

**Data Structures**

CS 221

Spring 2024

* 3 credits
* Prerequisite: CS 111
* Instructor: [Brother David Carlson](https://cis.stvincent.edu/cis/FacultyInfo/BrDavid.php)
* Office: Dupre Science Pavilion, Tenley Hall W217
* Office hours via email, phone, or in person in my office, or Zoom.
  + Mon 9:00 am – 10:20 am, 2:00 pm – 4:00 pm
  + Tue, Thurs 9:00 am – 9:45 am, 2:30 – 4:30 pm
  + Fri 9:00 am – 10:20 am
  + and by appointment
  + Office hours indicate times that I will normally be in the office and can likely meet with you or answer email. I will also try to answer at other times, though it might take longer to get a reply.
* The CIS lab in W214 of the Dupre science complex will be available according to a schedule that will be posted after classes start. The CIS tutors usually work in this room.
* Phone: 724-805-2416
* Email: [david.carlson@stvincent.edu](mailto:david.carlson@stvincent.edu)
* Class Times and Location
  + Tue, Thurs 10:00 am - 11:15 am, Dupre W214
* Date of Final Exam:
  + Tue, May 7, 8:30 am - 10:30 am

**Course Description**

The study of data structures and associated algorithms is developed in mostly an object-oriented fashion. Various implementations of data structures and the efficiency of the associated algorithms are discussed. Topics to be covered include stacks, queues, the STL, keyed tables, recursion, linked lists, binary search trees, sorting, searching, hash tables, graphs and their traversals, heaps, and B-trees. Prerequisite: CS 111. Three credits.

**Required Text and Other Materials**

Text: Data Structures, E. Olds, R. Lysecky, F. Vahid, T. Givargis, S. Lysecky, J. Hummel, Zyante Inc. (zyBooks.com). See our bookstore to purchase your access code for this online text, identified as STVINCENTCS221CarlsonSpring2024. Then you can go to <https://learn.zybooks.com>, select the correct textbook, and enter your access code to get into our online text.

Besides reviewing topics from CS 111 (such as searching, sorting, objects, classes, and the STL) we cover nearly all of the topics in the zyBook. We also supplement this with the advanced section of [Software Design Using C++](https://cis.stvincent.edu/html/tutorials/swd/index.html), found at <https://cis.stvincent.edu/swd>, which covers a lot of the same topics. This collection of web pages is abbreviated as SWD below.

**Course Learning Objectives**

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

1. Identify the important issues, modules, or variables in a computing problem.
2. Describe a solution using principles or techniques appropriate to the class.
3. Create and compare different potential solutions using analytical techniques appropriate to the class.
4. Design a solution that meets a given set of computing requirements using techniques appropriate to the class.
5. Implement a solution that meets a given set of computing requirements using techniques appropriate to the class.
6. Evaluate a solution using appropriate metrics for the problem.
7. Construct software to solve a given problem.
8. Explain the theory or software-development fundamentals underlying the solution he or she built to solve a given problem; or, show how theory was applied to solve the problem.
9. Use computer science theory or software-development fundamentals to select among different solutions.

The above will involve doing activities such as these:

1. Design, write, and debug programs with lengths up to about 8 pages of code, using good software engineering techniques, programming style, documentation, and practices.
2. Write programs that exhibit modular programming with appropriate use of functions, parameters, and classes.
3. Use, and sometimes implement, a variety of data structures, such as stacks, queues, and linked lists -- as well as typical associated algorithms for operating on those data structures.
4. Describe basic aspects of software engineering and how they apply to producing better software.
5. Identify elements of the ACM Code of Ethics that apply in software development case study situations.

**Relevant CIS Department Student Learning Outcomes**

By the time of graduation, the CS, IS, or Cybersecurity major will have:

1. The ability to analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.
2. The ability to design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program’s discipline.
3. The ability to apply computer science theory and software development fundamentals to produce computing-based solutions.

