Northeastern University
Khoury College of Computer Sciences

CS5008: Data Structures, Algorithms and Applications within Computing Systems

General Information

Instructor	Jonathan Mwaura
Office	Online (Via Teams see Canvas)
Email	j.mwaura@northeastern.edu
Location	Virtual via Zoom (see Canvas
Scheduled Times	Tuesday 6pm – 9.15pm (Lecture)
	Thursdays 6pm – 7.30pm (Lab)
Office Hour	Thursdays 3pm – 5pm or by appointment
Teaching Assistant	Dilshath Shaik: shaik.di@northeastern.edu
	Mon and Friday: 9am – 12 (noon)

Table 1: General Information

Contact the Instructor

- Office hours: the best way to contact the professor is to visit the professor's office hours.
- Canvas Discussion board & Teams: All discussions will occur via class Teams page. Professor will maintain discussions and notebooks with important items.
  Install Ms. Teams so that you can chat with Prof and your peers on the go!
- Email: If you need to send an email to discuss private issues (e.g., your grades), please keep the message brief and put "[CS5008]" in the email title. Otherwise, your email may not be read and replied in a timely manner. Please don't expect the emails will be read as soon as you send them out (leave at least 48 hours before re-emailing).

Required Textbook

- Data Structures – Zybooks
  - Sign in or create an account at learn.zybooks.com
  - Enter zyBook code: **NORTHEASTERNCS5008MwauraSpring2023**
  - Subscribe

Supplementary Textbook / Materials

- Optional: Data Structures: An Advanced Approach Using C, Esakov and Weiss
- Optional: Data Structures and Program Design in C, Second Edition by Kruse, Tondo and Leung.
- Algorithms in C, Third Edition by Robert Sedgewick (Parts 1-5)

Course Description

Pointers. Lists, stacks, and queues. Binary trees, AVL trees, n-ary trees. Advanced sorting via quicksort, heapsort, etc. Characters and strings. Graphs. Advanced file techniques. Recursion. Programming style, documentation, and testing. Systems components including Multithreading and Concurrency.

Course Category
This course is open for all students in the MSCS Align Program.

Course Core Learning Outcomes
- This course meets the Essential Learning Outcome of <u>Exploring Creative Expression and Innovation</u> as defined under the NU's Core Curriculum requirements. As such, it will reinforce the students' ability to identify, analyze, interpret, and evaluate arguments, data, evidence, problems, and conclusions as part of formulating an opinion or conclusion. Then use that information to design, evaluate and implement a strategy to achieve a desired outcome.
- This course meets the Essential Learning Outcome of <u>Conducting Formal and Quantitative Reasoning</u> as defined under the NU's Core Curriculum requirements. As such, the course will strengthen the students' competency and comfort in working with numerical data.
- This course meets the Essential Learning Outcome of <u>Analyzing and Using Data</u> as defined under the NU's Core Curriculum requirements. As such, it provides students with the opportunity to practice the skills needed to successfully locate, evaluate, and use data, a fundamental ability for scholars and citizens operating in a complex, global information landscape.

Course Prerequisites

Pre-req: CS5001 or some other programming experience.

Additional Course Information
Class Website – on Canvas. All class materials (including lecture notes, supplemental materials, etc.) and assignments are posted on Canvas. Assignments should be submitted through Canvas/GitHub.

Class Discussion Website – (via Canvas and Ms Teams – see link canvas)

This online discussion board and Teams may be used to clarify your question about assignments and discuss general questions. When possible, students should ask related questions through this portal instead of sending individual emails to the instructor. Please do NOT post your programming code or solutions there. If you have a specific question about your solution, please ask help from the instructor, TA, or approved tutors in their offices.

Tentative class schedule
Table 2:Tentative class schedule

Week	Start Dates (Spring 2021)	Topic
1	Jan 10th	Course Introduction The C programming Language – Intro to C, C data types, Arrays in C, Looping
2	Jan 17th	C Structs, Pointers, Dynamic Memory Allocation
3	Jan 24th	File I/O, Debugging, Registers and Assembly
4	Jan 31st	Vectors and Linked Lists
5	Feb 17th	Stacks
6	Feb 22nd	Queues
7	March 1st	Review
8	March 8th	Sorting and Searching and Analysis of Algorithms
9	March 15th	Trees, BST, AVL Trees
10	March 22nd	Heaps (Priority Queues)
11	March 29th	Hash Maps (Associative Arrays)
12	April 5th	Graphs
13	April 12th	Networking
14	April 19th	Concurrency
15	April 26th	Review + Final Projects

