



Carnegie Mellon University  
Master of  
Software Engineering

### 17-614: Formal Methods

MW 9:50-11:10am, Studio Theater, Cohon University Center  
A1, Fall 2020, 6 Units

#### Instructor

Prof. David Garlan  
Prof. Eunsuk Kang

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#### Office Location & Hours

TCS 420, by appointment  
TCS 322, Th 9:00-10:00 am

#### Teaching Assistants

Yueyi (Zoe) Fan

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F 8:00-9:00 pm

**Course Description.** Scientific foundations for software engineering depend on the use of precise, abstract models and logics for characterizing and reasoning about properties of software systems. A number of basic models and logics over time have proven to be particularly important and pervasive in the development of software systems. This course is concerned with that body of knowledge. It considers many of the standard models for representing sequential and concurrent systems, such as state machines, relational models, algebras and traces. It shows how you can use different logics to specify properties of software systems, such as functional correctness, deadlock freedom, and internal consistency. Concepts such as composition mechanisms, abstraction relations, invariants, non-determinism, and inductive and denotational descriptions are recurrent themes throughout the course.

**Prior Knowledge.** Basic discrete mathematics.

**Learning Objectives.** After completing this course, you should be able to understand the strengths and weaknesses of certain models and logics, including state machines, relational models, algebraic and trace models. You should be able to apply this understanding to select and describe abstract formal models for certain classes of systems. Further, you should be able to reason formally about the certain properties of modeled systems and use associated tools to analyze these systems.

#### Learning Resources.

- **Models of Software Systems**, by David Garlan, Jeannette Wing, and Orieta Celiku. Available on Canvas.
- **Concurrency: State Models and Java Programs**, Second Edition, by Jeff Magee and Jeff Kramer. Wiley, 2006.

- **Software Abstractions: Logic, Language, and Analysis**, Revised Edition, by Daniel Jackson. MIT Press, 2011.

**Use of Zoom in the Class.** In our class, we will be using Zoom. The link is available on Canvas. Please make sure that your Internet connection and equipment are set up to use Zoom and able to share audio and video during class meetings. (See this page for Computing Resources for information on the technology you are likely to need.) Let us know if there is a gap in your technology set-up as soon as possible, and we can see about finding solutions.

**Sharing video:** In this course, being able to see one another helps to facilitate a better learning environment and promote more engaging discussions. Therefore, our default will be to expect student to have their cameras on during lectures and discussions. However, I also completely understand there may be reasons students would not want to have their camera on. If you have any concerns about sharing your video, please email us as soon as possible and we can discuss possible adjustments. Note: You may use a background image in your video if you wish; just check in advance that this works with your device(s) and internet bandwidth.

During our class meetings, please keep your mic muted unless you are sharing with the class or your breakout group.

If you have a question or want to answer a question, please use the chat or the “raise hand” feature (available when the participant list is pulled up). The course staff will be monitoring these channels in order to call on students to contribute.

Our synchronous meetings will involve breakout room discussions, and those will work better if everyone in your small group has their camera turned on. During large group debriefs, you may keep your video off.

**Assessments.** Students learn more by applying and explaining ideas to others, thus, the course requires the following activities:

- **Weekly homework assignments**
- **Weekly quizzes**
- **Team project**
- **Final take-home exam**
- **Class participation**

Assessment	Final Grade %
Homework	30%
Quizzes	10%
Project	30%
Exam	30%

Grade	Percentage Interval
A	90-100%
B	80-89%
C	70-79%
D	60-69%
R (F)	59% or below

## Course and Grading Policies

- **Cooperation Policy:** We encourage you to discuss your homework with other students, but the final write-up must be your own work. It is not ok to obtain an electronic or physical copy of any other student's homework and use this as the basis for your own. If you work out ideas with someone on a whiteboard, you should erase the whiteboard before recreating your own homework. Note that when copying occurs both parties are in part to blame -- even if one person copies from another. If you have any questions about what is appropriate, please ask the instructors or the teaching assistant. Also, see the University Policy on Academic Integrity: <http://www.cmu.edu/policies/student-and-student-life/academic-integrity.html>
- **Late-work policy:** All work is expected to be handed in at the indicated due date and time. For fairness to the whole class, no late submissions will be accepted for the group work. In the first week of classes, you should receive a course schedule for each course; please use them to plan ahead. See the grading policy on Canvas for more information about our late policy.

This semester involves regular use of technology during class — both for in-person and remote students. Research has shown that divided attention is detrimental to learning, so I encourage you to close any windows not directly related to what we are doing while you are in class. Please turn off your phone notifications and limit other likely sources of technology disruption, so that you can fully engage with the material, each other, and me. This will create a better learning environment for everyone.

**Attendance.** In order to attend class in person, I expect that you will abide by all behaviors indicated in [A Tartan's Responsibility](#), including any timely updates based on the current conditions. In terms of specific expectations for in-person students, this includes:

- entering the classroom via the designated ingress route with appropriate physical distancing,
- wearing a facial covering throughout class,
- sitting in the seats with appropriate spacing and not moving furniture),
- using the sanitizing wipes available in the classroom to wipe surfaces (e.g., your desk, tablet arm) upon entry and exit,
- exit the classroom at my direction, proceeding in a row-by-row fashion, following the designated egress route and maintaining proper distancing.

