



SAINT VINCENT COLLEGE

Quality Education in the Benedictine Tradition



Introduction to Computability

CS 171
Spring 2020

- 3 credits
- Prerequisite:
 - CS 170
- Instructor: Brother David Carlson
- Office: Dupre Science Pavilion, Tenley Hall W217
- Office hours:
 - Mon, Fri 9:30 am - 11:20 am
 - Mon, Wed, Fri 2:00 pm - 4:00 pm
 - Thurs 1:00 pm - 2:15 pm
 - and by appointment
- Phone: 724-805-2416
- Email: david.carlson@stvincent.edu
- Class Times and Location
 - Tue, Thurs 2:30 pm - 3:45 pm, Dupre E106
- Date of Final Exam
 - Tue, May 5, 1:30 pm - 3:30 pm

Course Description

This course emphasizes the mathematical and theoretical foundations of computer science. The primary topics are computability theory and Turing machines, complexity theory (including the classes P, NP, NP-complete, and NP hard), grammars and 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 Course Books and Other Materials

Text: Discrete Mathematics and Its Applications, 8th ed., Rosen, K., McGraw-Hill (2019), loose leaf version, ISBN 978-1-259731280 or the textbook rental of the same text, ISBN 978-1-259676512.

- Do not get the e-book version. Our exams are open book, open notes, but e-books are not allowed on the exams.

- Try not to get a different edition or an international edition as there are typically considerable differences in the exercises and sometimes in the chapter material as well. One international edition left out an entire chapter.
- The instructor will supply considerable additional material. The above text covers only about half of the course.

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 Learning Objectives

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

1. prove the correctness of short programs that use IF and WHILE loop constructs.
2. write grammar rules so that an operator is left (or right) associative, one operator has higher priority than another operator, etc.
3. analyze the running time of an appropriate algorithm by constructing and solving a recurrence.
4. explain the importance of major theory of computing results such as the existence of unsolvable problems, the implications of the time complexity of the traveling salesperson problem, and the Church-Turing thesis.

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, Jan 14	syllabus, 1.7 introduction to proofs, 1.8 proof methods & strategy	Homework will be posted in Schoology
Wk 1, Jan 16	5.1 mathematical induction, 5.2 strong induction, briefly	
Wk 2, Jan 21	5.3 recursive definitions, structural induction 5.4 recursive algorithms (review briefly)	
Wk 2, Jan 23	Review Ch 13: Languages & Grammars, Finite State Machines, Language Recognition, sections 13.1 - 13.4	
Wk 3, Jan 28	13.4 Language Recognition, Pumping Lemma	

Wk 3, Jan 30	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 4	13.5 Turing Machines & Turing's Thesis	
Wk 4, Feb 6	Turing Machines & the General Halting Problem, Undecidable Problems	
Wk 5, Feb 11	Turing Machines and Computability, Church's Thesis	
Wk 5, Feb 13	Primitive recursive functions, partial recursive functions, Turing Machines and Complexity	
Wk 6, Feb 18	Covers all of the above, except Feb 13	Exam 1
Wk 6, Feb 20	Turing Machines and Complexity	
Wk 7, Feb 25	Status of the P = NP Problem, NP Complete, NP Hard, Godel's Incompleteness Theorem, Recursively enumerable languages	
Wk 7, Feb 27	Infinite Sets	
Mar 3	Spring Break	
Mar 5	Spring Break	
Wk 8: Mar 10	Infinite Sets	
Wk 8: Mar 12	Infinite Sets & Computable Functions	
Wk 9: Mar 17	5.5 Proofs of Program Correctness	
Wk 9: Mar 19	5.5 Proofs of Program Correctness	
Wk 10: Mar 24	5.5 Proofs of Program Correctness	
Wk 10: Mar 26	Travelling Salesperson Problem (TSP)	
Wk 11, Mar 31	8.1 Recurrences, 8.2 Linear Homogeneous Recurrence Relations	
Wk 11: Apr 2	Covers from Feb 13 to Mar 26	Exam 2
Wk 12: Apr 7	8.2 Linear Homogeneous Recurrence Relations	
Wk 12: Apr 9	Easter Break	
Wk 13: Apr 14	8.2 Linear Nonhomogeneous Recurrence Relations	
Wk 13: Apr 16	8.2 Linear Nonhomogeneous Recurrence Relations	
Wk 14: Apr 21	8.3 Recurrences for Divide-and-Conquer Algorithms	
Wk 14: Apr 23	8.4 Generating Functions and Recurrences	
Wk 15: Apr 28	8.4 Generating Functions and Recurrences	
Wk 15: Apr 30	Review	
Finals Week: Tue, May 5 1:30 - 2:30 pm	Final mostly covers Mar 31 to Apr 30 but includes a few review questions from earlier	Final exam

