Ira A. Fulton Schools of Engineering
Arizona State University

# Course Syllabus & Schedule/Map – Fall 2021 (Session A)

## CSE 565: Software Verification and Validation

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|---|---|
| **Instructor** | Subhasish Das |
| **Teaching Assistant** | Rutvik Bharatkumar |
| **Virtual Office Hours** | Details provided in Live Events section below and on course's Live Events page. |
| **Content Questions** | Weekly discussion forums and live events |
| **Course Issues** | Course "Feedback" tool (blue button on every course page) |
| **Technical Support** | Coursera Learner Help Center |
| NOTE: | Please make sure you are logged in with your ASU email address so that support personnel recognize you as an ASU degree student. |
| **Private Support** | mcsonline@asu.edu |
| NOTE: | When sending an email about this class, please include the prefix "CSE 565" in the subject line of your message. |
| **Slack Channel** | https://asu-2217-cse565-88014.slack.com |
| NOTE: | You will be automatically added to this workspace, but you must access it using your ASURITE credentials. |

## Course Description

Software as a stand-alone product or embedded within a system plays an integral role in our world today. As a consequence, it is essential that software works as expected. This requires software testing which entails answering both the verification questions: "Are we building the product right?" and the validation question: "Are we building the right product?" Understanding these questions is crucial for developing good test cases. This course is for anyone involved in testing software at any level starting from code modules to system testing. Strategies and techniques are presented for both testing software as well as planning and tracking testing efforts.

*Specific topics covered include*

- Testing background
- Testing process activities
- Requirements based testing techniques
- Structure based testing techniques
- System testing

- Testing tools
- Reliability models
- Statistical testing
- Test planning
- Tracking testing progress
- Test documentation
- Test process improvement

## Learning Outcomes

*Learners completing this course will be able to*

- Explain how testing activities fit within leading software development process models
- Understand and apply best practices for software testing
- Create test cases based on commonly used requirements-based testing techniques
- Create test cases to achieve control and data flow structure-based coverage
- Apply static analysis techniques to identify code anomalies
- Create test cases that demonstrate system-level requirements are being met
- Identify appropriate testing tools for applications
- Predict software reliability based on operational profile testing and reliability models
- Describe activities to perform for improving testing processes
- Analyze testing needs to create a plan to achieve test objectives
- Track testing progress against a plan

## Estimated Workload/Time Commitment Per Week

15-20 hours per week

## Required Prior Knowledge and Skills

- High-level programming language
- Software development life cycle models

## Technology Requirements

**Hardware**

Standard with major OS

**Software and Other**

To complete course projects, the following application will be required: Java

## Textbook and Readings

There is no required textbook for this course. Required course readings will be provided within each week these are assigned.

## Important Course Dates

The following dates will be key to your success in this course.

| Event | Date | Please Note |
|---|---|---|
| Class begins | Thursday, August 19, 2021 | |
| Holidays | Monday, September 6, Labor Day | University closed |
| Midterm exam | **Opens:** Friday, September 10, 12:15 AM (AZ)<br>**Closes/must be completed by:** Sunday, September 12, 11:45 PM (AZ) | Last appointment will be Sunday, September 12, 9:15 PM (AZ) |
| Final exam | **Opens:** Thursday, October 7, 12:15 AM (AZ)<br>**Closes/must be completed by:** Saturday, October 9, 11:45 PM (AZ) | Last appointment will be Saturday, October 9, 9:15 PM (AZ) |
| Class ends | Saturday, October 9, 2021 | |
| Grades due | Monday, October 11, 2021 | |
| Portfolio inclusion request | Saturday, October 23, 2021 | This date is for submitting the report requesting that you be allowed to include this course's project (its four graded assignments) in your MCS portfolio. |

## Course Schedule and Late Work

Unless otherwise noted, **all graded work** (unit quizzes, project deliverables, and exams), is **due** at **11:59 PM** the **Sunday** ending the week for which it is assigned.

