



SAINT VINCENT COLLEGE

Discrete Structures

CS 170
Fall 2020

- 3 credits
- Prerequisite:
 - CS 110
 - The student should have a solid background in high school algebra and precalculus.
- Instructor: Brother David Carlson
- Office: Dupre Science Pavilion, Tenley Hall W217, but all office hours will be online or by other electronic means, not in-person. Tentative plans are for at least one Zoom conference per week as well as communicating via Schoology messages, Webwork, or similar. See more about Webwork further on in this syllabus.
 - Mon, Wed, Fri 2:00 pm - 2:50 pm
 - Tue 12:30 pm - 2:30 pm
 - Thurs 8:30 am - 11:20 am
 - and by appointment
 - Office hours indicate times that I will be in the office and can likely answer messages you send me. I will also try to answer at other times, though it might take longer to get a reply.
 - We will also try a weekly Zoom conference for asking and answering questions. The day and time will be decided during the first week or two of the course.
- Phone: 724-805-2416
- Email: david.carlson@stvincent.edu
- Class Times and Location
 - Mon, Wed, Fri 8:30 am - 9:20 am, Dupre E106
- Final Exam: Tue, Nov 24, 8:00 - 9:45 am

Course Description

This course is an introduction to the topics in discrete mathematics that are of particular use in computing. Discrete mathematics is especially concerned with counting techniques and finite or infinite sets of integers (discrete numbers), instead of a continuous range of numbers (such as the real numbers used in calculus). Topics to be covered include logic, sets, functions, simple proof techniques, algorithms, counting techniques, basics of graphs and trees, finite state machines, parsing, and grammars.

The major purpose is to help the student to obtain some fluency in specific areas of discrete mathematics and to encourage the use of the associated techniques in other computing courses (such as CS 310). This course is also a prerequisite for CS 171.

Required Text

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 an e-book as only a printed text is allowed for in-class exams. If we should be forced to move to an online-only course, then an e-book would be acceptable.
- 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.
- Additional materials will be posted under our course in Schoology, <https://saintvincent.schoology.com> .

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 supports student learning outcome 1 and might involve the creation of a set of new computer grammar rules.
2. Implement a solution that meets a given set of computing requirements using techniques appropriate to the class.
This supports student learning outcome 1 and might involve implementing the new computer grammar rules in a particular parser.
3. Evaluate a solution using appropriate metrics for the problem.
This supports student learning outcome 1 and might involve finding $O()$ and $\Theta()$ running time estimates for one or more algorithms.
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.
This supports student learning outcome 2 and might involve the application of mathematical logic and running time analysis.
5. Use computer science theory to select among different solutions.
This also supports student learning outcome 2 and might involve the application of mathematical logic and running time analysis.

Relevant CIS Department Student Learning Outcomes

This course supports student attainment of the following 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 computing-based solution to meet a given set of computing requirements in the context of the program's discipline. (This course concentrates on the design and evaluation aspects of this outcome.)

- The CS major will have an ability to apply computer science theory and software development fundamentals to produce computing-based solutions.

Course Schedule

Note that assignments are in the Webwork online mathematical homework system unless stated otherwise. Homework marked as "from text" is either taken directly from the text or similar problems are supplied. Due dates are posted in Schoology. The schedule below merely attaches assignments to the correct places in the course.

In this course we expect to have approximately half of the students in attendance at each class session, with the other half being in an online conference at the same time. In the next next class session, the two halves change locations, so that those who were online are now physically in class, etc. Which students are to attend each in-class session will be announced just before the first week of classes.

Date	Topic	Assignment/Exam
Wk 1: Aug 17	syllabus, 2.1 sets, 2.2 set operations	Ch2Sec1, Ch2Sec2
Wk 1: Aug 19	2.3 functions	Ch2Sec3
Wk 1: Aug 21	2.4 sequences	Ch2Sec4a
Wk 2: Aug 24	2.4 sums	Ch2Sec4b
Wk 2: Aug 26	2.4 sums (skip 2.5), 2.6 matrices (briefly)	Ch2Sec6
Wk 2: Aug 28	1.1 propositional logic, 1.2 applications	Ch1Sec1
Wk 3: Aug 31	1.3 propositional equivalences	Ch1Sec3
Wk 3: Sept 2	1.4 predicates & quantifiers	Ch1Sec4
Wk 3: Sept 4	1.5 nested quantifiers	Ch1Sec5
Wk 4: Sept 7	1.5 nested quantifiers, 1.6 rules of inference	Ch1Sec6
Wk 4: Sept 9	1.6 rules of inference and simple proof methods (skip 1.7 and 1.8)	Proofs homework
Wk 4: Sept 11	3.1 algorithms (briefly), 3.2 growth of functions, big O and big θ	Ch3Sec2a homework from text
Wk 5: Sept 14	3.2 growth of functions, big O and big θ	Ch3Sec2b homework from text
Wk 5: Sept 16	3.3 complexity of algorithms	Ch3Sec3hw from text
Wk 5: Sept 18	4.1 Divisibility & modular arithmetic, review: especially big O, big θ , and complexity of algorithms	Ch4Sec1
Wk 6: Sept 21	Exam 1 on chapters 1, 2, 3	Exam 1
Wk 6: Sept 23	4.2 integer representations, conversion between bases, and algorithms	Ch4Sec2
Wk 6: Sept 25	4.3 primes, gcd, extended Euclidean algorithm	Ch4Sec3

