SAINT VINCENT COLLEGE
Quality Education in the Benedictine Tradition

Introduction to Numerical Computation

CS 270
Spring 2020

- 3 credits
- Prerequisite: MA 109 or MA 111
- 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
    - Mon, Wed, Fri 8:30 am - 9:20 am, Dupre W214
- Date of Final Exam
    - Wed, May 6, 8:30 am - 10:30 am

Course Description

This course has two main goals: to teach the student the basics of programming in a modern version of the Fortran language and to use that language to find numerical solutions to mathematical problems, especially problems of interest in mathematics, science, and engineering. In order to do this, a good deal of time is spent on studying elementary numerical analysis. Good software engineering techniques are emphasized in the programming portions of the course. Mathematica and hand calculators are used to help in solving several types of numerical analysis problems. However, the Fortran work that forms the bulk of the course is done on the CIS department's new Linux server, in part due to its speed.

It is assumed that the student is familiar with derivatives and integrals, algebra, and typical precalculus topics. No programming background is required. The coverage of Fortran will start at the beginning. GNU Fortran on the CIS Linux server will be used throughout this course. Programming topics covered include the structure of a Fortran program, input/output, arithmetic, built-in functions, decision structures, loop structures, software engineering techniques, number representation, errors, arrays, functions and subroutines. Numerical analysis and mathematical topics include limits of computer arithmetic and number representation, power series, Taylor series, roots of non-linear equations, systems of linear equations, the use of a library of numerical subroutines, numerical integration techniques, approximating the value of a derivative, an

introduction to eigenvalues and eigenvectors, and finding numerical solutions to simple ordinary differential equations.

Required Course Books and Other Materials

Text: <u>Fortran for Scientists and Engineers</u>, 4th edition, by Stephen J. Chapman. McGraw-Hill (2018). ISBN: 9780073385891 or 9781260152333 for the loose-leaf version. Do not get an e-book as only paper materials, including the printed textbook, can be used on the exams.

Relevant CIS Department Student Learning Outcomes

By the time of graduation

1. The CS, IS, or CYSEC major will have an ability to analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions.
2. The CS, IS, or CYSEC 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.
3. The CS, IS, or CYSEC major will have an ability to communicate effectively in a variety of professional contexts.
4. The CS major will have an ability to apply computer science theory and software development fundamentals to produce computing-based solutions.

Course Learning Objectives

By the end of the course, students will:

1. be able to design, implement, and evaluate basic Fortran programs that use the constructs outlined in the course description above.
2. be able to solve numerical analysis problems and other mathematical problems of the types described in the course description through the use of mathematics, Fortran programming, Mathematica, and appropriate reference materials.
3. be able to explain the mathematics behind the numerical analysis techniques that have been covered and to use this to explain the tradeoffs among competing solution methods.
4. be able to present and explain the results of their work on small group projects about solving numerical analysis problems.

Course Schedule

Due dates and other details for assignments are posted in Schoology. The approximate schedule below merely attaches assignments to the right general spot in the course.

Date	Topic	Assignment/Exam
Wk 1, Jan 13	Syllabus, Ch 1, introduction to Linux, simple computer architecture	Assign homework 1
Wk 1, Jan 15	More on Linux, build90, editors vi and nano	

Wk 1, Jan 17	Ch 2, integers, floating point numbers, character data	Homework 1 due
Wk 2, Jan 20	Accessing the Linux server Linux lab	Lab done in class counts as a homework
Wk 2, Jan 22	alpine, limits of number representations, assignment statements	
Wk 2, Jan 24	conversion, mixed-mode arithmetic, intrinsic functions, exponentiation issues	
Wk 3, Jan 27	input, output	Assign homework 2
Wk 3, Jan 29	Ch 3, trebuchet example, selection constructs	
Wk 3, Jan 31	print script, solving quadratic equations	Homework 2 due, assign homework 3
Wk 4, Feb 3	Ch 4, do loop	
Wk 4, Feb 5	while loop	Homework 3 due, assign homework 4
Wk 4, Feb 7	for loop	
Wk 5: Feb 10	manipulating character data, power series	
Wk 5: Feb 12	power series, review	Homework 4 due, assign homework 5
Wk 5: Feb 14		Exam 1 on chapters 1 - 4 and other topics covered in this time period
Wk 6: Feb 17	power series	Assign series group project 1
Wk 6: Feb 19	power series, Taylor's series	
Wk 6: Feb 21	Taylor's series	
Wk 7: Feb 24	Taylor's series	Homework 5 due
Wk 7: Feb 26	Ch 5, formatting output, file input/output	
Wk 7: Feb 28	small group presentations on series	Series group project 1 due
Mar 2	Spring Break - no classes	
Mar 4	Spring Break - no classes	
Mar 6	Spring Break - no classes	
Wk 8: Mar 9	files, Ch 6, arrays	Assign series group project 2
Wk 8: Mar 11	arrays, Ch 7, subroutines	
Wk 8: Mar 13	subroutines	
Wk 9: Mar 16	functions	Assign homework 6
Wk 9: Mar 18	review	
Wk 9: Mar 20	small group presentations on series	Series group project 2 due
Wk 10: Mar 23	Since things build, earlier topics may also be used, so in a way this is an exam on everything thus far.	Exam 2 especially on chapters 5, 6, and series
Wk 10: Mar 25	systems of linear equations, 2D arrays	