### Important Notice Regarding Course Deadlines:

Late penalties will be applied for work submitted after the scheduled due date and time unless prior accommodations have been agreed to:

**Graded Quizzes:** 10% penalty daily
**Projects:** 10% penalty daily
**Exams:** No late exams (one-time 100% penalty), only exception will be emergencies or other extenuating circumstances

Week-by-week begin/end dates and deadlines are as follows:

| Week | Main Topic | Begin Date | End Date | Graded Work Due *See Course Map* |
|---|---|---|---|---|
| 1 | Introduction to Software Verification, Validation and Testing | 8/19 | 8/22 | 8/22 |
| 2 | Specification-Based Techniques - Part 1 | 8/23 | 8/29 | 8/29 |
| 3 | Specification-Based Techniques - Part 2 | 8/30 | 9/5 | 9/5 |
| 4 | Structural-Based Techniques | 9/6 | 9/12 | 9/12 |
| | *Midterm* | 9/10 | 9/12 | 9/12 |
| 5 | Testing Software Quality Characteristics - Part 1 | 9/13 | 9/19 | 9/19 |
| 6 | Testing Software Quality Characteristics Part 2 | 9/20 | 9/26 | 9/26 |
| 7 | Test Management - Part 1 | 9/27 | 10/3 | 10/3 |
| 8 | Test Management - Part 2 | 10/4 | 10/9 | 10/9 |
| | *Final* | 10/7 | 10/9 | 10/9 |

## Grade Breakdown

| Course Work | Quantity/Details | % |
|---|---|---|
| Graded quizzes* | 8 | 10% |
| Project | Assignment #1 Part 1: Specification-Based Testing Part 1 | 5% |

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|---|---|---|
| | Assignment #1 Part 2: Specification-Based Testing Part 2 | 5% |
| | Assignment #2: Structural Based Testing | 10% |
| | Assignment #3 (Parts 1 and 2): Software Quality Characteristics Based Testing | 10% |
| Midterm exam (Weeks 1-4 covered) | 1 | 30% |
| Final Exam (Weeks 5-8 covered) | 1 | 30% |

* The system will automatically drop the grade of the quiz with the lowest score of the eight.

## Grade Scale

Consistent with CIDSE policy, you must have a cumulative grade of at least 83% to earn a “B” in this course, and 73% (“C”) to earn credit for this course. The full list of cutoffs that will be used to generate your letter grade follows:

| | |
|---|---|
| A+ | ≥97% |
| A | ≥93% |
| A- | ≥90% |
| B+ | ≥87% |
| B | ≥83% |
| B- | ≥80% |
| C+ | ≥77% |
| C | ≥73% |
| C- | ≥70% |
| D | ≥60% |
| E | < 60% |

NOTE: Grades may be further curved based on overall class performance. For more information about grading, visit ASU's Grades & Records webpage.

## Course Content

The course comprises the following elements:

| Instruction | Assessments |
|---|---|
| Video Lectures<br>Other Videos<br>Readings<br>Live Events/Virtual Office Hours<br>**NOTE:** Transcripts and PDFs of all lecture slides are provided with the videos. | Ungraded discussion assignments (staff-graded)<br>Practice quizzes (auto-graded)<br>Graded quizzes (auto-graded)<br>Project/assignments (individual, staff-graded)<br>Midterm and final exam (proctored, auto- and staff-graded) |

## Assessment Details and Settings

The table below summarizes what you can expect to encounter in the course's assessments.