Student Outcomes
At the completion of this course, students will have demonstrated:

- Gain experience with common systems programs including compilers, linkers, and debuggers. (Assessment: **programming, exams and/or quizzes**)
- The ability to create structured modular programs (Assessment: Programming exercises and/or exams)
- An understanding of the basics of procedural programming and the concept of generic data structures in C. (Assessment: Programming exercises and/or exams)
- Recognition of the importance and proficiency in the use of good programming style. (**Assessment:** Programming exercises)
- The ability to use the basic features of a Unix/Linux environment to create, debug, executre and submit programs in C using makefiles. (**Assessment:** Programming exercises)
- A demonstrated proficiency with lists, stacks, queues, vectors, trees, and basic graphs as well as an introductory understanding of asymptotic analysis of algorithms. (**Assessment:** Programming exercises)
- Explain the basic terminology of computing systems; various models of computation

(e.g sequential, multithreaded, parallel etc) and the role of the operating system as a resource manager for executing processes. (Assessment: exams, quizzes, programs)

- Analyze assembly code and its relationship to C code, the fetch and execute cycle and basic system architecture (Assessment: exams, quizzes, programs)
- Explain the basic terminology and architecture of networks and implement basic programs including socket programming (Assessment: exams, quizzes, programs)
- Explain how to choose appropriate data structures and algorithms based on problem definition, input data size and performance characteristics of underlying systems.

Methodology

Teaching methods:

This course will make use of lectures (videos), examples, and question and answer sessions. Class discussions conducted via the online platform (either in small group or with whole class), in addition to active reading, experimenting with sample programs, and problem solving, will be used during the semester. Independent homework assignments are used to evaluate the learning outcomes.

This is primarily a hands-on programming course whose homework and quizzes involve solving programming problems across different platforms. There will be independent and pair programming assignments to evaluate language and coding skills.

Assessment:

There will be regular weekly exercises, problem sets, and quizzes as described below.

- **10 Homework/Programming problem sets (25%)** – Each week we shall have programming assignments, (Pair programming is encourage)
- **CS5009 Labs (25%) :** This will come from the lab component of the course. Labs are weekly. (Pair programming is encourage)
- **10 timed online Quizzes (8%)** - These are timed quizzes (30 - 45 minutes) released either via Canvas or Grade scope. Quizzes will be available all week with a deadline at 11.30pm on **Mondays**. Students are required to allocate 30- 45 minutes to work on the quiz. Delivered via Gradescope.
- **Weekly Readings (10%)** – These are all drawn from the assigned readings and participation points from Zybooks.
- **1 Final project (10%)** – Includes a Leet-code programming portfolio. This is an individual project.
- **2 Course Syntheses (20%)** consist of short answer questions, as well as several multi-part problems connecting different areas of the course, allowing you to synthesize what you have learned. Think of the Course Synthesis as a week-long individual take-home exam where you may consult your class notes but not your classmates or any online resources other than the ones that are explicitly permitted by the course instructor.
- **4 SAIL Reflections (2%)** are your personal reflections on your journey of self-authored integrated learning (SAIL) in this course. You will reflect on your growth across five learning dimensions: Intellectual Agility, Global Mindset, Social Consciousness and Commitment, Professional and Personal Effectiveness, and Well-Being. For more details, check out https://sail.northeastern.edu/about/.

Final Grades:

A	93.00 – 100.00 %
A -	90.00 – 92.99%
B+	86.00 – 89.99%
B	83.00 – 85.99%
B-	80.00 – 82. 9%
C+	76.00 – 79.99%
C	73.00 – 75.99%
C-	70.00 – 72.99%
F	Less that 70%

Table 3: Final grading

Re-grading Assignments:

Requests for re-grading may be made up to **one week** after the assignment is returned. Please contact the TA first if you have any questions about the grading. If you still have questions, the request must be made in person with the instructor or be submitted in writing and include a short paragraph outlining the rationale for the re-grade. Acceptable requests include correcting errors in calculating a score, marking a correct answer incorrect, etc.

Course Policies

Accommodations:

The goal is for every student to succeed in this course. If you require any accommodations (e.g., childcare during class hours, extra time to complete assignments, support for a disability), let me know immediately so that we can work out appropriate arrangements. Speak to me at the end of class or contact me by email, and we will set up a time to meet during the first week of the course. I look forward to learning how I can be of service to you.

Attendance:

The class shall be offered using virtual (zoom) modality. Whereas the Professor will not take attendance and formal attendance is not mandated, students are strongly encouraged to attend and to watch the class recordings.

