



**KENNESAW STATE
UNIVERSITY**

COLLEGE OF COMPUTING AND
SOFTWARE ENGINEERING

Software Engineering and Game Development

SWE 6883/[insert section] – Formal Methods in Software Engineering

[Semester and Year]

SYLLABUS

FACULTY AND COURSE INFORMATION

Instructor name

E-mail: *Preferred method of contact

Office Phone:

Office Location:

Class Location and Meeting Times: **TBD**

Office Hours: **TBD**

Virtual Office Hours: By appointment

Electronic Communications - Please email me at my kennesaw email: XXX@kennesaw.edu. I will try to respond to email questions within 24 hours during the workweek (Monday – Friday) and within 48 hours during weekends. **Please do NOT email via D2.** Always include “SWE 6883” in *subject* of your email.

Required Texts or Other Resources –

No textbook is required.

Slides, Papers, and additional material will be distributed on D2L

GENERAL EXPECTATIONS FOR COURSEWORK IN GRADUATE PROGRAMS

Graduate study is markedly different from undergraduate study. This graduate course syllabus serves as a general description of goals and expectations in the course, as well as providing logistical and organizational information. It has been approved by the Faculty of your Academic Department to meet objectives in your discipline, as well as the University’s Graduate Faculty standards for graduate study. It contains a number of resources for and expectations of you as a student. Instructionally, it is a general “plan” for the course and not a contract - please know that the course instructor is permitted some departures from it. If you have questions regarding this, please contact the Chair of your Academic Department.

1. Roles and Responsibilities. A graduate student should always remember that he or she is taking a particular graduate course to learn advanced content in an academic discipline. While graduate students are expected to think critically and ultimately be able to demonstrate mastery of advanced disciplinary knowledge, his or her

instructor has already earned at least one – if not multiple – advanced degrees in the discipline, and spent (in some cases) decades studying it. A Graduate Faculty member may be regarded as a state or national authority in some aspect of the discipline being studied. Moreover, the instructor has an equal instructional obligation to all graduate students engaged in a particular learning activity. Consequently, the graduate instructor exercises discretion in framing instructional interactions about the discipline with graduate students, which may include decisions to terminate discussions or move the discussion to another topic.

2. Responsibility for Demonstrating Mastery of Advanced Content. Admission to a graduate program is both elective and selective. In graduate study, a graduate student bears primary responsibility for acquiring knowledge about the discipline he or she is studying. The primary role of a graduate instructor is to assist the student in appropriately applying that knowledge at an advanced level in the discipline. Ultimately, a graduate course provides a graduate student with the opportunity to demonstrate that she or he can master and apply advanced knowledge in an academic discipline. The burden of demonstrating this mastery and application to the satisfaction of the Graduate Faculty lies solely with the graduate student.

3. Availability of Graduate Faculty Members. Members of the Graduate Faculty are expected to be authorities in their academic disciplines. In addition to teaching, graduate faculty members serve in significant research, professional, and academic roles. Graduate students should be aware that, in any given semester, these other responsibilities may constitute between forty (40) and eighty (80) percent of a professor's workload. Consequently, graduate students are advised to schedule meetings with their instructors well in advance, knowing that a Graduate Faculty member's research and service obligations may result in him or her not being able to respond to the student for up to two (2) days during the academic week (M-F).

4. Interactions with Graduate Faculty Members. A graduate student should ensure that his or her interactions with her or his instructors are professional and appropriate. It is a relationship that is far more analogous to an employment relationship than a social friendship.

Within the Classroom (or Analogous) Environment. While graduate student thinking and discussion is expected to be far deeper, more challenging, and more critical about the advanced topic being studied than in undergraduate coursework, the context in which these discussions are framed should remain academically detached and appropriate. An element of graduate education – and particularly the application of advanced content – may require a graduate student to demonstrate the ability to think and analyze advanced knowledge in the discipline in a detached and clinical fashion.

This can be challenging when the topic under discussion relates to assumptions the student has never challenged previously. Neither graduate students nor members of the Graduate Faculty should “personalize” these discussions. A graduate student does not have the right to disrupt instruction in a learning activity. If a graduate student believes he or she cannot continue to engage in the discussion with appropriate academic detachment, she or he should disengage from the activity until the time that he or she believes he or she can appropriately resume. Simply put, in graduate study, thinking should be disruptive – conduct should never be.

