



SAINT VINCENT COLLEGE

Introduction to Computability

CS 171
Spring 2024

- 3 credits
- Prerequisite: CS 170
- Instructor: Brother David Carlson
- 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
- Phone: 724-805-2416
- Email: david.carlson@stvincent.edu
- Class Times and Location
 - Tue, Thurs 1:00 pm - 2:15 pm, JFW 214 (the engineering building)
- Date of Final Exam
 - Wed, May 8, 11:00 am - 1:00 pm

Course Description

This course emphasizes the mathematical and theoretical foundations of computer science. The primary topics are computability theory, Turing machines, complexity theory (including classes P, NP, NP-complete, and NP-hard), grammars, parsing, push-down automata, and running time analysis (especially using recurrence relations and generating functions). Important fundamental questions will be answered, such as whether all functions are computable and the existence of unsolvable problems. Also included is an introduction to proofs of program correctness and some running time analysis for algorithms to solve the traveling salesperson problem.

Required Text and Other Materials

Text: Discrete Mathematics and Its Applications, 8th ed., Rosen, K., McGraw-Hill, any version (print, electronic, etc.), ISBN 978-1-260912784 or similar.

- The instructor will supply considerable additional material. The above text covers less than half of the course.

Course Learning Objectives

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

1. Design a solution that meets a given set of computing requirements using techniques appropriate to the class. (This might be done by using mathematics to estimate $O()$ running times of competing algorithms in order to choose the fastest.)
2. Implement a solution that meets a given set of computing requirements using techniques appropriate to the class. (One place this might be done is in writing grammar rules that force an operator to be left associate versus right associative.)
3. Evaluate a solution using appropriate metrics for the problem. (With a detailed solution, a more exact running time function might be obtainable and could be used to see the running time more exactly than what a $O()$ estimate would give.)
4. 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. (For example, the theory of linear recurrences could be applied to get a running time estimate.)
5. Use computer science theory to select among different solutions. (For example, proof of program correctness methods might be used to select a correct solution over one which is not correct in all cases.)

Relevant CIS Department Student Learning Outcomes

By the time of graduation

1. The CS, IS, or Cybersecurity major will have an ability to design, implement, and evaluate a computer-based solution to meet a given set of computing requirements in the context of the discipline.
2. The CS major will have an ability to apply theory in the design and implementation of computer-based solutions.
3. The CS major will have an ability to reason about and explain computer-based solutions at multiple levels of abstraction.

Course Schedule

Due dates are posted in Schoology. The schedule below merely attaches assignments to the approximate correct places in the course.

Date	Topic	Assignment/Exam
Wk 1, Jan16	Syllabus, 1.7 Introduction to Proofs, 1.8 Proof Methods & Strategy	Homework will be posted in Schoology
Wk 1, Jan18	5.1 Mathematical Induction, 5.2 Strong Induction, brief	
Wk 2, Jan 23	5.3 Recursive Definitions, Structural Induction 5.4 Recursive Algorithms (review briefly)	
Wk 2, Jan 25	Review Ch 13: Languages & Grammars, Finite State Machines, Language Recognition, Sections 13.1 - 13.4	

Wk 3, Jan 30	13.4 Language Recognition, Pumping Lemma	
Wk 3, Feb 1	Parsing & Push-Down Automata, LL(k) and LR(k) Parsers, Grammar Questions: How to get operators to be left/right associative, priority of AND vs OR, nested IF..THEN..ELSE ambiguity	
Wk 4, Feb 6	13.5 Turing Machines & Turing's Thesis	
Wk 4, Feb 8	Turing Machines & the General Halting Problem, Undecidable Problems	
Wk 5, Feb 13	Turing Machines and Computability, Church's Thesis	
Wk 5, Feb 15	Primitive Recursive Functions, Partial Recursive Functions, Turing Machines and Complexity	
Wk 6, Feb 20	Covers all of the above, except Feb 15	Exam 1
Wk 6, Feb 22	Turing Machines and Complexity	
Wk 7, Feb 27	Status of the P = NP Problem, NP Complete, NP Hard, Godel's Incompleteness Theorem, Recursively Enumerable Languages	
Wk 7, Feb 29	Infinite Sets	
Mar 5	Spring Break	
Mar 7	Spring Break	
Wk 8: Mar 12	Infinite Sets	
Wk 8: Mar 14	Infinite Sets & Computable Functions	
Wk 9: Mar 19	5.5 Proofs of Program Correctness	
Wk 9: Mar 21	5.5 Proofs of Program Correctness	
Wk 10: Mar 26	5.5 Proofs of Program Correctness	
Wk 10: Mar 28	Easter Break	
Wk 11, Apr 2	Travelling Salesperson Problem (TSP)	
Wk 11: Apr 4	Covers from Feb 15 to Mar 26	Exam 2
Wk 12: Apr 9	8.1 Recurrences 8.2 Linear Homogeneous Recurrence Relations	
Wk 12: Apr 11	8.2 Linear Homogeneous Recurrence Relations	
Wk 12: Apr 16	8.2 Linear Nonhomogeneous Recurrence Relations	
Wk 13: Apr 18	8.2 Linear Nonhomogeneous Recurrence Relations	
Wk 14: Apr 23	8.3 Recurrences for Divide-and-Conquer Algorithms	