**Course Schedule**

Note that besides daily homework done using the zyBook, there are also occasional labs that will be assigned in the zyBook. There are also a few larger programming projects to be done in Visual Studio and submitted in Schoology. Due dates and further details are posted in Schoology. You should submit each assignment (all of your .cpp and .h files for the project) in Schoology unless an assignment says otherwise.

Tue Thurs

|  |  |
| --- | --- |
| Jan 16  Assign hw1: background info, syllabus, program formatting, grading, documentation, Ch 1 ADTs | Jan 18  How to use Visual Studio & debugger, hw1 due Fri  Ch 1 Efficiency, Characteristics of software quality |
| Jan 23  Object-oriented programming, Ch 2: O(), recursion, time complexity, binary search, linear search | Jan 25  Sorting |
| Jan 30  Ch 3: Sorting | Feb 1  Ch 3: Sorting |
| Feb 6 Ch 14, 15, 16  Review of the STL (Standard Template Library) | Feb 8  Ch 4: Lists |
| Feb 13  Ch 4: Lists | Feb 15  Ch 4: Lists, Ch 5: Stacks and Queues |
| Feb 20  Ch 5: Stacks and Queues, Review | Feb 22  Exam 1 (covers chapters 1 to 5) |
| Feb 27  Ch 6: Hash Tables | Feb 29  Ch 6: Hash Tables |
| Mar 5  Spring Break | Mar 7  Spring Break |
| Mar 12  Ch 7: Trees | Mar 14  Ch 7: Trees |
| Mar 19  Ch 8: Balanced Trees | Mar 21  Ch 8: Balanced Trees, Review |
| Mar 26  Exam 2 (covers chapters 6 to 8) | Mar 28  Running Time Analysis |
| Nov 14  SWD AVL trees | Mar 28  Easter Break |
| Apr 2  Ch 9: Heaps | Apr 4  Ch 9: Heaps |
| Apr 9  Ch 10: Graphs | Apr 11  Ch 10: Graphs |
| Apr 16  Ch 10: Graphs | Apr 18  Proofs of Correctness |
| Apr 23  Ch 11: Algorithms | Apr 25  Ch 12: B-trees |
| Apr 30  Ch 12: B-trees, B+ trees | May 2  Review |

Final Exam: Tue, May 7, 8:30 am - 10:30 am, covers primarily chapters 9, 10, 11, 12, but may also include proofs of correctness, AVL trees, running time analysis, and a few review questions from earlier chapters.

**Course Requirements and Grading**

* 8% Activities in your zyBook
* 8% Labs in your zyBook
* 20% Programming projects
* 20% Exam 1
* 20% Exam 2
* 24% Final Exam

Letter grades will be assigned according to the scheme found in the current College Bulletin. Exams will be announced in advance and will be closed-book, pencil and paper exams in nature, except that you may use two 2-sided 8.5 in. x 11 in. pages of notes of any kind. Thus, on exams, only the test paper, calculators, the two pages of notes, pens, pencils, and erasers may be used. Cell phones, tablets, laptops, PCs, and similar devices should be turned off and put away. Calculators may be used on exams but are not to be shared among students.

The programming projects are more important than the zyBook activities and labs, so put more effort into the programming projects. Note that the programming projects will be graded using the following rubric:

* 55% Correctness (meets its specifications)
* 10% Good program design
* 10% Clarity, style, and readability
* 15% Good documentation, including answering any questions that the assignment asks for (such as a running time analysis, a comparison with a different version of the project, etc.).
* 10% Efficiency

On a practical level, strive to do well in the course: **work on your programming projects over the 2 or 3 weeks before each is due -- not at the last minute**, read the text and other course materials, attend class, do the work, ask questions, and try to answer questions in class! Programming and computer science are not spectator sports! They require active participation and repeated practice. Almost no one writes a reasonable program on the first attempt. Instead, you sketch out the design and then make a first attempt at the program, figure out what is wrong and fix that, then find something that is inefficient and devise a way to make that section of code run faster, etc. It may take a whole series of attempts to get a program that is correct and reasonably efficient. If you begin to feel lost, consult one of the tutors, attend a CLP session, or send a message to the instructor. Do not let yourself get behind. In fact, one key to academic success is to start early on homework, projects, and other tasks. Last-minute miracles seldom work! Note in particular that attendance is important. Student performance is bound to deteriorate when classes are missed.

