<div align="center">

SOFTWARE TESTING AND VERIFICATION

CEN6070 Section 1F45
Class Periods: MWF 8, 3:00-3:50 PM
Location: CSE E221

CEN4072 Sections 7629 and CERT
Class Periods: MWF 7, 1:55-2:45 PM
Location: CSE E221

Academic Term: Spring 2023

</div>

Instructor:
Steve Thebaut
smt@cise.ufl.edu (the best way to contact me!)
Office Hours via Zoom (tentative): Tu/Th 10:00–11:30 AM or by appointment (request appointment via e-mail)
Website: (under construction)

The course website will be used to post announcements, the course syllabus, self-study lecture notes, etc. In addition, a Canvas course shell will be available via E-Learning (https://elearning.ufl.edu/) to support assignment posts and submissions, Zoom meetings, etc., and to view scores/grades.

Teaching Assistant/Peer Mentor/Supervised Teaching Student: (TBD)

Course (Catalog) Descriptions:
<u>CEN4072</u>: *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. Credits: 3. Prereq: CEN 3031.*

<u>CEN6070</u>: *Concepts, principles, and methods for software testing and verification. Topics include human and machine-based testing strategies, formal proofs of correctness, and software reliability. Credits: 3. Prereq: CEN 5035*

Expanded Course Pre-Requisites / Co-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 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 – including iterative constructs (looping and recursion).

<u>In addition, the non-programming, reading, writing, and problem solving-intensive nature of this course is such that students should already be comfortable with English and with using the technical terms necessary for computer scientists/engineers to effectively communicate with each other in small, diverse groups</u>. Therefore, it may be inadvisable for some students whose first or native language is not English to take Software Testing and Verification *during their first semester at UF.*

Students who have already earned credit for CEN4072 at UF may not take CEN6070 for credit.

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 <u>reasoning logically</u> 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 assigned readings, the review of instructor provided self-study lecture notes, in-class small-group learning exercises (when feasible), and various other activities that may or may not involve course content covered in the readings or lecture notes. In addition to physical face-to-face class meetings, recorded or online-only classes may be utilized when deemed necessary and appropriate by the University.

Policies Related to Covid-19, RSV, and Influenza:
The University of Florida *recommends* wearing masks on campus and encourages everyone to get vaccinated and stay current with boosters to minimize infection risks. This especially applies when students are engaged in small-group, in-class exercises.

If you become ill, please do not come to class. If you have Covid, RSV, or Influenza symptoms, please seek treatment ASAP and get tested. If you test positive, stay home and follow Centers for Disease Control and Prevention guidelines for isolation.

Note that a mask is **required** when attending face-to-face office hours with the course instructor or when meeting face-to-face with teaching assistants/graders outside class.

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/

A Canvas course shell will be available via E-Learning to support assignment posts and submissions, Zoom-based meetings, etc., and to view scores/grades.

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

Intro to V&V Techniques and Principles	Formal Specification
Requirements and Specifications	Axiomatic Verification
Black-Box Test Case Design Strategies	Weak Correctness
Partition Testing	Rules of Inference
Combinatorial Approaches	Strong Correctness
Other Strategies	Predicate Transforms
White-Box Test Case Design Strategies	Computing Predicate Transforms
Logic Coverage	Predicate Transforms and Loops
Dataflow Coverage	Functional Verification
Path Conditions and Symbolic Evaluation	Complete and Sufficient Correctness
Other Strategies	Axiom of Replacement
Integration and Higher Level Testing	Correctness Conditions
Object-Oriented Software Testing Overview	Iteration Recursion Lemma
Reviews and Inspections	Invariant Status Theorem
Testing Tools and Automation	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	

They 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 be asked to work together on some of the problems in small-group, in-class exercises.

Attendance Policy, Class Expectations, and Make-Up Policy

Limited physical face-to-face class attendance is required in connection with some class activities (e.g., scheduled exams and group learning exercises).

Students are expected to complete all assignments in a timely manner. Late submissions will not be accepted except in extenuating circumstances associated with a period of excused absence. Excused absences must be in compliance with university policies and require appropriate documentation. 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.