Wk 7: Sept 28	4.4 Solving congruences (skip 4.5)	Ch4Sec4
Wk 7: Sept 30	4.6 RSA encryption, RSASection4_6TheoremsExamples.pdf	Ch4Sec6
Wk 7: Oct 2	5.3 recursive definitions (but skip structural induction), 5.4 recursive algorithms (briefly)	Ch5Sec3 from text
Wk 8: Oct 5	6.1 basics of counting	Ch6Sec1
Wk 8: Oct 7	6.2 pigeonhole principle	Ch6Sec2
Wk 8: Oct 9	6.3 permutations & combinations, 6.4 binomial coefficients, binomial theorem (skip 6.5 and 6.6)	Ch6Sec3
Wk 9: Oct 12	7.1 intro to discrete probability	Ch7Sec1
Wk 9: Oct 14	7.2 probability theory, Bernoulli trials, binomial distribution	Ch7Sec2
Wk 9: Oct 16	7.3 Bayes' Theorem	Ch7Sec3 from text
Wk 10: Oct 19	7.4 expected value and variance, review	Ch7Sec4 from text
Wk 10: Oct 21	Exam 2 on chapters 3 (repeated), 4, 5, 6, 7	Exam 2
Wk 10: Oct 23	13.1 languages & grammars, Chomsky's hierarchy	Ch13Sec1 from text
Wk 11: Oct 26	13.2 finite-state machine with output, 13.3 finite-state machines with no output	Ch13Sec1and2 from text
Wk 11: Oct 28	13.4 language recognition	Ch13Sec3 from text
Wk 11: Oct 30	13.4 language recognition, a table based LR(1) parser	Ch13Sec4 from text
Wk 12: Nov 2	grammars and parsing	3 homework projects over 3 weeks
Wk 12: Nov 4	10.1 graphs & graph models, 10.2 graph terminology & special types of graphs	Ch10Sec1And2 from text
Wk 12: Nov 6	10.2 graph terminology & special types of graphs, 10.3 representations & isomorphism	Ch10Sec3And4 from text
Wk 13: Nov 9	10.4 connectivity	Ch10Sec3And4 from text
Wk 13: Nov 11	10.5 Euler & Hamilton paths, 10.6 shortest-path problems	Ch10Sec5And6 from text
Wk 13: Nov 13	10.6 shortest-path problems, 11.1 intro to trees (briefly), 11.3 tree traversal (briefly) (skip 10.7)	Ch10Sec1And3 from text
Wk 14: Nov 16	(skip 11.2) 11.4 spanning trees, 11.5 minimum spanning trees	Ch10Sec4And5 from text
Wk 14: Nov 18	briefly: 10.8 graph coloring, intro to relations (ch 9)	
Wk 14: Nov 20	Review	

Wk 15: Nov 22 - 24	Final mostly covers chapters 10, 11, 13, and parsing, but includes a few review questions from earlier	Final exam: Tue, Nov 24, 8:00 - 9:45 am
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Course Requirements and Grading

- 25% First Exam
- 25% Second Exam
- 25% Final Exam
- 25% Homework (including Webwork)

Letter grades will be assigned according to the scheme found in the current College Bulletin. Exams will be announced in advance. Calculators may be used (and are expected to be used) on exams. Calculators, Wolfram Alpha, and other calculation software are of use in the graphing of functions and in certain other parts of this course. These can also be used in doing homework.

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 computer science are not spectator sports! They require active participation and repeated practice. If you begin to feel lost, consult one of the tutors 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 and other tasks. Last-minute miracles seldom work! Note in particular that attendance (in-class or online) is important. Student performance is bound to deteriorate when classes are missed.