Tests will ask critical thinking questions that require careful analysis, explanation, and sensible conclusions. For example, you might be presented with a section of a program and asked to trace what it produces, to write the documentation describing at a high level what this section does, or to give an alternative implementation of this section. You might also be asked to write a section of code that carries out a particular task. A few multiple choice or true/false questions may also be included.

Watch Schoology for details of assignments, their due dates, etc.

Homework will include short exercises in your zyBook. These allow you unlimited attempts and tell you if you have or have not been successful in solving the problem. Then there are occasional zyLabs that require a little more thought, but are usually somewhat short. The programming projects are longer programming assignments done in Visual Studio. This is one place where you show that you can produce useful software that meets its requirements. Programming involves typing code into a source file, compiling it, testing it, and fixing it as necessary. It requires careful work and typically cannot be completed in one sitting. **Work on your programming projects over the 2 weeks or so before each is due -- not at the last minute.** Plan to have each project done early so that there will be time to test it and to fix the problems that testing usually reveals. That also gives you time to ask the instructor or one of the tutors for assistance. Note that a programming project nearly always takes longer than you expect! Last minute attempts are very likely to fail. That holds true whether you are working on a huge million-dollar software project or a project in this course. **Projects must be done separately by each individual** unless the instructor tells you otherwise. **Do not ask a fellow student in the class how to solve the problem, ask to see that person's code, get ChatGPT or similar to produce a solution, or get a solution in some other way, as that is plagiarism!** Of course, you are allowed to look up small items such as how a particular C++ function (such as getline) works. You may consult only the tutors or the instructor for homework, lab, and programming project help.

Make-up exams are discouraged. If possible, take the regularly scheduled exam. However, see your instructor ahead of time if you know you must miss an exam and consult with your instructor for any other situations involving missing an exam. Going on vacation is not a valid excuse for missing an exam. Being sick is a valid excuse.

**CIS Department Policies**

Although we intend to keep a traditional in-person class schedule this semester, policies may change during the semester if significant danger develops because of covid or some other disease. Here are our current policies:

* For all assignments and exams, illegible answers will not be graded, and no points will be awarded.
* At any time, you may be asked to explain the code you turned in for an assignment or as the answer to an exam question. If you cannot explain it, you will not receive any points for that assignment or exam question. See the Academic Honesty Policy below.
* If you cannot attend a class: Email me to let me know about this.
* If you miss a class, it is your responsibility to get any notes, handouts, or assignments. If a reasonable excuse is provided, you will be given the opportunity to make up any missed in-class assignment. In cases of illness that requires quarantine or similar, remote attendance may be possible via Zoom. Please contact me as soon as possible when such a situation arises.
* In general, recording the class is prohibited. However, see the general college policy on recordings below.
* An essential characteristic of Saint Vincent College is the dignity and civility with which students and instructors conduct themselves both inside and outside the classroom. All students share in the responsibility of making the classroom, whether physical or virtual, a positive place to learn. Attendance is more than just being in the classroom or logged into the course. Students are expected to be prepared, attentive, and respectful of others.
* If a class must be canceled for any reason, I will contact you by email and/or a posting in Schoology, if at all possible. If assignments are due when a class has been canceled, they should be turned in via Schoology by the same due date.
* Students should consult the CIS Department Policies, [DepartmentPolicies.pdf](https://cis.stvincent.edu/cis/DeptInfo/DepartmentPolicies.pdf), for additional information regarding course and department policies.
* Please use the same seat throughout the semester to aid in taking attendance. See specific attendance policies below.