Outside the Traditional Classroom Environment. While graduate students and their faculty members may have richer and less formal interactions outside of the classroom environment than those in undergraduate programming (for example, having coffee together to discuss a particular aspect of a study the student wishes to conduct or jointly working on research), it is important for both the faculty member and graduate student to remember that the “formal” instructor/student relationship that undergirds these interactions, and act consistently with that. If a graduate student believes that the faculty member's interactions with him or her are inappropriate, the graduate student should contact the Department Chair of her or his academic department, or the appropriate University official.

5. Intellectual Property Issues. More than any other part of the University enterprise, graduate study may result in the creation of ideas and thinking that are legally recognized and protected as intellectual property.

Consequently, graduate students should carefully monitor their conduct to ensure that they do not inadvertently misappropriate the intellectual property of a member of the Graduate Faculty or another graduate student. The Graduate College has prepared an overview of intellectual property issues

6. Electronic Recording. While graduate students may wish to electronically record a class session as a study aid, in graduate school, this requires a careful balancing of the interests of the student, her or his fellow students, and the graduate instructor. Consequently, a graduate student may not disseminate any electronically recorded class discussion unless given explicit permission by the graduate instructor in writing. Irrespective of whether the student disseminates it, a graduate student should ask permission of his or her graduate instructor before electronically recording the instructor's lectures.

A University generates ideas, and ideas can become intellectual property irrespective of whether they are written in a book or paper. As a recognized authority in her or his academic discipline who has spent years studying, synthesizing, and expanding advanced knowledge in the academic discipline to which he or she has devoted his or her life's work, a graduate instructor has a legally-recognized property interest in her or his thinking about that work, which may include the graduate instructor's lectures. Kennesaw State University prohibits the misappropriation of intellectual property (which is a form of theft), which can result in discipline for a graduate student, up to and including dismissal from the University. If the graduate student is also a member of a profession with an applied code of ethics, it may additionally result in professional discipline, as well as subjecting the student to any civil legal remedies protecting intellectual property. Graduate students should recognize the rights of their fellow graduate students to engage in free exchange of ideas in their graduate coursework, asking questions or making observations that they might not make if they believed those observations could be publicly disseminated without their knowledge or permission.

If a student needs to electronically record a course as a result of a recognized disability or other exceptionality, the student should contact the University's Disabled Student Support Services to develop an appropriate reasonable accommodation.

COURSE DESCRIPTION, CREDIT HOURS, AND PREREQUISITES

SWE 6883: Formal Methods in Software Engineering

3 Class Hours 0 Laboratory Hours 3 Credit Hours

Formal methods are a set of mathematically rigorous techniques for specifying, validating, and verifying safety-critical systems, i.e., system whose failure or malfunction may result in death or serious injury to people, loss or severe damage to equipment/property, and/or environmental harm. Self-driving vehicles and aircrafts are examples of such a system.

This course will present best practices for the application of formal methods and will explore their tools, techniques, and applications of formal methods using real-world case study.

This course will use a hands-on interactive approach.

Prerequisites: SWE 6613 and SWE 6623.

COURSE LEARNING OUTCOMES

By the end of this course, you will be able to:

1. Specify system requirements formally in Linear Temporal Logic (LTL).
2. Specify systems as formal models.
3. Apply model checking to system models and LTL specifications to determine if the models satisfy the specifications.
4. Use tools popular in industrial verification labs, including explicit and symbolic model checkers, and theorem provers.

5. Evaluate real-world systems to determine appropriate formal methods to use in their analysis.
6. Analyze and draw conclusions about real-world systems regarding formal properties.

TEACHING PHILOSOPHY AND INSTRUCTION METHODS

This course aims to help you to develop into critical, independent-thinking, and creative scientists.

This course is organized in modules. Class/online sessions will include discussions of the readings, small group activities, and lecture. Students are encouraged to participate actively in class/online sessions.

During lectures I will try to explain, clarify, emphasize, summarize, encourage, and motivate. I can also answer questions, lead discussions, and ask questions. In class you have an opportunity to test your understanding, so things work best if you come to class prepared.

