



Course Syllabus

Instructor

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Office Hours: via appointment, please send an email and we can schedule a call/meeting

Class Meeting Times

TF 8:00 – 9:40 am

Room TBD

Prerequisites

(EECE 2540: Fundamentals of Networks

AND

EECE 2560: Fundamentals of Engineering Algorithms)

OR

Graduate Standing.

Brief Description

In the next few years, telecommunication networks (both wired and wireless), and especially the Internet, will become software-centric, transitioning from deployments based on monolithic pieces of hardware (like routers and base stations) to network functions dynamically implemented on generic servers, with everything controlled and orchestrated by software. Future generations of network engineers will thus need to be cognizant of this evolving environment and master *softwarized* networks through principles and hands-on experience. Particularly, programming robust, multi-threaded software to be reliably deployed in network environments will become a required skill to any network engineer.

This course will provide an introduction on how to develop code libraries and applications that can communicate with each other through modern data networks, using C++ as a programming language. Students will gradually learn how to implement programs in C++, starting from the basic language and progressing to master more complex features (like inheritance, templates, smart pointers). The final aim is to lead them to know the principles and the logic of multithreading and socket programming, namely, the core of network programming. In-class lab sessions will be organized in parallel to the lectures to provide students with hands-on experiences with both fundamental and advanced programming concepts. The last part of the course will be fully focused on lab sessions in which the students will be guided to implement real-world examples interactively, how to emulate and/or simulate communication channels, UDP- and TCP-based file transfer between devices, and concurrent queueing. This course will provide the students with solid knowledge and skills not only to theoretically understand the basic concepts of network programming, but also to practically develop the software that will run the connected society of the future.

Objectives and Expected Outcomes

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

- Understand and develop complex programs in C++, using the language features relevant to network programming, the available data structures, and the C++ standard library
- Design and organize the software in basic modules and units, following the object-oriented paradigm of C++
- Write code that exploits advanced programming concepts, such as multi-threading, concurrent programming, smart-pointers, and socket programming
- Implement communication systems based on the TCP/IP technology of the Internet that work on a real network
- Have a basic understanding of containers (e.g., Docker)

Contents

1. Basic C++11 syntax (lectures + labs)
2. Designing modular software: C++ classes and object-oriented programming (lectures + labs)
3. Start a network programming project from scratch: compiling chain & code versioning (lab)
4. Programming software for networks: socket programming for TCP and UDP, headers and serialization, protocol stacks (lectures + labs)
5. Memory management for network programming: smart pointers (lectures + labs)
6. Manage concurrent transmission and reception of data: multi-threaded programming in C++ (lectures + labs)
7. Implementation and testing of practical examples (bidirectional chat, FTP-like file transfer) (labs)

In the in-class laboratory sessions (labs) of each topic, the students will develop software and complete examples that are designed to let them experiment with the features presented in the associated lectures.

Organization

- **Exams**
 - Midterm Exam: Oct 21st, 4:35-5:40 PM
 - Written test: assessment of basic C++ concepts for network programming with short open questions (closed book)
 - Final Exam: Dec 15th, 8-10 AM eastern
 - Written test: assessment of network programming concepts with short open questions (closed book; first half of the final exam)
 - Programming test: complete the development of some parts of a C++ codebase (the students can use any material they want, also on-line; second half of the final exam)
- **Homework:**
 - 6 to 8 take home assignments throughout the semester
 - To be solved individually
 - The students will have to hand in the code for each homework. Peer-review activities may be organized.

Course Materials

All the course material will be **available on Canvas**:

- Lecture slides
- Additional reading materials
- Code examples developed for the class

Recommended textbooks (not mandatory):

1. Brian "Beej Jorgensen" Hall, Beej's Guide to Network Programming: Using Internet Sockets, independently published, 2019
2. Bjarne Stroustrup, The C++ Programming Language, Addison-Wesley Professional, 2013.