| Content Type | Description | Time Limit | # of Attempts | Feedback |
|---|---|---|---|---|
| Practice quizzes – Knowledge Check | Each module includes Knowledge Check practice quizzes, which cover only each module's topic. The system may present a different selection of questions to you after your first attempt. These quizzes do not contribute toward your final score in the class. | None | Unlimited | Full (score, correct / incorrect choices, explanations) |
| Graded quizzes – Unit/Weekly | Units 1-7 include one graded quiz that covers the entire unit and counts toward your final score in the course. NOTE: The lowest quiz score will be automatically dropped. | 60 minutes | 1 | Partial (score and correct / incorrect choices) |
| Project / Assignments | You will complete four (4) assignments (= one project) comprising multiple submissions. | n/a | n/a | Staff (rubric-based) |
| Exams | You will have two (2) proctored exams, a midterm and a final, taken in the course with ProctorU, a live, remote proctoring service that allows students | Midterm: 135 minutes total (2 hours plus 15 minutes | 1 | Limited (score only) |

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|---|---|---|---|---|
| | to take exams online while ensuring the integrity of the exam for the institution. Exams are generally available for three (3) days. Additional information is provided in the Course Map, Week 1's "Course Exams" reading, exam-specific instructions in Weeks 4 and 8, and the MCS Onboarding Course accessible from your Coursera dashboard). | start-up with proctor)<br><br>Final: 135 minutes total (2 hours plus 15 minutes start-up with proctor) | | |

## Live Events/Virtual Office Hours

This course will offer multiple live event/virtual office hour sessions each week, all of which will be hosted on Zoom. These sessions have an open, "drop-in" format to provide everyone an opportunity to meet with the course instructor and/or teaching assistant as well as classmates to ask questions and learn more about course topics and assignments

Live events/virtual office hours may be joined using a computer or a mobile device. iOS devices, however, are not fully supported at this time. To join from an iOS device, use the Zoom app and paste in the event's URL. Using other mobile operating systems or a computer, simply open the Coursera app, navigate to "Live Events," and click the available event link to join.

**Live Event Days and Times**
All events will run for **one hour**. Times shown are AZ.

| Day | Start Time | Hosted By | Zoom URL |
|---|---|---|---|
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Watch for announcements and check the Live Events page in the course for possible revisions to this schedule.
*Note: These events will be recorded and the instructor's events will be uploaded to the course by the end of the day following each event. Look for the "Weekly Live Event/Office Hour Recordings" section at the end of each week.*

## Slack Channel

This course will have a unique Slack workspace where you can communicate with your classmates.

Note: You must join/access this workspace using your ASURITE credentials.
Slack is intended to provide a space to create community with your classmates. Please remember to follow the communication protocol pinned in your Slack channel to ensure that any questions or concerns you have are addressed in a timely manner. Also, please remember ASU's Academic Integrity policy, and please refrain from sharing assessment questions, answers or solutions

## Policies

All ASU and Coursera policies will be enforced during this course. For policy details, please consult the MCS Graduate Handbook and the MCS Onboarding Course.

### Absence Policies

a. If you are not able to attend live events, you are encouraged to watch the recording(s) that will be made available each week. In addition, participation in the discussion forums may be considered a measure of your engagement.
b. Excused absences are governed by the following policies:
    i. Related to religious observances/practices: ACD 304–04, "Accommodation for Religious Practices."
    ii. Related to university sanctioned events/activities: ACD 304–02, "Missed Classes Due to University-Sanctioned Activities."
    iii. Related to missed class due to military line-of-duty activities: ACD 304–11.

### Policy Regarding Expected Course Behavior

You are expected to observe Coursera's policies as well as ASU's netiquette standards.

### Academic Integrity

Students in this class must adhere to ASU's academic integrity policy, which can be found at https://provost.asu.edu/academic-integrity/policy). Students are responsible for reviewing this policy and understanding each of the areas in which academic dishonesty can occur. In addition, all engineering students are expected to adhere to both the ASU Academic Integrity Honor Code and the Fulton Schools of Engineering Honor Code. All academic integrity violations will be reported to the Fulton Schools of Engineering Academic Integrity Office (AIO). The AIO maintains record of all violations and has access to academic integrity violations committed in all other ASU college/schools.