Course assignments will help you achieve the objectives of the course. Brief descriptions of the assignments follow. Detailed instructions will be provided when each assignment is given.

COURSE CONTENT AND REQUIREMENTS

This syllabus represents my current plans and objectives. As we go through the semester, those plans may need to change to enhance the class learning opportunity. Such changes, communicated clearly, are not unusual and should be expected

Tentative Schedule and Topic Coverage

- 3/13 - Symbolic Model Checking (basics), Reachability Analysis, Bounded Model Checking
- 3/18 - Explicit-State Model Checking ([Extra Slides](#))
- 3/20 - Project mini-updates
- 3/25 - *Spring break: no class*
- 3/27 - *Spring break: no class*
- 4/1 - Abstraction, CEGAR and Interpolation ([Slides used in class](#))
- 4/3 - Interpolation based Model Checking; IC3/PDR
- 4/8 - Simulation and Bisimulation
- 4/10 - Compositional Reasoning; Automata Learning
- 4/15 - Synthesis from Temporal Logic
- 4/17 - Project Mini-Updates
- 4/22 - Verification by Reduction to Synthesis; Formal Inductive Synthesis ([Slides](#))
- 4/24 - Verification of AI/ML based Systems ([Slides](#))
- 4/29 - Run-Time Verification and Assurance ([Slides](#))
- 5/1 - Conclusion ([Slides](#))
- 5/6 - *Final Project Presentations* (1-4 pm in 540 Cory)

Module #1		
Weeks 1-2	Introduction and overview Propositional and predicate logic review	Syllabus Quiz.

		<p>Discussion: Introduce yourself and your learning expectation after reading the formal methods overview research paper.</p> <p>Assignment #1: Evaluate formulae in propositional and predicative logic. Use logic for formalize properties</p>
Module #2		
Weeks 3-4	Sat Solvers and SMT solvers	<p>Discussion on “SMT Solvers in Software Security”.</p> <p>Assignment #2: Use Z3 to solve a simple problem</p> <p>Quiz covering the module topics.</p>
Module #3		
Weeks 5-6	Modeling for verification and temporal logic	<p>Discussion on “Generation of Library Models for Verification of Android Applications”.</p> <p>Assignment #3: Select the appropriate model for a given specification and model it.</p> <p>Quiz covering the module topics.</p>
Module #4		
Week 7	Explicit model checking	<p>Discussion: Limits of explicit model checking</p> <p>Quiz covering the module topics.</p>
Module #5		
Weeks 8-9	Symbolic model checking	<p>Discussion: How symbolic model checking improve model checking performance?</p> <p>Students presentations</p> <p>Assignment #4: Use of nuSMV</p> <p>Quiz covering the module topics.</p>
Week 8	Midterm	
Module #6		
Weeks 10-11	LTL model checking	<p>Discussion: How to choose between model checking approaches?</p>

		Students presentations Assignment #5: Use of SPIN Quiz covering the module topics.
Module #7		
Weeks 12	Verification and Synthesis	Discussion: Advantages of using synthesis. Students presentations Final project: Choose a technique to present to the class. Quiz covering the module topics.
Module #8		
Weeks 13-14	Theorem proving	Assignment #6: Use of a theorem prover of your choice. Students presentations Discussion: Advantages and difficulties of using theorem proving. Quiz covering the module topics.
Week 15/Final	Presentations	

Grading Scale and Course Policies

Examinations

A midterm examination will be given, covering the material from readings and homework from the first half of the course.

A **final project** spanning the second half of the course will serve in place of a final exam. All students will be required to present the results of their final project to the class at the end of the semester in lieu of a final exam.

Homeworks and Projects

All homework submitted should be typed and formatted. For all homework, you are allowed to consult other books, papers, or physical published materials in the university library. The internet is NOT considered a published material. You may not search for answers, post questions to internet forums, or discuss any assignments on the internet.

Presentation

Each member of the class will present a research paper in applied formal methods to the class during the second half of the semester.

Grading

Grades will be assigned based on performance on homework, projects, presentations, a midterm exams, and a final project.