We will be using the **Webwork online mathematical homework system** for some of the homework this semester. This will provide you with more feedback and assistance in doing homework than what is typically available with written homework. A very useful feature is that you can send me a message from the page with a Webwork problem that you are having trouble with. Webwork will then show me the exact same problem as well as the last answer that you tried. Since some of the Webwork problems are randomized, this helps by showing me the exact question that you are working on. It may take me a while to answer due to other classes and responsibilities, but I do try to answer these as soon as I can. Webwork will usually allow you more than one attempt at a problem and may even give a hint. It will also show you the answers after the due date, which is useful in learning how to solve problems that you did not get and in studying for exams. However, there will be written homework for some of the topics in the course. On occasion a written homework assignment may be 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 (including Webwork) 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 determining the most important instructions that get repeated, counting them, and then generalizing from this to a formula for the number of these instructions done in the general case. 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 with proper 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.

CIS Department Policies

As much as possible, the CIS Department faculty intend to keep a traditional lecture schedule this semester. Bear in mind, policies may change during the semester as the covid situation changes. Please refer to the Department's website for the latest information. Here are our policies:

- We will provide normally scheduled lectures. Depending on the class, we may offer synchronous on-line lectures, recorded lectures, or some other format. Faculty will provide specific instructions for their classes in their syllabi.
- Given lecture-room capacity limitations due to the College's covid response, you may be asked to attend in-class lecture only once or twice per week. For all other lectures, you must attend the synchronous, on-line lecture for your class.
- If you cannot attend synchronous, on-line lectures, the faculty will accommodate you. The form of accommodation will vary among classes. The faculty will **not** normally publish lecture recordings.
- Usually, assignments will be distributed and collected through Schoology. Some classes, however, may use different websites for homework and projects.
- The College has allowed office hours and group meetings (e.g., research, senior-project teams) to be held via Zoom. Check the syllabus for your class to determine how and when office hours will be held. Faculty will make available in their syllabi both the methods and times when they will be available for office hours. Please use those hours!
- Tutoring and CLP sessions will be delivered via Zoom. Schedules will be posted on the department's website <https://cis.stvincent.edu>.
- Please use the same seat throughout the term to minimize contamination and to aid faculty in taking attendance. Faculty must take attendance in each class for contact tracing if there is a covid case on campus. Attendance policies are given in the course syllabus. Please read it.
- When working in teams, remember to follow the College's policies for distancing and masks.

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 and Webwork problems. Other 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. You may not look at the Webwork answers of another student or show yours (even a part of it) to another student. You may not work out a Webwork assignment with one or more other people or have someone else solve Webwork problems for you. If you break one of the conditions just listed here, 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.

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 as such and may incur additional sanctions.

Attendance Policy

Saint Vincent College recognizes that the current pandemic situation complicates face-to-face attendance for many students. The tradition of face-to-face classes is at the heart of a liberal arts education and we value the way that being physically present in the same

space promotes dynamic interactions and community building. As such, we are making these opportunities available as much as possible. At the same time, in order to minimize risk of disease transmission, SVC has modified classroom arrangements and instructors are modifying their modes of instruction to make the best and safest use of space, while also utilizing technology-based modes of instruction that have been shown to meet our learning objectives. The Saint Vincent policy for Fall 2020 and Spring 2021 is that no student can be penalized for not being physically present in a classroom. Each instructor will establish a course-specific attendance contingency plan that incorporates alternative modes of instruction and attendance for students who are required to quarantine, or who have secured accommodations through Ms. Marisa Carlson, the Director of COVID-19 Accommodations.

In this course, students who cannot attend in-person classes for any reason, including because only half of the students can be in class on any given class day, should attend virtually through the live Zoom conference. If a student cannot attend in-person or by means of the live Zoom conference, a recording of the conference may be made available to that student, but recordings are not normally made available to the class.

- 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.
- Late work is not normally accepted, but partial credit is given for incomplete homework that is submitted on time.
- Email me if you must miss class (in-person or online) 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.
- Because of the possibility of the covid-19 virus, the flu, or other communicable diseases affecting us on campus, please practice good hand washing, wearing of masks, staying at least 6 feet apart, etc. If you get ill, please notify me and follow good medical advice and college policy. Check with me about what you miss. You are still responsible for all course material, but an incomplete grade can be given if you cannot finish the course in the given time frame. See the Campus Reopening Health and Safety Plan at <https://www.stvincent.edu/student-life/campus-reopening> .

Class Cancellation Policy

If the instructor needs to cancel class, every effort will be made to send an online message to students and/or post a notice in the course in Schoology.

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 in to the course. Students are expected to be prepared, attentive, and respectful of others.

Accessibility Statement for Students with Disabilities

Students with disabilities who may be eligible for academic accommodations and support services should contact Ms. Marisa Carlson, Assistant Dean of Studies, by email (marisa.carlson@stvincent.edu) to schedule a meeting. 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 on the [Saint Vincent Student Life page](#).

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 Student Life page](#).