

1. Course Number and Course Title:

COE 545 - Modeling and Testing in Software Engineering

2. Credits Hours: 3 – 0 – 3

3. Prerequisites and/or Co-Requisites:

Prerequisite: Approval of the CSE Department Head

Co-requisites: None

Competencies: Undergraduate course in software engineering, design, or testing

4. Name and Contact Information of Instructor:

Dr. Khaled El-Fakih Office: ESB-2065

Email: kelfakih@aus.edu Phone: 06-515-2492

Office Hours: Posted on iLearn and by appointment

5. Course Description (Catalog Description):

Explores the modelling of system requirements using formal specification techniques and languages. Covers finite state automata, extended, timed and untimed state machines, labeled transition systems, and Petri Nets. Covers advanced software and system testing methods focusing on black-box and white-box testing, and test derivation and optimization using reinforcement learning, genetic algorithms, and simulated annealing. Explores current research trends in selected topics from incremental testing, smart-space testing, machine learning algorithms for testing, and/or fault diagnosis.

6. Textbook and other Supplemental Material:

Textbook:

- Jorgensen, P., & DeVries, B., Software Testing: A Craftsman's Approach, 5th Edition, CRC Press, 2021.

Supplemental material:

- Linz, P., An Introduction to Formal Languages and Automata, 5th edition, Jones and Bartlett, 2011.
- Mathur, A., Foundations of Software Testing, 2nd edition, Addison Wesley, 2011.
- Turner, K. J., Using Formal Description Techniques – An Introduction to Estelle, LOTOS and SDL, John Wiley and Sons Ltd., 1993.
- Kohavi, Z., Switching and Finite Automata Theory, McGraw-Hill Book Company, NY, 2009.
- Sutton, S. R., Barto G. A., Reinforcement Learning: An Introduction, 2nd edition, The MIT Press, 2015.
- Selected papers and book chapters

7. Learning Outcomes:

Upon completion of the course, students will be able to:

1. Construct specifications using known computation models and languages such as finite state machines, labeled transition systems, and Petri Nets.
2. Develop functional black-box conformance tests from specifications modeled

as finite state machines and apply boundary, class equivalence, and decision table testing methods.

3. Construct functional tests using white-box testing techniques.
4. Employ reinforcement learning for state machine based testing and the utilization of genetic and simulated annealing algorithms in test optimization.
5. Investigate current research on selected topics from: incremental testing, smart-space testing, fault diagnosis, and/or machine learning algorithms for testing.
6. Conduct independent research on software and system modeling and/or testing.

8. Teaching and Learning Methodologies:

Methods include lectures; problem solving; assignments, class presentation, survey report, exams and research project, and class discussions and presentations.

9. Course Topics and Schedule:

Topic	Week#
Overview of specification methods for reactive systems	Week 1
Requirements Modeling: Finite state automata	Week 2
Requirements Modeling: Finite state machines	Week 3
Requirements Modeling: Extended state machines	Week 4
Requirements Modeling: Labeled transition systems	Week 5
Requirements Modeling: Petri Nets	Week 6
Overview of software testing methods	Week 7
Black-box Testing: W-Method and its derivatives	Week 8
Reinforcement learning for state machine based testing	Week 9
Black-box Testing: Boundary, class equivalence, and decision table methods	Week 10
Midterm exam	Week 11
White-box Testing: Data-flow and control-flow methods	Week 12
Genetic and simulated annealing algorithms for test optimization	Week 13
Current research on selected topics from: testing of smart-spaces, fault diagnosis, incremental testing, and/or machine learning algorithms for testing.	Week 14
Project presentations	Week 15
Final exam	Week 16

10. Schedule of Laboratory and other Non-Lecture Sessions:

Each student (or group of two students) are required to carry out an independent research project on a selected topic (with the consent of the instructor) related to the course.

Research Project	Due Date
Part 1: Project selection (area and topic)	Week 2
Part 2: Proposal: Problem definition and related work	Week 4
Part 3: Preliminary results (initial solution)	Week 11
Part 4: Final report and project presentation	Week 15

11. Out-of-Class Assignments with Due Dates:

Assignment	Due Date
Homework 1	Week 3
Homework 2	Week 6
Homework 3	Week 8
Homework 4	Week 11
Course Project	Week 15

12. Student Evaluation:

Assessment	Weight	Due Date (tentative)
Homework	10 %	Cf. Section 11
Midterm Exam	15 %	Week 9
Research project	35 %	Cf. Section 10
Class presentation of a specification/testing method or tool	10 %	Cf. Section 10
Final Exam	30 %	Week 16

13. Assessment Instrument:

Assessment	Course Learning Outcomes
Homework assignments	O1 – O3
Midterm Exam	O1 – O3
Research project	O1 – O6
Class presentation of a specification/testing method or tool	O6
Final Exam	O1 – O5

The final research project and report will be done in teams of one or two students. In the final project, students will be required to apply some of the techniques given in class to elicit and solve current research problems and provide related assessments.

14. Contribution of Course to Program Outcomes:

This course contributes to the accomplishment of the following program outcomes:

MSML Program Outcomes	Extent of Contribution	Course Learning Outcomes
1. Perform research emphasizing creativity, independent learning, and scientific methods in the field of Machine Learning.	○	O4- O6
2. Apply advanced mathematics, computer science knowledge, and software tools in identifying, formulating, and solving real world problems.	●	O1-O4, O6
3. Demonstrate an in-depth understanding of modern Machine Learning approaches, algorithms, and tools.	○	O4-O5
4. Select and use techniques, skills, and modern tools necessary for research or professional practice.	●	O5
5. Communicate effectively through technical presentations and reports.	●	O6
6. Recognize the need for, and engage in, lifelong learning in professional areas.	○	O5, O6
7. Attend to professional and ethical responsibilities within global and societal contexts.		

Extent of contribution: ● high; ● medium; ○ low; Blank – Nothing Specific Expected

15. Letter Grade Table:

Total (T)	Letter Grade
$90 \leq T$	A
$85 \leq T < 90$	A-
$80 \leq T < 85$	B+
$75 \leq T < 80$	B
$70 \leq T < 75$	B-
$65 \leq T < 70$	C+
$60 \leq T < 65$	C
$T < 60$	F