Syllabus for CECS 329, Concepts of Computer Science Theory

Instructor: Dr. Todd Ebert

Spring 2026, Last Updated: January 19th, 2026

General Course Information

Academic Unit Department of Computer Engineering and Computer Science, California State University, Long Beach

Prerequisite CECS 328 with a grade of "C" or better.

Catalog Description Seminar on fundamental topics in theoretical computer science. Topics include regular languages, finite automata, context-free languages, Turing machines, computability theory, computational complexity, and NP-completeness.

Section Call Numbers 5932 (Section 1)

Instructor Dr. Todd Ebert (Todd.Ebert at csulb.edu)

Instructor Office Hours TuWTh 9:30 am - 10:30 am, ECS 548

Teaching Assistant Marley Schneider Email: Marley.Schneider01 at Student.CSULB.EDU

Course Meeting Times TuTh 8:00-9:15 am in ECS 105

Textbook

Required Textbook M. Sipser, "Theory of Computation", Cengage Learning, 2012, 3rd Edition, 978-1133187790

Course Topics

The course is divided into three one-unit sections, each of which spans five weeks and ends with an exam on the material from that unit.

Unit1: Weeks 1-5. Logic Problems, Computational Complexity Theory: Mapping Reducibility, Complexity Classes (`P`, `NP`, and co-`NP`), NP-completeness, NP-complete problems and proof of completeness via mapping reducibility.

Unit2: Weeks 6-10. Automata and Formal Language Theory: Deterministic and Nondeterministic Finite Automata, Regular Expressions, Context-Free Languages.

Unit3: Weeks 11-15. Computability Theory: Turing Machines, Church-Turing Thesis, Encoding and Decoding of Programs, Universal Programs, Diagonalization Method, Decidability and Undecidability.

Learning Outcomes

This course has eleven **core learning outcomes (LO's)** that will be assessed on each exam, as well as on five quizzes. For each outcome, your understanding is assessed via a problem that is provided on the quiz or exam. In addition to earning points (on exams only) for solving these problems, you will also receive either a Pass (P) or No Pass (NP) grade. Receiving a pass grade means that you have successfully demonstrated competency with respect to that LO.

The following are some guidelines for success towards passing each of the learning outcomes.

1. When preparing for the learning-outcome problem, carefully read its official description in the syllabus so that you know what is expected for a passing mark.
2. Each LO has a set of core exercises (with solutions) to help you prepare. These exercises are located at the end of the lecture that introduces the LO.
3. During exams and quizzes you are allowed to bring pens/pencils, eraser, and a non-programmable scientfic calculator **All other computing devices (cell phones, laptops, smart watches, etc.), notes, and books must be put away before starting. Failure to abide by these rules is grounds for receiving a final course grade of F without the possibility of having the grade forgiven**.
4. To help prevent cheating during in-class assessments, when possible, please select a seat that leaves one or more empty seats between you and your nearest neighbor. **When there is sufficient evidence of exam or quiz plagiarism, all involved students are subject to receiving a final course grade of F without the possibility of having the grade forgiven**.

5. Carefullly read the directions for each problem and include all the pertinent steps of your solution.

6. Solve each LO assessment problem on a **SINGLE and SEPARATE** sheet of paper that includes your first name and surname (the one that determines your alphabetical order).

7. During exams and quizzes, both a five and two-minute warning will be announced before solutions are to be turned in. Please have the courtesy to turn in your work before the final call. A student who is still working after the final call will receive a warning and any subsequent infractions will result in the student's work not being graded.

8. At the end of the semester each student will receive grade points in accordance with the following table and based on the number of different LO's passed.

Number Passed	**Grade Points**
1-3	0
4	0.5
5	1.0
6	1.25
7	1.5
8	2.0
9	3.0
10	3.5
11	4.0

The following are the LO's for which competency must be demonstrated.

LO1. The ability to read, comprehend, and correctly use set, function, and logic notation and the ability to demonstrate the steps of the `2SAT` algorithm that solves `2SAT` decision problem.

LO2. The ability to provide the definition of what it means to be a mapping reduction f from some problem A to another problem B, demonstrate one of the following reductions for some instance $x \in A$, and verify that the solution to $x \in A$ is the same as the solution to $f(x) \in B$.