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. Due to the technical nature of the course, exams will be of the open-book, open-notes variety. Calculators may be used (and are expected to be used) on exams. Cell phones and pagers should be turned off and put away during exams. On a test, students may only use the test itself, books, notes, handouts, calculators, pens, pencils, and erasers. Calculators may not be passed between students. No laptops or other computers may be used on an exam. Calculators and Mathematica are of use in the graphing of functions and in certain other parts of this course. These can also be used to aid in doing homework.

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.

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

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.

Make-up exams are strongly discouraged. If possible, take the regularly scheduled exam. For an excused absence or other significant reason, the instructor may agree to give a make-up exam. Whenever possible, see your instructor ahead of time if you know you must miss an exam (e.g. due to sports). Normally some type of written documentation is required (such as a note from the coach, doctor, etc.). If the documentation or reason for missing an exam is poor, the student can count on receiving a significantly more difficult exam, if one is given at all! Do ask about a makeup exam if you have a good reason to miss an exam, even if documentation is not readily available, as it is understood that illnesses and other complications do happen. Students participating in sports teams are required to notify the instructor in advance of games that might conflict with class.

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. In any case of academic dishonesty, the faculty member together with the Assistant Vice President for Student Success and Retention, who confers 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. Written homework can be done together unless explicitly stated otherwise. 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, another student, etc. If you need assistance beyond simple clarification of the description of the assignment, consult the instructor. If you get answers or even partial answers from someone else on an exam (or an individual homework if we have any of those), then this is a case of **academic dishonesty**. See above for how this gets handled and the possible consequences.

Attendance Policy

- If the student does not attain a passing average in the test category, a failing grade will be received for the course.
- Each unexcused absence after the first 3 results in 1.5 percentage points being deducted from the final course grade.
- 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 the failure of the course.
- 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 accepted unless resulting from an excused absence, but partial credit is given for incomplete homework that is submitted on time.
- 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 are not in class.

- Written documentation (such as a note from a doctor's office or coach of one's sports team) is normally required for an absence to be excused. Always bring a copy of such a note to give to your instructor when you can do so. In special circumstances, check with your instructor, as it is not always possible to get documentation.
- Note on flu:
 - Because of the possibility of the flu affecting us on campus, please practice good hand washing, etc. If you get the flu, please notify me by phone or e-mail and stay home for 24 hours after the fever has gone. Check with me about what you miss. You will not be penalized for missing class in this situation. It is better to stay away from class and not spread the flu when you are ill.

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.

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 a positive place to learn. Attendance is more than just being in the classroom, laboratory or field experience. Students are expected to be prepared and attentive. Some specific behaviors that are distracting and should be avoided include holding side conversations, arriving late or leaving early, doing work for other classes, eating, or using laptops to check email or surf the web. Cell phones, pagers, and other electronic devices must be turned off when students are in the classroom, labs, or when meeting with a faculty or staff member unless specific permission has been given by the instructor. Students should check with individual professors for additional expectations and guidelines for classroom etiquette, including whether or not tape recording of classroom lectures is permitted.

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 another student in the course. 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.

Accommodations for Disability

Students with disabilities who may be eligible for academic accommodations and support services should contact Ms. Marisa Carlson, Assistant Dean of Studies, by phone (724-805-2828), email (marisa.carlson@stvincent.edu) or by appointment (Academic Affairs-Headmasters Hall). 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.

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 means that I have a mandatory duty to report to the Title IX Coordinator any information I receive about possible sexual misconduct. This includes information shared in class discussions or assignments, as well as 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, including possibilities for holding accountable the person who harmed you. Know that you will not be forced to share information and your level of involvement will be your choice. 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 at <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 MySVC portal under Quick Links or on the web at <https://www.stvincent.edu/student-life/title-ix>.