Wk 10: Mar 27	systems of linear equations	
Wk 11: Mar 30	systems of linear equations, LU decomposition	Assign systems of linear equations group project
Wk 11: Apr 1	LU decomposition, numerical integration techniques	Homework 6 due
Wk 11: Apr 3	numerical integration techniques	
Wk 12: Apr 6	library of numerical subroutines	
Wk 12: Apr 8	approximating the value of a derivative at a point, solving simple ordinary differential equations	Assign numerical integration group project
Wk 12: Apr 10	Easter break - no classes	
Wk 13: Apr 13	Easter break - no classes	
Wk 13: Apr 15	solving simple ordinary differential equations	
Wk 13: Apr 17	small group presentations on solving systems of linear equations	Systems of linear equations group project due
Wk 14: Apr 20	Introduction to eigenvalues and eigenvectors	
Wk 14: Apr 22	Introduction to eigenvalues and eigenvectors	
Wk 14: Apr 24	Introduction to eigenvalues and eigenvectors	
Wk 15: Apr 27	Roots of non-linear equations using Newton's method	
Wk 15: Apr 29	Roots of non-linear equations using bisection, review	
Wk 15: May 1	small group presentations on solving integration problems	Numerical integration group project due
Finals Week: Wed, May 6, 8:30 - 10:30 am	Covers mostly topics from after the midterm exam, but a few questions from the first half of the course may be included.	Final exam

Course Requirements and Grading

- 20% Exam 1
- 20% Exam 2
- 25% Final exam
- 35% Assignments and small group projects
- If the student does not attain a passing average in the test category, a failing grade will be received for the course

Letter grades will be given using the scale found in the College Bulletin. Due to the technical nature of the course, exams will be open book, open notes and will be announced in advance. Be sure to bring to each exam notes from class, handouts, homework solutions, and example programs. However, you must still be well-prepared as it is not possible to look up how to solve every problem in the time given. Homework and test answers are expected to be written using good English and good mathematics. These items will be graded not just on the correctness of their answers, but also on the clarity of their presentation. This is intended to help the student to develop good written communications skills. On exams, cell phones, tablets, laptops, and similar

devices should be turned off and put away. The use of calculators is encouraged (and, in fact, necessary to answer some exam questions), but calculators are not to be shared among students during an exam. Some homework will be done on an individual basis, but there will also be 4 small group projects. Thus a problem may be given to a small group of students, who will be responsible for solving it (usually by writing a Fortran program, using Mathematica, and doing some math), analyzing it, seeing if their results agree (and if not, finding out why not) and presenting the results to the class. Some of these small group problems will require you to look up additional information about the type of problem given. On homework, students can use computerized mathematics systems such as Mathematica to supplement their work in Fortran.

Software assignments will be graded using the following rubric:

- 60% Correctness (meets its specifications)
- 10% Good program design
- 10% Clarity, style, and readability
- 10% Good documentation (including getting the units right)
- 10% Efficiency

Tests will ask critical thinking questions that require careful analysis (often using mathematics), explanation, and meaningful 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, to solve a numerical analysis problem using appropriate mathematics and a hand calculator, or to explain the mathematics behind a certain numerical analysis technique. You will usually not be asked to prove theorems. In this course you will write programs that are about 1 to 6 pages in length, including well-written documentation. There will be about 8 to 10 programming assignments in this course. Watch Schoology for details of assignments, their due dates, etc.

Make-up exams are discouraged. If possible, take the regularly scheduled exam. For an excused absence or other significant reason, the instructor will likely 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 and individual programming problems. You can and should work together on the small group projects. Every assignment should list all sources that contributed to the solution. This would include the individual student (or the group members). It may also include the instructor, a reference book, a web site, etc. Web sites or people that simply give you a solution to an assignment are not to be used. One student or group should not consult another student or group in the class. 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 (or group) in this course or show yours (even a part of it) to another student (or group) in the course. You may not work out an assignment with one or more other students from the course (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.

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 class absence after the first 4 results in 1 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 work 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 were 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, computer science, and cybersecurity 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.