The weight assigned to each component is as follows:

Grade Component	Percentage
Homeworks	36%
Midterm	20%
Research Paper Presentation	15%
Evaluation of Other Presentations	4%
Final Project	25%

Course grades will be assigned as follows; minimum totals for grades may be lowered, but they will not be raised:

A: 89.51 to 100

B: 79.51 to 89.5

C: 69.51 to 79.5

D: 59.51 to 69.5

F: 0 to 59.5

Late work will be penalized by deducting 10 points per calendar day and will not be evaluated if submitted with more than 3 days delay. Late work is penalized for two reasons: to be fair (all students should be given the same time limits!) and to help you to have sufficient time for each assignment (if you spend too much time on one assignment, it is quite likely that you will have insufficient time to spend on the subsequent one). If you will have to miss a deadline for extraordinary reasons (e.g., personal illness, death in the family, etc.), you should inform me as soon as you can, indicating when you will submit the work. The instructor will try to accommodate your needs.

Course Policies:

Attendance Policy: *Students are solely responsible for managing their enrollment status in a class; nonattendance does not constitute a withdrawal.*

Attendance at all classes is highly encouraged. Concepts and ideas discussed in one class are used as building blocks for more concepts and ideas in the next class. In being successful in this subject matter, a good rule-of-thumb is to study at least 3 hours per one hour of lecture. *Any class sessions missed by the student are the student's responsibility to make up, not the Professor's.* **Makeup** exams will NOT be given; instead, the final exam will count in place of the missed exam; if the final exam is missed, an average of the other exams will be used. No finals will be given outside of the University finals schedule. Project assignments **MUST** be turned in on time to receive full credit. Students will not be allowed to makeup missed project assignments or labs. Students are expected to read the text and any other supporting documentation the Professor distributes. If the student requires additional materials to read or additional problems to solve in better understanding the topics and concepts, the Professor expects the student to take the initiative in locating additional materials or problems. The Professor expects students to take advantage of office hours when needing clarification or help. The Professor greatly supports students sending emails at any time – it will be the goal of the Professor to reply to emails within a 24-hour time span.”

COURSE WITHDRAWAL

See below for commentary on withdrawals from the 2019-2020 Graduate Catalog:

Students may withdraw from one or more courses up to one week prior to the last day of class. To completely or partially withdraw from classes at KSU, a student must withdraw online at www.kennesaw.edu, under Owl

Express, Registration and Student Records. Students who officially withdraw from courses before mid-semester will receive a "W" in those courses and receive no credit. They will not, however, suffer any academic penalty. Students who officially withdraw after mid-semester one week prior to the last day of class will receive a "WF," which will be counted as an "F" in the calculation of their grade point average. Exact withdrawal dates will be published in the official academic calendar and are subject to approval by the Board of Regents.

For attendance verification, faculty may assign "non-attendance" or submit a grade of W or WF for students who stop attending class and do not officially withdraw along with the last day of known attendance.

The only exceptions to these withdrawal regulations will be for instances involving unusual circumstances that are fully documented.

Students will receive refunds only when they withdraw from all their classes and only by the schedule outlined in the University System refund policy.

KSU Military Withdrawals Policy

Kennesaw State students who are called to active duty or who are deployed during the term may be eligible for a military withdrawal. Students who withdraw for military reasons will receive a WM grade in all courses and receive a refund of tuition and mandatory fees and a pro rata refund of other fees. Students who would like to withdraw for military reasons must submit a copy of their official orders to the Registrar's office. Military withdrawals do not count as part of the eight (maximum) allowed withdrawals.

KSU Reasonable Accommodations Policy

Students with qualifying disabilities under the Americans with Disabilities Act (ADA) and/or Section 504 of the Rehabilitation Act who require "reasonable accommodation(s)" to complete the course may request those from Office of Student Disability Services. Students requiring such accommodations are required to work with the University's Office of Student Disability Services rather than engaging in this discussion with individual faculty members or academic departments. If, after reviewing the course syllabus, a student anticipates or should have anticipated a need for accommodation, he or she must submit documentation requesting an accommodation and permitting time for a determination prior to submitting assignments or taking course quizzes or exams. Students may not request retroactive accommodation for needs that were or should have been foreseeable. Students should contact the office as soon as possible in the term for which they are seeking accommodations. Student Disability Services is located in the Carmichael Student Center in Suite 267 on the Kennesaw campus or Building A in Suite 160G on the Marietta campus. Please visit the [Student Disabilities Services website](#) for more information, or call the office at 470-578-2666 (Kennesaw campus) or 470-578-9111 (Marietta campus).