### Copyright

Course content, including lectures, are copyrighted materials and students may not share outside the class, upload to online websites not approved by the instructor, sell, or distribute course content or notes taken during the conduct of the course (see ACD 304–06, "Commercial Note Taking Services" and ABOR Policy 5-308 F.14 for more information).

You must refrain from uploading to any course shell, discussion board, or website used by the course instructor or other course forum, material that is not the student's original work, unless the students first comply with all applicable copyright laws; faculty members reserve the right to delete materials on the grounds of suspected copyright infringement.

## Policy Against Threatening Behavior (SSM 104-02)

Students, faculty, staff, and other individuals do not have an unqualified right of access to university grounds, property, or services. Interfering with the peaceful conduct of university-related business or activities or remaining on campus grounds after a request to leave may be considered a crime. All incidents and allegations of violent or threatening conduct by an ASU student (whether on- or off-campus) must be reported to the ASU Police Department (ASU PD) and the Office of the Dean of Students.

## Disability Accommodations

Suitable accommodations will be made for students having disabilities. Students needing accommodations must register with the ASU Disabilities Resource Center and provide documentation of that registration to the instructor. Students should communicate the need for an accommodation in sufficient time for it to be properly arranged. See ACD 304-08 Classroom and Testing Accommodations for Students with Disabilities.

## Harassment and Sexual Discrimination

Arizona State University is committed to providing an environment free of discrimination, harassment, or retaliation for the entire university community, including all students, faculty members, staff employees, and guests. ASU expressly prohibits discrimination, harassment, and retaliation by employees, students, contractors, or agents of the university based on any protected status: race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, and genetic information.

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at https://sexualviolenceprevention.asu.edu/faqs.

**Mandated sexual harassment reporter:** As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, https://eoss.asu.edu/counseling, is available if you wish to discuss any concerns confidentially and privately.

## Course Faculty

The following faculty member created this course.

**James Collofello**

Dr. James Collofello serves as Vice Dean of Academic and Student Affairs and has held this position since 2006. In this capacity he leads the school's student recruitment and retention, career development and placement, K-12 programming, new curriculum development, accreditation and oversight of Fulton Difference programming. The Fulton Difference consists of innovative programs operated at scale to provide students with opportunities to develop and enhance their research, leadership, project development and entrepreneurship skills. Major Fulton Difference programs include engineering student organizations, Fulton Undergraduate Research Initiative, Grand Challenge Scholars Program, Undergraduate Teaching Assistant Program and Engineering Projects in Community Service. He is also a professor of computer science and software engineering. His teaching and research interests lie in the software engineering area with an emphasis on software quality assurance, software process improvement and software project management. He has also been active in developing and improving computer science curriculum and working to improve undergraduate retention. In addition to his academic activities, he has also been involved in applied research projects, training and consulting with many large corporations over the last 25 years.

# Course Map with Assignments

## Unit 1: Software Testing Overview (Aug 19 - Aug 22, 2021)

**Learning Objectives**

1.1 Define common testing terminology
1.2 Describe how testing is integrated into software development
1.3 Define the objectives of the different levels of testing
1.4 Explain best practices for software testing

**Unit Structure**

Module 1: Testing Background
Module 2: Testing Throughout Life Cycle
Module 3: Testing Best Practices and Standards

**To Do**

- ❑ Download/print the CSE 565 Syllabus and Course Map (this document)
- ❑ Attend and/or watch recorded Live Event/Virtual Office Hour(s)
- ❑ Create your ProctorU account (if you do not already have one)
- ❑ Schedule midterm exam with ProctorU (see exam details under Week 4 below)
- ❑ If you are registered with SAILS (formerly DRC) and require accommodations, inform the instructor.