3. Anthony Williams, C++ Concurrency in Action. 2nd Edition, Manning Publications, 2019.
4. Scott Meyers, Effective Modern C++: 42 Specific Ways to Improve Your Use of C++11 and C++14, O'Reilly Media, 2014.

Grading Policy

Grade Distribution:

- **Homework:** 35%
- **Midterm Exam:** 30%
- **Final:** 35%
 - **Written test:** 15%
 - **Programming test:** 20%

Total Points	Final Grade
95-100	A
90-94	A-
85-89	B+
80-84	B
75-79	B-
70-74	C+
65-69	C
60-64	C-
55-59	D+
50-54	D
<50	F

Expectations of Students

- Students are expected to act in a professional manner. A student's grade may be reduced due to unprofessional or disruptive behavior. Please:
 - **Use professional style in all communications**, including email, with course faculty and teaching assistants
 - **Refrain from use of cell phones** or other electronic devices unless they are clearly linked to class purposes (e.g., note-taking)
 - **Attendance** will be also considered for your professionalism including coming to class late. Attendance will be randomly checked in the lectures
 - **Respect:** You are expected to treat your instructor and all other participants in the course with courtesy and respect. Your comments to others should be factual, constructive, and free from harassing statements. You are encouraged to disagree with other students and the instructor, but such disagreements need to be respectful and be based upon facts and documentation (rather than prejudices and personalities). Falling to adhere to this expectation may result in a lower grade. Part of the learning process in this course is respectful engagement of ideas with others
- Homework assignments should be submitted on or prior to the due date.
- Students are permitted to share ideas regarding homework assignments, but each student must independently write and submit their own solution.
- Makeup exams will be given provided that the two following conditions are simultaneously satisfied:
 1. You contact the instructor prior to the exam
 2. You have a valid and documented reason to miss the exam
 - Serious illness or family emergency are acceptable excuses

- Sleeping in, lack of preparation, ennui, grogginess, etc., are not acceptable excuses

Academic Integrity

A commitment to the principles of academic integrity is essential to the mission of Northeastern University. The promotion of independent and original scholarship ensures that students derive the most from their educational experience and their pursuit of knowledge. Academic dishonesty violates the most fundamental values of an intellectual community and undermines the achievements of the entire University.

As members of the academic community, students must become familiar with their rights and responsibilities. In each course, they are responsible for knowing the requirements and restrictions regarding research and writing, examinations of whatever kind, collaborative work, the use of study aids, the appropriateness of assistance, and other issues. Students are responsible for learning the conventions of documentation and acknowledgment of sources in their fields. Northeastern University expects students to complete all examinations, tests, papers, creative projects, and assignments of any kind according to the highest ethical standards, as set forth either explicitly or implicitly in this Code or by the direction of instructors.

Go to <http://www.northeastern.edu/osccr/academic-integrity-policy/> to access the full academic integrity policy.

Student Accommodations

Northeastern University and the Disability Resource Center (DRC) are committed to providing disability services that enable students who qualify under Section 504 of the Rehabilitation Act and the Americans with Disabilities Act Amendments Act (ADAAA) to participate fully in the activities of the university. To receive accommodations through the DRC, students must provide appropriate documentation that demonstrates a current substantially limiting disability.

For more information, visit <http://www.northeastern.edu/drc/getting-started-with-the-drc/>

Diversity and Inclusion

Northeastern University is committed to equal opportunity, affirmative action, diversity and social justice while building a climate of inclusion on and beyond campus. In the classroom, members of the University community work to cultivate an inclusive environment that denounces discrimination through innovation, collaboration and an awareness of global perspectives on social justice.

Please visit <http://www.northeastern.edu/oidi/> for complete information on Diversity and Inclusion.

TITLE IX

Title IX of the Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender-identity, in educational programs and activities that receive federal financial assistance.

Northeastern's Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. The Title IX Policy applies to the entire community, including male, female, transgender students, faculty and staff.

In case of an emergency, please call 911.

Please visit www.northeastern.edu/titleix for a complete list of reporting options and resources both on- and off-campus