

SOFTWARE TESTING AND VERIFICATION

CEN 4072 Section 29219

CEN 6070 Section 29220

Class Periods: MWF | Period 10 (5:10 PM – 6:00 PM)

Location: PSY 0151

Academic Term: Fall 2024

8/23-12/09 (first class through scheduled final exam)

Instructor

Steve Thebaut

smt@cise.ufl.edu (the best way to contact me!)

Office Hours: Wed/Fri, 10:00-11:00 AM or by appointment (request appointment via e-mail), Zoom link to be made available via Course Website and CANVAS

Course Website: www.cise.ufl.edu/class/cen6070/fa24.html

The course website will be used to post announcements, the course syllabus, self-study lecture notes, etc. **To access the website from a NON-UF network, students will need to establish a Gatorlink VPN connection.**

In addition, a Canvas course shell will be available to registered students via E-Learning (<https://elearning.ufl.edu/>) to support posting of course assignments/uploading submissions, to view scores/grades, etc.

Teaching Assistant TBD – see course website

Course (Catalog) Descriptions

CEN 4072: Concepts, principles and techniques of software testing and verification. Strengths and limitations of black-box and white-box testing methods; techniques for proving the correctness of programs.

CEN 6070: Concepts, principles, and methods for software testing and verification. Topics include human and machine-based testing strategies, formal proofs of correctness, and software reliability.

Course Pre-Requisites

CEN 4072: CEN 3031

CEN6070: CEN 5035

Expanded Course Pre-Requisites

- (1) Successful completion of an upper-division undergraduate or graduate-level software engineering survey course (such as UF's CEN 3031/5035), or comparably diverse professional software engineering experience;
- (2) Familiarity with programming using a high-level language (C, C++, Java, SPARK, APL, Lisp, etc.);
- (3) Basic knowledge of algorithms, data structures, and discrete math (including symbolic logic);
- (4) An interest in fundamental V&V processes used in the development of long-lifetime, high-dependability software systems; and
- (5) A desire for deeper insights into programming and program semantics – especially iterative constructs (looping and recursion).

A self-assessment *pre-test* is available at the course website to assist students in determining their preparedness for the course vis-a-vis coverage of a small subset of prerequisite knowledge.

Course Objectives

Software Testing and Verification is a survey course on concepts, principles, and techniques related to software testing and verification for the development of dependable systems. Students will become acquainted with both the strengths and limitations of various functional and structural testing methods, as well as fundamental techniques for **reasoning logically** about the functional correctness of sequential programs. A significant portion

of the course is devoted to introducing fundamental techniques and methods employed by software/test engineers in the development of **high dependability** (e.g., safety/mission-critical) systems (as opposed, for example, to web services/business systems developed using a rapid development/continuous delivery approach). **It is NOT a vocational training or professional certification course, and it is NOT "hands-on" tool use-oriented.**

Topics include the psychology and economics of testing, black-box and white-box test case *design* strategies, incremental integration testing techniques, overview of testing object-oriented software, reviews and inspections, formal specification, axiomatic verification, predicate transforms, and function-theoretic verification. (See the more detailed "Outline of Course Topics" below.)

Learning Modalities

Students will explore course topics via physical face-to-face class meetings, assigned readings, the study of instructor provided lecture notes, individual and small-group exercises, and various other learning activities. ***Class meetings will not be recorded by the instructor unless officially mandated in connection with extraordinary circumstances such as public health emergencies, natural disasters, etc.***

Respiratory Viruses Epidemiological Update - August 2024

COVID-19 activity is currently increasing in most areas. The CDC recommends that all people use core prevention strategies to protect themselves and others:

- Stay up to date with COVID-19 vaccines. Although vaccinated people sometimes get infected with the virus that causes COVID-19, staying up to date on COVID-19 vaccines significantly lowers the risk of getting very sick, being hospitalized, or dying from COVID-19.
- Practice good hygiene (practices that improve cleanliness)
- Take steps for cleaner air

When you are sick:

- Use precautions to prevent spread, including staying home and away from others (including people you live with who are not sick) if you have respiratory symptoms. Learn when you can go back to your normal activities.
- Seek health care promptly for testing and/or treatment if you have risk factors for severe illness. Treatment may help lower your risk of severe illness, but it needs to be started within a few days of when your symptoms begin.

Additional Prevention Strategies: In addition, there are other prevention strategies that you can choose to further protect yourself and others.

- Wearing a mask and putting distance between yourself and others can help lower the risk of COVID-19 transmission.
- Testing for COVID-19 can help you decide what to do next, like getting treatment to reduce your risk of severe illness and taking steps to lower your chances of spreading COVID-19 to others.