GRADE APPEALS AND STUDENT COMPLAINTS

See below for commentary on withdrawals from the 2019-2020 Graduate Catalog:

Grade appeal will follow the level of the course. Students' rights to grade appeals are defined in the university catalog. A key element in the grade appeal procedure is the faculty member's responsibility to publish a specific grading policy for each of his/her classes. Specifically, the grade appeal procedure states: "Each faculty member must specify his/her grading policy, at the first of the semester. He/she may change his/her grading policy for cause after that time, but he/she must do so uniformly, with ample notification to students, if at all possible."

Note that failure to publish the grading policy would mean that a faculty member would have great difficulty in sustaining his/her assigned grade if a student appealed with anything but a frivolous or irresponsible basis for

his/her charge. The grading policy should be quite specific and should be distributed to each class in written form. Some departments may also require faculty members to file grading policy statements in the departmental office. Because the student can submit a grade appeal to the Department Chair within 20 business days after the first day of classes of the next academic term after the academic term in which the final grade was awarded to the student (see Grade Appeals Procedure, section B), it is strongly recommended that instructors retain any student papers, tests, projects, or other materials not returned to the student for 70 days after the end of a semester or if an appeal is filed until the appeal is resolved. Refer to the following section for specific grade appeal procedures.

Students can find more details regarding the appeal process here:

<http://catalog.kennesaw.edu/>

Copyright Law

It is the responsibility KSU faculty and students to respect the rights of copyright holders and complying with copyright law. The University System of Georgia recognizes that the exclusive rights of copyright holders are balanced by limitations on those rights under federal copyright law, including the right to make a fair use of copyrighted materials and the right to perform or display works in the course of face-to-face teaching activities. The University System of Georgia facilitates compliance with copyright law and, where appropriate, the exercise in good faith of full fair use rights by faculty and staff in teaching, research, and service activities. The University System of Georgia ensure compliance with copyright law in the following ways.

- A. The USG informs and educates students, faculty, and staff about copyright law, including the limited exclusive rights of copyright holders as set forth in 17 U.S.C. § 106, the application of the four fair use factors in 17 U.S.C. § 107, and other copyright exceptions.
- B. The USG develops and makes available tools and resources for faculty and staff to assist in determining copyright status and ownership and determining whether use of a work in a specific situation would be a fair use and, therefore, not an infringement under copyright law;
- C. The USG facilitates use of materials currently licensed by the University System of Georgia and provides information on licensing of third-party materials by the University System; and
- D. The USG identifies individuals at the University System and member institutions who can counsel faculty and staff regarding application of copyright law.

ACADEMIC INTEGRITY

Every KSU student is responsible for upholding all provisions of the Student Code of Conduct, as published in the Undergraduate and Graduate Catalogs. The Code of Conduct includes the following:

- A. Section II of the Student Code of Conduct addresses the University's policy on academic honesty, including provisions regarding plagiarism and cheating, unauthorized access to University materials, misrepresentation/falsification of University records or academic work, malicious removal, retention, or destruction of library materials, malicious/intentional misuse of computer facilities and/or services, and misuse of student identification cards. Incidents of alleged academic misconduct will be handled through the established procedures of the University Judiciary Program, which includes either an "informal" resolution by a faculty member, resulting in a grade adjustment, or a formal hearing procedure, which may subject a student to the Code of Conduct's minimum one semester suspension requirement.
- B. Students involved in off-campus activities shall not act in a disorderly or disruptive fashion, nor shall they conduct any dangerous activity.
- C. Students involved in off-campus activities shall not take, damage or destroy or attempt to take, damage or destroy property of another.

CAMPUS POLICIES

KSU Disruption of Campus Life Policy:

All students are responsible for knowing the information, policies and procedures outlined in the Kennesaw State University Codes of Conduct. [Student Conduct and Academic Integrity](#) (SCAI) includes: the general Student Code of Conduct, the Residential Code of Conduct, and the Code of Academic Integrity.

KSU Web Accessibility Policy Statement:

Federal law Section 508 Subsection 1194.22 of the Rehabilitation Act and the Board of Regents (BOR) of the University System of Georgia (USG) Web Accessibility Guidelines require that all web content meet the federal government's accessibility guidelines. As such, KSU complies with USG guidelines.