Course readings:

All readings will be derived from the class required textbook. It is a student's objective to complete all required reading and the ensuing assignments. Note that assignments related to the readings will not be extended.

Assignments:

Assignments will be distributed via the canvas platform. Students are responsible for managing due dates and understanding submission procedures to turn in assignments. All assignments are due at 11.30pm on Mondays. Note that this has been considered to give you enough time to prepare for the Tuesday class.

Late work:

Late assignments will not be accepted without PRIOR approval. Students must consult the instructor at least 12 hours prior to the scheduled due date to make alternative arrangements; however, the instructor is under no obligation to grant any such request. Any late assignment will be assessed a 50% penalty for up to 2 days of lateness. Work submitted after 2 days (48 hours) will receive zero (0) credit. Note that 1 minute late is considered within the 2 days (48 hours) lateness. Internet or computer issues are NOT valid excuses of late submission.

Note that this late penalty only applies to Problem Sets and Course Syntheses. The remaining assessments (In-Class/timed online Quizzes, SAIL Reflections, Final Project) must be submitted on time; failure to do so will result in an automatic zero.

Exams:
The course will NOT have formal timed exams:

Academic integrity:

The practice of good ethical behavior is essential for maintaining good order in the classroom, providing an enriching learning experience for students, and as training as a practicing computing professional upon graduation. This practice is manifested in the University's Academic Integrity policy. Students are expected to strictly avoid academic dishonesty and adhere to the Academic Integrity policy as outlined in the course catalog. Violations will be dealt with as outlined therein.

As a general rule, all work submitted for grading must be the student's OWN work.

Regarding homework, students may discuss the problems (what is being asked for), appropriate material from class lectures, the textbook or acceptable other sources. Students, however, may not share answers or the specifics of how to answer the question. Note pair programming is encouraged for all programming assignments and students who are working as part of a pair can submit the same code.

Use of material from previous classes, solution manuals, material from the Internet or other sources (e.g., parents, siblings, friends, etc.) that directly bears on the answer is strictly prohibited. Please cite the references if you use any help.

In addition, you are not allowed to post course materials and solutions to problem sets assigned in this class in public places (e.g. Github, courseHero) without the instructor's permission. Solutions include your own solutions as well as solutions that may be provided by the instructor. The University policy on academic integrity states that assisting students in their own acts of academic dishonesty is itself a violation of academic integrity. Doing so will be considered an act of academic dishonesty and you will receive a grade of 0 for the actual assignment or a grade of F for the course.

At the discretion of the instructor, students may be asked to sign a statement that they have abided by the University's Academic Integrity policy and its application to this class. This statement may appear on homework, or tests.

When in doubt, consult the course professor before doing something that may result in violation of the University's Academic Integrity policy (http://www.northeastern.edu/osccr/academic-integrity)

The sanction for the first violation of the Academic Integrity policy or plagiarism policy will result in a minimum failing grade on the relevant assignment and the violation will be reported to the student's department chair. Once the final decision has been rendered and any or all appeals exhausted by any parties involved, the instructor or appropriate parties will carry out the recommended sanction.

Title IX Policy

Title IX of the USA 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. Though our campus is located in Canada, all Northeastern University campuses follow the Title IX Policy.

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.

If you or someone you know has been a survivor of a Prohibited Offense, confidential support and guidance can be found through University Health and Counseling Services staff and the Center for Spiritual Dialogue and Service clergy members. By law, those employees are not required to report allegations of sex or gender-based discrimination to the University.

Alleged violations can be reported non-confidentially to the Title IX Coordinator within The Office for Gender Equity and Compliance at: titleix@northeastern.edu and/or through NUPD Emergency 617.373.3333; Non-Emergency 617.373.2121. Reporting Prohibited Offenses to NUPD does NOT commit the victim/affected party to future legal action.

Faculty members are considered "responsible employees" at Northeastern University, meaning they are required to report all allegations of sex or gender-based discrimination to the Title IX Coordinator.

In case of an emergency, please call 911. Please visit http://www.northeastern.edu/titleix for a complete list of reporting options and resources, both on-campus and off-campus.

Feedback

Your opinions are very important to me. All students are strongly encouraged to use the Teacher Rating and Course Evaluation (TRACE) system, at https://www.northeastern.edu/trace/, to complete your course evaluations. A reminder about TRACE should arrive via email about two weeks before the end of the course.

In addition, I will be asking for your feedback at least once, about halfway through the semester. However, if you have concerns about the course, do not wait until you are asked. Please schedule a meeting with me, and we will discuss your concerns then.