**Facial coverings.** If you do not wear a facial covering to class, I will ask you to put one on (and if you don't have one with you, I will direct you to a distribution location on campus). If you do not comply, please remember that you will be subject to student conduct proceedings, up to and including removal from CMU. Accordingly, I will be obliged to take other measures for the safety of the whole class.

**Recording of Class Sessions.** All synchronous classes will be recorded via Zoom so that students in this course (and only students in the course) can watch or re-watch past class sessions. Please note that breakout rooms will not be recorded. I will make recordings available on Canvas as soon as possible after each class session (usually within 3 hours of the class meeting). Recordings will live in our Canvas website(<https://canvas.cmu.edu/courses/19500>). Please note that you are not allowed to share these recordings. This is to protect your FERPA rights and those of your fellow students.

**Transferring to Fully Remote During the Semester.** If the class needs to go fully remote, you will receive an email from me and an announcement will be published on our course website on Canvas.

At any point during the semester, you may choose to participate in the class remotely. If you decide to switch to remote for one or more classes, please try to let us know by at least 24 hours in advance so I can prepare the breakout rooms and in-class sessions appropriately. In addition, if you are able, let me know the expected length of your remote engagement (e.g., number of classes or for an extended period of time).

**Course Schedule.** The following schedule provides a general overview of topics and assignments. Please refer to the syllabus online in Canvas for specific lecture topics, reading assignments and due dates.

#	Date	Topic	Subtopic	Reading	Due
1	M 08/31	<a href="#">Introduction</a>	<a href="#">Course Overview</a>  <a href="#">What is a model?</a> 		
2	W 09/02	<a href="#">Foundations</a>	<a href="#">Propositional &amp; Predicate Logic</a> 	Ch 1-3; N+15	<a href="#">HW 1</a>
3	W 09/09*		<a href="#">Proof Techniques</a> 	Ch 4, 5	<a href="#">HW 2</a>
4	M 09/14		<a href="#">Sets, Relations, Functions</a> 	Ch 6	<a href="#">HW 3</a>
5	W 09/16		<a href="#">Sequences &amp; Induction</a> 	Ch 7	
6	M 09/21		<a href="#">State Machine Basics</a> 	Ch 8	<a href="#">HW 4</a>
7	W 09/23	<a href="#">State Machines</a>	<a href="#">State Machine Variations</a> 	Ch 9	
8	M 09/28		<a href="#">FSP &amp; LTSA</a> 	Ch 10	<a href="#">HW 5</a>
9	W 09/30		<a href="#">Reasoning about State Machines</a> 	MK06 Ch 1, 2.1	
10	M 10/05	Concurrency	Concurrency Modeling		HW 6
11	W 10/07		Concurrency Reasoning		
12	M 10/12	<a href="#">Structural Modeling</a>	<a href="#">Object Modeling</a> 	Jac11 Ch 1, 2	<a href="#">HW 7</a>
13	W 10/14		<a href="#">Intro to Alloy</a> 	Jac11 Ch 3	Project
14	M 10/19		Applications & Review		<a href="#">HW 8</a> 

\*Marks classes that follow a holiday

**Accommodations for Students Disabilities.** If you have a disability and have an accommodations letter form the Disability Resources office, I encourage you to discuss your

accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at [access@andrew.cmu.edu](mailto:access@andrew.cmu.edu).

**Academic Integrity.** Honesty and transparency are important to good scholarship. Plagiarism and cheating, however, are serious academic offenses with serious consequences. If you are discovered engaging in either behavior in this course, you will earn a failing grade on the assignment in question, and further disciplinary action may be taken. For a clear description of what counts as plagiarism, cheating, and/or the use of unauthorized sources, please see the [University's Policy on Academic Integrity](#).

If you have any questions regarding plagiarism or cheating, please ask me as soon as possible to avoid any misunderstandings. For more information about Carnegie Mellon's standards with respect to academic integrity, you can also check out the [Office of Community Standards & Integrity](#) website.

**Student Wellness.** As a student, you may experience a range of challenges that can interfere with learning, such as strained relationships, increased anxiety, substance use, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may diminish your academic performance and/or reduce your ability to participate in daily activities. CMU services are available, and treatment does work. You can learn more about confidential mental health services available on campus at the [Counseling and Psychological Services](#) website. Support is always available (24/7) from Counseling and Psychological Services: 412-268-2922.

This semester is unlike any other. We are all under a lot of stress and uncertainty at this time. Attending Zoom classes all day can take its toll on our mental health. Make sure to move regularly, eat well, and reach out to us or your support system if you need to. We can all benefit from support in times of stress, and this is semester is no exception.

**Respect for Diversity.** It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know if any of our class meetings conflict with your religious observations so that I can make alternate arrangements for you.