Grading Policy/Evaluation of Grades:

Course grades will be based **solely** on: (1) performance in approx. 6 focused group learning activities (see tentative schedule on course website), (2) a closed-notes/closed-book Mid-Term Exam ("Exam 1") tentatively scheduled for Wed., March 8, and (3) a, closed-notes/closed-book End-of-Term Exam ("Exam 2") tentatively scheduled for Wed, April 26. Note: there is no "comprehensive final exam" for this course, and no plans to use the scheduled final exam period (week of April 29-May 5), but students will be expected to make themselves available at this time should this become necessary for some unexpected reason.

Exam Grading Errors: General exam re-grade requests (AKA "fishing expeditions") are NOT accepted. Suspected grading errors (with evidence) should be brought to the instructor's attention ASAP, but no later than one week

after graded exams are made available for review, for appropriate consideration. Your original, UNALTERED, exam must be returned together with a correction request form (to be made available) to the instructor. Note that partial credit policies are not subject to debate.

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

The *nominal* course grading weights are as follows:
- In-class group learning activities: 1/3
- Mid-Term Exam ("Exam 1"): 1/3
- End-of-Term Exam ("Exam 2"): 1/3

"Passing performance" for in-class group learning activities will be based on receiving a grade of "COMPLETE" on a single group work submission (or re-submission, in the case of an initial submission receiving a moderately low score). For example, a group submission scoring at least 75% may receive a "COMPLETE" with no further (re-)work required. A submission scoring at least 30% but less than 75% may require that the group continue work on the exercise outside of class and re-submit their results, within a limited amount of time, earning a score at or near 100% in order to receive a "COMPLETE". Finally, a group receiving an initial score below 30% may be assigned an "INCOMPLETE" with no re-submission option. Note that the actual % scores required will vary depending on the nature of the assignment. All group members who fully participate in an exercise will receive the same "COMPLETE" or "INCOMPLETE" grade; those who do not will, by default, automatically receive an "INCOMPLETE".

All assignments will concern *course-related* topics but *may* require creative insights NOT directly provided in class, the readings, or lecture notes. Evidence of having completed all assigned readings together with any other suggested preparatory activities in advance of undertaking group learning activities, together with providing thoughtful, creative group submissions, is paramount in this regard!

Course letter grades will be determined at the end of the semester. In the past, typical (BUT NOT PRE-DETERMINED) grade distributions for CEN4072 have 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-: 15-20%, C+ (2.50 grade points): 10-15%, C (2.00 grade points): 5-10%, lower than a C (0.00-1.50 grade points): 0-10%.

For CEN6070, typical grade distributions 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 graduate students must have an overall GPA of 3.0 (B average) or better. (A B- average is equivalent to a GPA of 2.67, and therefore does NOT satisfy this requirement.) Under-graduate students must have an overall GPA and an upper-division GPA of 2.0 (C average) or better. (A C- average is equivalent to a GPA of 1.67, and therefore does NOT satisfy this requirement.)

More information on UF grading policy for graduate courses may be found at:

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

and at:

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

for undergraduate courses.

Fishbowl Group Discussion Format: Various forms of "fishbowl discussions/conversations" may be employed in this class. In a fishbowl activity, a small group of students is chosen to discuss and/or demonstrate their knowledge and understanding of a topic, provide logical arguments for a position concerning a topic, etc. The rest of the class watches, listens, evaluates the arguments being presented, and reflects on new insights provided by the discussion. The presenter/observer roles change on a regular basis.

> *The fishbowl is a method to organize presentations and group discussions that offers the benefits of small group discussions – most notably, a spontaneous, conversational approach to discussing issues – within large group settings. This is done by arranging the room so that the speakers are seated in the center of the room with other participants sitting around them in a circle watching their conversation 'in the fishbowl.'*

> *- https://www.unicef.org/knowledge-exchange/files/Fishbowl_production.pdf*

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/policies/student-honor-code-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 broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you believe 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 Graduate Program Coordinator
• Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.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: http://www.counseling.ufl.edu/cwc, 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**, 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 suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. https://www.crc.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://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

On-Line Students Complaints: http://www.distance.ufl.edu/student-complaint-process.