Course Policies

Academic Honesty Policy

Saint Vincent College assumes that all students come for a serious purpose and expects them to be responsible individuals who demand of themselves high standards of honesty and personal conduct. Therefore, it is college policy to have as few rules and regulations as are consistent with efficient administration and general welfare. **Fundamental to the principle of independent learning and professional growth is the requirement of honesty and integrity in the performance of academic assignments, both in the classroom and outside, and in the conduct of personal life. Accordingly, Saint Vincent College holds its students to the highest standards of intellectual integrity and thus the attempt of any student to present as his or her own any work which he or she has not performed or to pass any examinations by improper means is regarded by the faculty as a most serious offense.** Faculty decide, for example, in each class and will clearly state in their syllabus or assignment instructions how AI large language models may be used or prohibited; failure to adhere to these expectations, including citing the AI if use is allowed, constitutes academic dishonesty. In any case of academic dishonesty, the faculty member together with the Academic Integrity Officer (usually the Assistant Vice President for Academic Affairs), who may meet with the student, decide on the appropriate sanction. Depending on the seriousness of the offense, possible sanctions are failure for the assignment, failure for the course, suspension, or expulsion. If a student receives the sanction of a failure for the course during the withdrawal period and drops the course, a WF will be recorded on the transcript.

**In this course, students are expected to do entirely their own work on the exams and homework. However, some of the homework might be team projects, but most will be individual projects. Any team project should be done with each team doing its own work. No team should consult a different team.** Every assignment should list all sources that contributed to the solution. This would include the individual student (or the group members for something done as a team). It may also include the instructor, a reference book, a web site, etc. AI (such as ChatGPT) is **not** to be used unless an assignment specifically asks you to use it. Web sites or people that simply give you a solution to an assignment are **not** to be used. If you need assistance beyond simple clarification of the description of the assignment, consult the instructor or one of our tutors. **Except for a group project, you may not look at the work of another student or show yours (even a part of it) to another student. You may not work out an assignment with one or more students from the course (who are not on your team, if we do a group project). If you break one of those conditions, then this is a case of academic dishonesty**. See above for how this gets handled and the possible consequences.

*Appropriate Academic Use of Recordings*

Please be advised that elements of this course may be recorded for the sake of students in need of certain accommodations. This recording may include any contributions you make during the class sessions by answering/asking questions or making presentations. If you have concerns about being recorded, please contact your professor before class to discuss those concerns and the possibility of other ways that you might contribute.

All students are expected to use recorded course material only for their own personal academic use. Recorded content may not be shared with others outside of the course unless the instructor has given explicit permission for the student to do so. Note that class sessions are not likely to be recorded unless it is known to the instructor that someone has a legitimate reason to miss the class.

Violations of this policy will be reported to and addressed by the Office of Student Conduct. Behavior that constitutes a violation of academic integrity will also be reported to Academic Affairs and may incur additional sanctions.

*Photographs*

Students are not allowed to take photographs during class without the permission of the instructor. If you missed something in a lecture, check with me or ask a fellow student about the item that you missed.