What to watch out for: Using these prevention strategies can be especially helpful when

- Respiratory viruses, such as COVID-19, flu, and RSV, are causing a lot of illness in your community
- You or those around you have risk factors for severe illness
- You or those around you were recently exposed to a respiratory virus, are sick, or are recovering

PLEASE, if you become ill, do not come to class. If you have Covid, RSV, or Influenza symptoms, please seek treatment ASAP and get tested. If you test positive, please follow the CDC guidelines for isolation and let me know that you will be doing so.

Materials and Supply Fees N/A

Required Textbooks and Software

None. Reference sources are identified in class. Self-Study Lecture Notes will be made available (often on a *just-in-time* basis) on the course website, along with Lesson Plans, Problem Sets, Course Announcements, etc. Required readings will be available via the course website, the WWW, or the UF Libraries website (select the Course Reserves tab at <http://www.uflib.ufl.edu>) at NO CHARGE. Note: Before accessing UF Course Reserves from a NON-UF network, you must log into the UF VPN client. To download the UF VPN client, visit:

<https://net-services.ufl.edu/provided-services/vpn/clients/>

Outline of Course Topics The following topical areas will be covered in the order listed.

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|---|-------------------------------------|
| (1) Intro to V&V Techniques and Principles | (9) Formal Specification |
| (2) Requirements and Specifications | (10) Axiomatic Verification |
| (3) Black-Box Test Case Design Strategies | Weak Correctness |
| Partition Testing | Rules of Inference |
| Combinatorial Approaches | Strong Correctness |
| Other Strategies | (11) Predicate Transforms |
| (4) White-Box Test Case Design Strategies | Computing Predicate Transforms |
| Logic Coverage | Predicate Transforms and Loops |
| Dataflow Coverage | (12) Functional Verification |
| Path Conditions and Symbolic Evaluation | Complete and Sufficient Correctness |
| Other Strategies | Axiom of Replacement |
| (5) Integration and Higher-Level Testing | Correctness Conditions |
| (6) Object-Oriented Software Testing Overview | Iteration Recursion Lemma |
| (7) Reviews and Inspections | Invariant Status Theorem |
| (8) Testing Tools and Automation | (13) Cleanroom Software Engineering |

Problem Sets There are seven Self-Study Problem Sets, covering the areas:

- | | |
|---|-----------------------------|
| (1) Black-box Testing | (5) Axiomatic Verification |
| (2) Logic Coverage | (6) Predicate Transforms |
| (3) Dataflow Coverage | (7) Functional Verification |
| (4) Path Conditions and Symbolic Evaluation | |

The Problem Sets are important learning tools and may introduce significant course content that is not included in the lecture notes or discussed in class. Some may involve problems that are non-trivial and/or require a *creative* (“clinical”) application of techniques introduced in the course. Problem Set introductions and solution hints/notes will be provided, and students may work together on some of the problems in small groups.

Attendance Policy, Class Expectations, and Make-Up Policy

Physical face-to-face attendance is required for all scheduled tests and in-class group exercises. Attendance (with advance notice) may also be required at other times (e.g., guest and/or otherwise critical lectures). **Up to 3 absences from required-attendance classes (excepting scheduled tests) will be deemed “excused” without exculpatory documentation; thereafter absences will be excused only in accordance with university policies and the submission of appropriate documentation.**

Comparable “make-ups” are not typically possible for missed group exercises and required-attendance classes. Therefore, **when excused**, their weight toward the final course grade calculation will be shifted to that associated with the two course tests (see below).

Students are expected to complete all course assignments in a timely manner. However, some late assignment submissions may be accepted **prior to the posting of solution notes** in extenuating circumstances.

IMPORTANT: Please do NOT schedule elective activities (family gatherings, interview trips, weddings, divorces, vacations, visa application trips, etc.) that could interfere with completing course assignments on-time. **You are expected to be physically present on campus from Friday, 8/23 (first day of class) through Monday, 12/09 (scheduled final exam).**

Grading Policy/Evaluation of Grades

Course grades will be based **solely** on (1) required-class attendance and acceptable performance on individual and/or small group problem solving exercises: (1/3 of course grade); (2) Test 1 (covers Topics 1-8): a closed-notes/closed-book in-class or assembly Mid-Term Exam on or about **Wednesday, October 9** (1/3 of course grade), and (3) Test 2 (covers Topics 9-13): a closed-notes/closed-book in-class or assembly End-of-Term Exam on or about **Wednesday, December 4** (1/3 of course grade).

