact ACCESS for assistance and/or appropriate referral. The ACCESS office is located in the Student Success Center, Room 1270. You can also reach the office by e-mail at myaccess@siue.edu or by calling 618.650.3726. For more information on policies, procedures, or necessary forms, please visit the ACCESS website at `www.siue.edu/access`.

# 5 CS 447 in a Nutshell




WS## – Wireshark Labs, M# – Graduate Standing Project Milestones, PR## – Programming Projects, ME – Mid-Term, FE – Final

## 5.1 Tentative Schedule*

*Subject to adjustment and Change. I reserve the right to change topics or add an item of related interest. All changes will be announced in class.

| Week | Dates | Topics | References | Assignments/Exams |
|---|---|---|---|---|
| 01 | Jan. 14, 16 | Introduction and Course Overview<br>Fundamentals of Network Communication | PR7e/01 | WS00 > out |
| 02 | Jan. 21, 23 | **MLK Day**<br>Network Performance Measurement | PR7e/02 | WS00 < in |
| 03 | Jan. 28, 30 | **Application Layer:** HTTP, FTP<br>DNS, SMTP, P2P | PR7e/02,03 | WS01 > out<br>M1 < in |
| 04 | Feb. 04, 06 | Socket Programming Tutorial<br>**Transport Layer:** Mux/Demux | PR7e/03 | WS01 < in<br>PR01 > out |
| 05 | Feb. 11, 13 | Reliable Data Transfer Principles | PR7e/03 | |
| 06 | Feb. 18, 20 | UDP TCP: Flow Control, Congestion Control<br>**Network Layer:** Routing vs. Forwarding, Routers | PR7e/04 | PR01 < in |
| 07 | Feb. 25, 27 | IPv4 Addressing, DHCP<br>Routing Protocols, RIP, OSPF, BGP | PR7e/05 | WS02 > out |
| 08 | Mar. 04, 06‡ | ICMP, IPv6, Broadcast and Multicast Routing<br>Midterm Exam | PR7e/05 | WS02 < in<br>M2 < in |
| 09 | Mar. 11†, 13† | **Spring Break** | | |
| 10 | Mar. 18, 20 | Midterm Review<br>**Link Layer:** Error Detection and Correction | PR7e/06 | PR02 > out |
| 11 | Mar. 25, 27 | ALOHA, Slotted ALOHA<br>CSMA, CSMA/CD, Taking Turns | PR7e/06 | |
| 12 | Apr. 01, 03 | ARP, Link Layer Addressing, Ethernet<br>VLANs | PR7e/06 | PR02 < in |
| 13 | Apr. 08, 10 | **Network Security**: Application Layer Security<br>Transport Layer Security | PR7e/08 | WS03 > out |
| 14 | Apr. 15, 17 | Network Layer Security<br>**Wireless Networks:** CDMA, WiFi | PR7e/07 | WS03 < in<br>PR03 > out, M3 < in |
| 15 | Apr. 22§, 24§ | *Topic TBA* | | |
| 16 | Apr. 29§, May 01§ | *Topic TBA* | | PR03 < in, M4 < in |
| 17 | May. 07 | **Final Exam: 10.00 – 11.40 a.m.** | | |

†Spring Break, ‡Midterm Exam, §Graduate Project: In class presentations