(a) `Even` $\leq_m$ `Odd` See Exercise 1 of the Mapping Reducibility lecture for the kind of problem to expect.

(b) `Max Independent Set` $\leq_m$ `Max Clique`

(c) `Set Partition` $\leq_m^p$ `Subset Sum`

(d) `Hamilton Path` $\leq_m^p$ `LPath`

(e) `Subset Sum` $\leq_m^p$ `Set Partition`

(f) `Vertex Cover` $\leq_m^p$ `Half Vertex Cover`

(g) `Clique` $\leq_m^p$ `Half Clique`

LO3. An understanding of the complexity classes `P`, `NP`, and `co-NP`, including the ability to identify the appropriate complexity class for some decision problem, identify an appropriate certificate for an `NP` problem, and show that some `NP` verififer requires a polyrnomial number of steps.

LO4. The ability to demonstrate and/or answer questions about the following polynomial-time mapping reductions that establish the NP-completeness of some decision problem: 3SAT to Clique, 3SAT to Subset Sum, SAT to 3SAT, 3SAT to DHP, DHP to UHP, and Hamilton Cycle to Traveling Salesperson.

LO5. The ability to design and draw the state diagram of a DFA that accepts a given regular language. The ability to provide the computation of the DFA on one or more input words.

LO6. The ability to i) provide the state diagram of an NFA that accepts a given language and only uses a prescribed number of states, ii) provide the δ-transition table for an NFA N that is defined via a state diagram, and iii) convert the table to an equivalent DFA M (i.e. M and N accept the same language).

LO7. Given the description of a regular language, the ability to provide a regular expression that correctly describes the language. An understanding of the basic language operations: including set-theoretic operations (including union, intersection, complement, symmetric difference, and difference) as well as the concatenation and star operations.

LO8. The ability to demonstrate the equivalence between NFA's and regular expressions: convert a regular expression to an NFA that recognizes the language described by the expression, and convert an NFA to a regular expression that describes the language recognized by the NFA.

LO9. Given the description of a context-free language L, the ability to provide a context-free grammar G for which $L = L(G)$. Also, given a context free grammar G and a word $w \in L(G)$, the ability to derive w using the rules of G.

LO10. An understanding of the deterministic Turing machine model of computation, including the ability to design a Turing machine for the purpose of solving some problem, and, given a Turing machine M, the ability to demonstrate a computation with respect to M and some input.

LO11. TBA

Reading Assignments

A reading assignment will be provided on most weeks of the semester. Reading the textbook will offer a somewhat alternative and more comprehensive viewpoint of the subject matter. Please check the "Reading Assignments" link at the course website for the current and past assignments. The reading assignment topics pertain to those topics that will be covered in the class meetings for the following week.

Class Meetings

Our class meetings will be devoted to working through the course lecture notes. These notes have several examples. Some have provided solutions while the solutions to others will be demonstrated in class. The notes also contain all the needed definitions, formulas, theorems, exercises, and exercise solutions. Although class attendance is not mandatory, quite often there will be one or more students whose final course GPA may be on the borderline from earning a higher final course grade, and the decision on whether or not to improve the student's final grade largely depends on regular attendance and a demonstration of consistent improvement throughout the semester. Attending class each day reflects a disciplined approach to the course that hopefully includes a disciplined approach towards doing the necessary work for success.

Weekly Exercises

Associated with each learning outcome presented in lecture will be a set of assigned practice exercises, as well as some additional exercises that pertain to a related peripheral learning outcome or represents a more advanced exercise that may form the basis for an advanced exam problem.

Homework

Homework will be occasionally assigned and consist of one or two problems that expand on course topics that were covered during a previous week. These problems are meant to either highlight interesting applications or represent a more advanced problem that requires more time to complete than a typical exercise.

The following are some rules and guidelines for solving the HW problems and submitting their solutions.