Wk 14: Apr 25	8.4 Generating Functions and Recurrences	
Wk 15: Apr 30	8.4 Generating Functions and Recurrences	
Wk 15: May 2	Review	

Final Exam: Wed, May 8, 11:00 am - 1:00 pm, covers primarily chapter 8 on solving recurrences but may also include a few review questions from earlier in the course.

Course Requirements and Grading

- 25% First Exam
- 25% Second Exam
- 25% Final Exam
- 25% Homework

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, open-notes, pencil and paper exams. Calculators may be used (and are expected to be used) on exams, but calculators may not be passed between students. Cell phones and pagers should be turned off and put away during exams. On a test, students may only use the test itself, notes, handouts, calculators, pens, pencils, and erasers. No laptops or other computers may be used on an exam.

Some, but not all, of the homework will be collected and graded. Homework and test answers are expected to be written using good English and good mathematics. These items will be graded on the correctness of the steps used to get the answers, as well as the answers themselves, and (with a lesser weight) the clarity of their presentation. That last category is intended to help the student to develop good written communications skills. The rubric for grading the homework is:

- 80% Correctness of answers and correctness of steps to get the answers (weighted equally)
- 20% Clarity of argument, style, and readability

On a practical level, strive to do well in the course: read the text, attend class, do the work, ask questions, and try to answer questions in class! Mathematics and computing are not spectator sports! They require active participation and repeated practice. If you begin to feel lost, consult one of the tutors, see the instructor, or work through the difficulties with the help of the other student on your team. Do not let yourself get behind. In fact, one key to academic success is to start early on homework and other tasks. Last-minute miracles seldom work! Note in particular that attendance is expected. Student performance is bound to deteriorate when classes are missed.

Exam questions normally require you to show all major steps for producing the answer to each question. Failure to do so will likely result in losing a significant number of points on the problem. It is more important to know how to solve a problem and explain it well than to simply have the correct answer. Exceptions where you can simply write the answer will be marked (if not obvious).

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

Homework assignments and exams will ask critical thinking questions that require careful analysis, mathematical explanation and/or proof, and meaningful conclusions. For example, given some algorithm, you might be asked to estimate its running time by using the techniques from this class. You

might also be asked to summarize the running time with a tight big-O estimate and to compare this running time to that of other algorithms for the same problem in order to conclude which is best in various situations. The details should be written in good mathematical notation, with good English descriptions where needed, especially in the introduction and conclusion. In some cases, the solution to a question requires some interpretation, some explanation of the meaning and/or correctness of the solution. Other problems might ask for mathematical proof of some proposition. **Homework 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 homework problem, ask to see that person's answer, get ChatGPT or similar to produce a solution, or get a solution in some way other than doing it yourself, as that is plagiarism!**

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 answers 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](#), 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 any individual homework. Some of the homeworks might be team projects, but most (or perhaps all) will be individual homeworks. Any team project should be done with each team doing its own work. No team should consult a different team. Every written homework should list all sources that contributed to the solution. This would include the individual student. It may also include the instructor, a reference book, a web site, etc. Web sites, AI chat bots, 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. **You may not look at the work of another student in this course or show yours (even a part of it) to another student in the course. You may not work out an assignment with one or more other students (who are not in your group, for 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 covid 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 covid 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 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 normally required, such as a note from a nurse, doctor or coach, 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 Mrs. Nicole Kerr, the Accommodations Coordinator to schedule a meeting. Mrs. Kerr can be reached at 724-805-2371 or by email to (academicssupport@stvincent.edu). Her office is located in the Academic Affairs suite on the 2nd floor of Headmasters Hall (above the campus 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](#).

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](#).