The grades assigned for individual/small group problem solving exercises will be based on the number of submissions (or re-submissions, in the case of an initial submission receiving a moderately low score for *in-class* group exercises only) deemed "COMPLETE". For example, an initial numeric score of at least 75% for an in-class exercise may result in a grade of "COMPLETE" with no further re-work required. A group scoring less than 75% but at least (for example) 30% for an in-class exercise would be allowed to continue work on the exercise outside of class for a limited amount of time before re-submission. A grade of "COMPLETE" would then be assigned only if the new score is near 100%. Finally, an initial score below 30% would be assigned a grade of "INCOMPLETE" with no re-submission option. Note that the actual scores used in these determinations (75% and 30%) may vary depending on various factors including the relative difficulty of the assignment.

Note: there is no "comprehensive final exam" for this course, and currently no plan to use the scheduled final exam period (5:30-7:30 PM on Wednesday, May 1), but ALL students are expected to make themselves available ON-CAMPUS at this time should this become necessary for some unanticipated reason.

There will be no online (e.g., "Honorlock") tests.

Grading Errors: Clear and obvious grading errors should be brought to the instructor's attention ASAP, but no later than one week after graded tests are made available for review. Note that partial credit policies are not subject to debate, and that generic re-grade requests *without specific coherent written hypotheses/substantiating evidence to simply garner additional points ("fishing expeditions")* will not be accepted.

Course letter grades will be determined at the end of the semester. In the past, the typical (BUT NOT PRE-DETERMINED) grade distribution for CEN4072 has been A (4.00 grade points): 5-10% of students completing the course, A- (3.67 grade points): 10-15%, B+ (3.33 grade points): 15-20%, B (3.00 grade points): 15-20%, B- (2.67 grade points): 15-20%, C+ (2.33 grade points): 10-15%, C (2.00 grade points): 5-10%, lower than a C (0.00-1.67 grade points): 0-10%. Typical (BUT NOT PRE-DETERMINED) grade distributions for CEN6070 have been A (4.00 grade points): 10-20% of students completing the course, A- (3.67 grade points): 25-35%, B+ (3.33 grade points): 25-35%, B (3.00 grade points): 10-20%, lower than a B (0.00-2.67 grade points): 0-5%.

Grade requirements for graduation: Note that undergraduate students must have an overall GPA and an upper-division GPA of 2.0 ("C average") or better. More information on UF grading policies may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Graduate students must have an overall GPA of 3.0 ("B average") or better. More information on UF grading policy for graduate courses may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

Finally, note that requests for “adjustments” or “special consideration” with regard to the determination of grades due to personal matters or concerns that are inconsistent with University policies are inappropriate and may be construed as a violation of the UF Honor Code (see University Honor Policy below).

Course Feedback Please provide the instructor with your feedback/recommendations about this course at any time during or after the semester in which you are enrolled. This may be done verbally (e.g., during online office hours), in writing or via the end-of-semester course evaluation. Suggestions about how to improve the course *at any time* will be especially appreciated.

Instructor Biography

Steve Thebaut received the BA in Mathematics from Duke University in 1977, and the MS and PhD in Computer Science from Purdue University in 1979 and 1983, respectively. His research interests have included software requirements engineering, software testing and formal verification, and software engineering technology transfer. He has received funding from the National Science Foundation, IBM, the Florida Department of Education, the Florida High Technology and Industry Council, the Sino-Software Research Center at Hong Kong University of Science and Technology (HKUST), the Software Engineering Research Center (SERC), an NSF Industry/University Cooperative Research Center, and the Software Engineering Institute (SEI) at Carnegie Mellon University, where he was an invited lecturer in the SEI production of "Software Project Management," a nationally distributed video-based continuing education course. From 1991-1993 he was a Visiting Scholar in the Department of Computer Science at the Hong Kong University of Science and Technology (HKUST), and was an Educational Consultant and Visiting Lecturer in Software Engineering at Infosys Technologies, Ltd., Mysore, India in 2009. He has been a course developer and consultant for IBM IS&PG Technical Education, and has served on the program committee of the IEEE International Conference on Software Engineering Education and Training. He was Associate Editor of the International Journal of Computer and Software Engineering from 1990-1996, UF Site Director of the Software Engineering Research Center (SERC) from 1994-2004, and Associate Chair of the Computer and Information Science and Engineering Department at UF from 2000-2015.

Additional Important Information/Resources for Students:

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

End-of-Semester Course Evaluation via GatorEvals

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session. Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values varied perspectives and lived experiences within our community and is committed to supporting the University’s core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

If you feel that your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Undergraduate Coordinator
- HWCHE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](mailto:title-ix@ufl.edu), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://elearning.ufl.edu/>.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/getting-help/>; <https://distance.ufl.edu/state-authorization-status/#student-complaint>.