Attendance Policy

* Follow the current college policies on dealing with diseases (such as covid).
* Note that any significant changes to the health situation may require modifications to this policy.
* In person attendance is normally expected in this class. Attendance will be taken. Each unexcused absence after the first 3 will result in 1.5 points being subtracted from the final course grade.
* If there is anyone in this course who must attend remotely, and your instructor is willing to allow this, contact the instructor immediately so that arrangements can be worked out.
* Students who are required to quarantine or isolate due to disease will be given excused absences from the relevant class sessions. These students should contact their professor for how they can continue with the class remotely. A likely method is to follow along in the text (and its interactive exercises) and to read through the other course materials. The use of Zoom might also be a possibility.
* Students who have some other significant reason for missing a class should contact their professor to see if the absence can be excused. The reason for the absence should fit under the category of extreme verifiable circumstances. Examples of extreme circumstances are serious illnesses or the death of a family member. Examples of non-extreme circumstances are nonrefundable airline tickets, sporting events and concert tickets. Proof of the extreme circumstance is required, such as a note from a nurse, doctor or coach, or an obituary notice, or a receipt from a car-towing company, etc.
* Email me if you must miss class for any reason, whether it is due to an illness or some other issue. It is always best to let me know instead of leaving me to wonder why you were not in class.
* Arriving late for class or leaving early (without a proper excuse) is counted as 1/2 of an absence.
* An unexcused absence from an exam results in reducing the course grade by one entire letter (for example, a B- becomes a C-). If the missed exam is not made up before the end of the semester, the course grade becomes an F.
* Make-up exams are discouraged. If possible, take the regularly scheduled exam. However, see your instructor ahead of time if you know you must miss an exam (e.g. due to sports) and consult with your instructor for any other situations involving missing an exam.
* Unexcused absence from more than one-third of the semester's classes results in the failure of the course.
* Attendance is used to decide borderline grades at the end of the semester.
* Late work is not normally accepted, but partial credit is given for incomplete work that is submitted on time. Contact me if unusual circumstances might be cause for an exception.

*Class Cancellation Policy*

If the instructor needs to cancel class, every effort will be made to send an email message to students' Saint Vincent email accounts and/or to place a note on the course Schoology page.

Classroom Etiquette

An essential characteristic of Saint Vincent College is the dignity and civility with which students and instructors conduct themselves both inside and outside the classroom. All students share in the responsibility of making the classroom, whether physical or virtual, a positive place to learn. Attendance is more than just being in the classroom or logged into the course. Students are expected to be prepared, attentive, and respectful of others.

*Accessibility Statement for Students with Disabilities*

For spring 2024, students with disabilities who may be eligible for academic accommodations and support services should contact Ms. Nicole Kerr, the Accommodations Coordinator to schedule a meeting. Ms. Kerr can be reached at 724-805-2371 or by email to [AcademicSupport@stvincent.edu](mailto:AcademicSupport@stvincent.edu). Her office is located in the Academic Affairs suite on the 2nd floor of Headmasters Hall (above post office). Reasonable accommodations do not alter the essential elements of any course, program, or activity. The Notification of Approved Academic Accommodations form indicates the effective date of all approved academic accommodations and is not retroactive.

**Sexual Harassment and Title IX Statement**

Saint Vincent faculty are committed to helping create a safe learning environment for all students and for the college as a whole. If you have experienced any form of gender or sex-based discrimination or harassment, including sexual assault, sexual harassment, intimate partner (dating or domestic) violence, sexual exploitation, or stalking, know that help and support are available. Saint Vincent College has staff members trained to support students in navigating campus life, accessing health and counseling services, providing academic and housing accommodations, and more. The College strongly encourages all students to report any such incidents.

Please be aware that all Saint Vincent employees (other than those designated as confidential employees such as counselors, clergy and healthcare providers) are required to report information about such discrimination and harassment. This does not include information shared in class discussions or assignments, but it does include information shared in conversations outside class. The Title IX Coordinator will contact you to inform you of your rights and options and connect you with support resources. The purpose of reporting is to allow Saint Vincent to take steps to ensure that you are provided with any necessary resources needed and to provide a safe learning environment for all.

The College’s Title IX Coordinator is:

Eileen K. Flinn, Esq.

Saint Vincent College

Second Floor, Alfred Hall

724-805-2897

The College also has confidential resources available, who can provide assistance to those who have experienced sexual misconduct without triggering a mandatory reporting duty.  More information about confidential resources is available on the [Saint Vincent College website](https://www.stvincent.edu/student-life/title-ix).

If you wish to speak to a confidential employee who does not have this reporting responsibility, you can contact Campus Ministry at 724-805-2350 or the Wellness Center in the Carey Student Center at 724-805-2115. For more information regarding your rights and options, please see the Sexual Misconduct and Harassment policy which can be found on the MySV portal under Quick Links or on the [Saint Vincent College website](https://www.stvincent.edu/student-life/title-ix).