**Due by August 22, 2021**

- ❑ Getting Started Quiz
- ❑ Get to Know Your Classmates Discussion Assignment
- ❑ Weekly Graded Quiz

## Unit 2: Specification-based Testing Technique Part 1 (Aug 23 - Aug 29, 2021)

**Learning Objectives**

2.1 Contrast requirements-based versus scenario-based testing
2.2 Apply the equivalence partitioning testing technique
2.3 Apply the boundary value testing technique
2.4 Apply cause-effect testing technique
2.5 Test asynchronous events
2.6 Apply state-based testing technique
2.7 Describe model-based testing strategies

**Unit Structure**

Module 1: Input Sampling Techniques
Module 2: Model-Based Testing

**To Do**

- ❑ Attend and/or watch recorded Live Event/Virtual Office Hour(s)
- ❑ If you haven't yet, schedule midterm exam with ProctorU

**Due by August 29, 2021**

- ❑ Weekly Quiz
- ❑ Assignment #1: Specification-Based Testing Part 1

## Unit 3: Specification-based Testing Technique Part 2 (Aug 30 - Sep 5, 2021)

**Learning Objectives**

3.1 Apply combinatorial test coverage to assess test quality
3.2 Apply design of experiments to develop tests
3.3 Define mutation testing
3.4 Define fuzz testing
3.5 Define metamorphic testing
3.6 Apply defect-based testing techniques
3.7 Describe the role of exploratory testing

**Unit Structure**

Module 1: Combinatorial Testing Techniques
Module 2: Mutation Testing
Module 3: Fuzz Testing
Module 4: Metamorphic Testing
Module 5: Defect Based Testing
Module 6: Exploratory Testing

**To Do**

- ❑ Attend and/or watch recorded Live Event/Virtual Office Hour(s)
- ❑ If you haven't yet, schedule midterm exam with ProctorU

**Due by September 5, 2021**

- ❑ Weekly Quiz
- ❑ Assignment #1: Specification-Based Testing Part 2

## Unit 4: Structural Based Testing Strategies (Sep 6 - Sep 12, 2021)

**Learning Objectives**

4.1 Develop test cases to achieve control flow coverage
4.2 Apply structured testing technique

4.3 Develop test cases to achieve data flow coverage
4.4 Identify static analysis techniques
4.5 Utilize symbolic execution

### Unit Structure

Module 1: Dynamic Analysis
Module 2: Static Analysis

### To Do

❑ Attend and/or watch recorded Live Event/Virtual Office Hour(s)

### Due by September 12, 2021

❑ Weekly Quiz
❑ Midterm Exam (see below)

### Midterm Exam

❑ Midterm Exam - Proctored

**Opens:** Friday, September 10, 2021, 12:15 AM (AZ)
**Closes:** Sunday, September 12, 11:45 PM (AZ)
**Last available appointment:** Sunday, September 12, 2021, 9:15 PM (AZ)

**NOTICES:**

- You must schedule your exam at least 72 hours prior to your desired appointment to avoid having to pay a late-scheduling fee.
- Conduct a ProctorU system test PRIOR to your exam.

**Covers:** Weeks (Units) 1 – 4
**Duration:** 135 minutes (120 minutes + 15 minutes for start-up with proctor)
**Format:** Multiple choice and fill-in-the-blank
**Grading:** Auto- and staff-graded

#### Allowed Materials

**Scratch paper:** Two sheets (both sides) of 8.5x11 (or international equivalent) paper

NOTE: Use of supplemental electronic devices (calculators, etc.) or software will ***not*** be permitted during the exam. No bathroom breaks allowed.

## Unit 5: Testing Software Quality Characteristics Part 1 (Sep 13 - Sep 19, 2021)

### Learning Objectives

5.1 Utilize strategies for performance testing
5.2 Utilize strategies for stress testing
5.3 Utilize strategies for volume testing
5.4 Utilize strategies for configuring testing
5.5 Utilize various strategies for regression testing

5.6 Identify approaches for mobile system testing

**Unit Structure**

Module 1: Performance Testing
Module 2: Stress Testing
Module 3: Volume Testing
Module 4: Configuration Testing
Module 5: Regression Testing
Module 6: Mobile Testing

**To Do**

❑ Attend and/or watch recorded Live Event/Virtual Office Hour(s)