University accessibility assistance is provided by several offices as noted below. Staff in these offices work to accommodate requests for access or assistance with access as soon as possible in order to either accommodate the request or identify an effective alternative for the requestor.

Student Support Services
Student Disability Services
470-578-2666

studentdisability@kennesaw.edu

Student Technology Assistance
University Information Technology Services
470-578-3555

studenthelpdesk@kennesaw.edu

Third Party Technology Assistance
University Information Technology Services
470-578-6999

service@kennesaw.edu

Confidentiality and Privacy Statement (FERPA):

Kennesaw State University adheres to the Family Educational Rights & Privacy Act of 1974 - FERPA. See the following link for more information:

http://usg.edu/information_technology_handbook/section9/tech/9.5_privacy_and_security

University - Student Rights & Responsibilities:

Students of Kennesaw State University are entitled to an environment that is conducive to learning and individual growth. To this end, students enrolling at Kennesaw State University assume a responsibility to abide by the policies and regulations expressed in this section. By doing so, students may fulfill their responsibilities and enjoy the exercise of their own rights while also respecting the rights of others.

<http://catalog.kennesaw.edu/content.php?catoid=27&navoid=2263>

Ethics Statement:

All students are responsible for knowing the information, policies and procedures outlined in the Kennesaw State University Codes of Conduct. The KSU Codes of Conduct include: the general Student Code of Conduct, the Residential Code of Conduct, and the Code of Academic Integrity. Kennesaw State University reserves the right to make changes to this code as necessary and once those changes are posted online, they are in effect. Students are encouraged to check online for the updated versions of all policies.

<http://scai.kennesaw.edu/codes.php>

Sexual Misconduct Policy:

Kennesaw State University is committed to providing programs, activities, and educational environment free from all forms of sex discrimination. For more information click [here](#). KSU issues this statement of policy to inform the community of the University's comprehensive plan addressing sexual misconduct, educational programs, and procedures that address sexual assault, domestic violence, dating violence, and stalking, whether the incident occurs on or off campus. This policy generally covers faculty, students, and staff of the University, as well as third parties. Third parties include but are not limited to guests, vendors, contractors, retirees, and alumni.

<http://scai.kennesaw.edu/procedures/sexual-misconduct.php>

Course Accessibility Statement (ADA Statement):

<http://catalog.kennesaw.edu/content.php?catoid=27&navoid=2263&hl=FERPA&returnto=search#ADA>

Academic Feedback:

Institutional Chief Academic Officers will encourage faculty to clarify for students, at the beginning of each course, the basis on which grades will be determined and to provide timely academic feedback as the course progresses ([BOR Academic and Student handbook policy 2.18](#)).

Netiquette: Communication Courtesy:

All members of the class are expected to follow [rules of common courtesy in all email messages](#), threaded discussions and chats.

Inclement Weather Policy:

During the course of the year, Kennesaw State University may decide to close campus or operate on a delayed schedule in cases of inclement weather.

The University will announce campus closures and delayed schedules in several ways. The cell phone number on file with the university will automatically receive KSU Alerts, so make sure your information in OwlExpress is accurate at all times. An email will also be sent to your university account.

In addition, announcements will be made by a notice on the [Kennesaw State University home page](#).

ADDITIONAL STUDENT RESOURCES

For CCSE Student resources:

<http://ccse.kennesaw.edu/student-resources.php>

For KSU Student resources:

https://curriculum.kennesaw.edu/resources/ksu_student_resources_for_course_syllabus.php

KSU Service Desk:

The KSU Service Desk is your portal to getting assistance or access to University IT Services. Students call: 470-578-3555 or email studenthelpdesk@kennesaw.edu

For Academic Advising information and to schedule appointments:

<http://ccse.kennesaw.edu/advising/index.php>

Links to frequently used and helpful services:

<http://www.kennesaw.edu/myksu/>

Department of Career Planning & Development

<https://careers.kennesaw.edu>

Counseling and Psychological Services

<https://counseling.kennesaw.edu>

Center for Health Promotion and Wellness

<https://wellness.kennesaw.edu>

Student Health Services

<https://studenthealth.kennesaw.edu>