1. Problems will be made available at least one week before they are due.
2. Solutions should be submitted by uploading a single PDF file to the appropriate Canvas drop box.
3. Please make sure to write your full name at the top of each page.
4. Solutions should be presented in the same order that they appear on the problem sheet.
5. **All solutions should be handwritten (including the use of an electronic writing tablet) Typed solutions will not be graded** unless the assignment directions provide an exception.

6. Homework plagiarism shall not be tolerated. When plagiarism is first detected, the students involved will receive a warning. Detecting plagiarism a second time will result in a final homework grade of F. It is OK for students to collaborate on homework, but it's not OK for students to copy one another or copy from a source on the web. Each student has the responsibility to present each solution in a unique way that is consistent with writing style and degree of understanding.

Quizzes

There will be five quizzes given during the semester. The purpose of each quiz is to provide students with the opportunity to demonstrate competency in one or more of the core learning outcomes. Therefore, each quiz problem is graded as pass/no pass.

Featured Problems. Headlining each quiz (except for Quiz 5) are two **featured problems**, each pertaining to one of the course LO's. Although students are expected to solve these problems, there is no penalty for not doing so.

Makeup Problems. In addition to the two featured problems, there will also be LO make up problems. Each student may solve one of these problems (or one half of each of two different problems). When making up two halves of different LO problems, please include both on the same solution sheet.

Extra Credit. When a learning outcome is being assessed for the first time, and the assessment occurs on a quiz, then a student who *completely* passes the assessment shall be awarded extra credit in the form of 0.1 grade points (per passed LO) that are added to the student's end-of-semester final course GPA. For example, LO1 will be assessed for the first time on Quiz 1. Any student who completely passes this assessment will receive 0.1 extra credit. The same is true for LO's 2, 5, 6, 9, and 10 for a total of up to 0.6 in GPA boosting.

Quiz Dates and Featured LO's

Quiz 1 LO's 1 and 2, February 5th

Quiz 2 LO's 5 and 6, March 12th

Quiz 3 LO's 7 and 8, April 9th

Quiz 4 LO's 9 and 10, April 23rd

Quiz 5 LO's 1-10 (Choose three to solve or choose two plus two halves), May 7th

Exams

There will be two midterm exams and a final exam. Each exam will have six equally-weighted problems: four core learning-outcome assessment problems, and two additional problems. The additional problems are drawn from one of the following.

1. definitions, concepts, and resullts that support one of the core learning outcomes
2. a problem similar to one of the additional problems appearing at the end of one of the lectures
3. a problem similar to a learning outcome assessment problem but more advanced

Each exam is weighted as 20% of a student's final grade.

WARNING: passing a learning outcome on a previous quiz does **NOT** mean automatic awarded points for that LO on the exam. Students should solve **ALL** problems in order to earn a high grade on the exam. The benefits of having already passed a learning outcome that appears for points on an exam may include i) increased confidence and better preparation for solving the problem, and ii) less stress because, no matter what the outcome, at least the LO is passed (once an LO is passed, it stays passed).

Exam Dates

Exam 1 February 19th

Exam 2 March 26th

Final Exam Thursday, May 14th, 8:00-10:00 am

Exam and Quiz Makeups

Exam and Quiz Makeups will only be permitted in case of a documented accident, emergency, or illness. Acceptable documentation includes a note or letter from a medical establishment, a police report, and insurance documentation. Documentation must be provided before approving a makeup assessment.

Final Grade Determination

At the end of the semester, grades will be assigned based on the six categories shown in the table below.

Categories	Percentage Weight
Learning Outcomes	30%
Exam 1	20%
Exam 2	20%
Final	20%
Homework	10%

The grade points earned for each category are weighted according to the percentage weight to obtain the final course grade point average

$$\text{GPA} = 0.3 \times \text{LO} + 0.2 \times E_1 + 0.2 \times E_2 + 0.2 \times F + 0.1 \times \text{HW} + \text{ Extra Credit}$$

which is rounded to the nearest tenth. The grade point average is then converted to a letter grade: A (3.5 and above), B (2.5 to 3.4), C (1.75 to 2.4), D (0.5 to 1.74), and F (0-0.5).

Registration Deadlines

February 2nd Last day to add or drop classes without approval

February 9th Deadline to add a course

April 17th Withdrawal deadline