**Due by September 19, 2021**

❑ Weekly Graded Quiz

❑ Assignment #2: Structural Based Testing

## Unit 6: Testing Software Quality Characteristics Part 2 (Sep 20 - Sep 26, 2021)

**Learning Objectives**

6.1 Develop error detection, recovery and serviceability tests
6.2 Generate usability tests
6.3 Identify how software reliability models work
6.4 Apply operational profile testing to assess software reliability
6.5 Identify basic security testing approaches

**Unit Structure**

Module 1: Error Detection, Recovery and Serviceability Testing
Module 2: Usability Testing
Module 3: Reliability Testing
Module Module 4: Security Testing

**To Do**

❑ Attend and/or watch recorded Live Event/Virtual Office Hour(s)
❑ If you haven't already, schedule final exam with ProctorU (see exam details under Unit 8 below)

**Due by September 26, 2021**

❑ Weekly Graded Quiz

## Unit 7: Test Management Part 1 (Sep 27 - Oct 3, 2021)

### Learning Objectives

7.1 Identify the major components of a system test plan
7.2 Create a test schedule
7.3 Estimate testing effort
7.4 Follow a process for estimating testing effort
7.5 Perform risk based testing
7.6 Select test exit criteria
7.7 Identify the different types of test documentation

### Unit Structure

Module 1: Testing Plan
Module 2: Testing Schedule
Module 3: Estimating Testing Effort
Module 4: Risk Based Testing
Module 5: Test Exit Criteria
Module 6: Test Documentation

### To Do

- ❑ Attend and/or watch recorded Live Event/Virtual Office Hour(s)
- ❑ If you haven't already, schedule final exam with ProctorU (see exam details under Unit 8 below)
- ❑ Work on Assignment #3 Part 1
- ❑ Study for final exam

### Due by October 3, 2021

- ❑ Weekly Graded Quiz

## Unit 8: Test Management Part 2 (Oct 4 - Oct 9, 2021)

### Learning Objectives

8.1 Utilize various measures to track testing progress
8.2 Identify how to analyze and improve the testing process
8.3 Develop a plan for outsourcing testing
8.4 Apply best practices for maximizing test team performance
8.5 Plan and participate in various work product inspections
8.6 Apply causal analysis to improve test effectiveness
8.7 Assess the maturity level of a testing organization

### Unit Structure

Module 1: Test Tracking
Module 2: Testing Process Improvement

Module 3: Test Outsourcing
Module 4: People Management
Module 5: Software Inspections
Module 6: Causal Analysis
Module 6: Test Maturity Model

**To Do**

- ❑ Attend and/or watch recorded Live Event/Virtual Office Hour(s)
- ❑ Course Survey
- ❑ Optional: Portfolio Inclusion Request for ASU MCS Degree

**Due by October 9, 2021**

- ❑ Weekly Graded Quiz
- ❑ Project #3: Software Quality Characteristics Based Testing (Part 1 and Part 2)
- ❑ Final Exam (see below)

**Final Exam**

❑ Final Exam - Proctored

**Opens:** Thursday, October 7, 2021, 12:15 AM (AZ)
**Closes:** Saturday, October 9, 11:45 PM (AZ)
**Last available appointment:** Saturday, October 9th 2021, 9:15 PM (AZ)

**NOTICES:**

- You must schedule your exam at least 72 hours prior to your desired appointment to avoid having to pay a late-scheduling fee.
- Conduct a ProctorU system test PRIOR to your exam.

**Covers:** Weeks (Units) 5 – 8
**Duration:** 135 minutes (120 minutes + 15 minutes for start-up with proctor)
**Format:** Multiple choice
**Grading:** Auto- and staff-graded

**Allowed Materials**

**Scratch paper:** Two sheets (both sides) of 8.5x11 (or international equivalent) paper

NOTE: Use of supplemental electronic devices (calculators, etc.) or software will ***not*** be permitted during the exam. No bathroom breaks allowed.