

## CE 160: Automata and Formal Languages (3 units)

Additional information on this course shall be made available at

[http://www.geocities.com/lui\\_agustin/ce160](http://www.geocities.com/lui_agustin/ce160)

as the semester progresses. Students are expected to regularly check this site for updates.

CE 160 A: TTh, 0730-0900, F-310

CE 160 B: TTh, 0900-1030, F-310

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[http://www.geocities.com/lui\\_agustin](http://www.geocities.com/lui_agustin)

consultation hours: by appointment, F312/F311

### 1. Course description

This course is an introduction to automata and formal language theory. Topics include finite automata, regular expressions and grammars, push-down automata, context-free grammars, and context-sensitive grammars.

Prerequisite: CE 21

### 2. Course Objectives

In this course students must be able to

- \* design Deterministic Finite Automata
- \* prove claims regarding properties of Deterministic Finite Automata
- \* write Regular Expressions
- \* describe languages represented by Regular Expressions
- \* design Context Free Grammars
- \* prove claims regarding Context Free Grammars
- \* draw Parse Trees
- \* prove claims regarding Parse Trees
- \* design Pushdown Automata
- \* design Turing Machines
- \* design Nondeterministic Finite Automata
- \* convert Nondeterministic Finite Automata to equivalent Deterministic Finite Automata
- \* design Nondeterministic Finite Automata with Epsilon Transitions
- \* convert Nondeterministic Finite Automata with Epsilon Transitions to equivalent Deterministic Finite Automata
- \* convert between Regular Expressions and Finite Automata
- \* manipulate Regular Expressions algebraically
- \* minimize Deterministic Finite Automata
- \* prove claims regarding the ambiguity of some grammars
- \* convert between Pushdown Automata accepting by final state and empty stack
- \* convert between Pushdown Automata and Context Free Grammars
- \* design Deterministic Pushdown Automata
- \* convert Context-Free Grammars into Chomsky Normal Form
- \* pursue a project in Automata Theory or its applications

### 3. Textbook

John Hopcroft, Rajeev Motwani, and Jeffrey Ullman, *Introduction to Automata Theory, Languages and Computation*, 2nd ed, 2001.

#### 4. Course Outline and Timeframe

##### Course Outline:

##### Survey of Automata Theory

- Central Concepts of Automata Theory (sec 1.5)
- Deterministic Finite Automata (secs 2.1, 2.2)
- Regular Expressions (sec 3.1)
- Context-Free Grammars and Parse Trees (secs 5.1, 5.2)
- Pushdown Automata (sec 6.1, 6.2)
- Turing Machines (secs 8.1, 8.2)

[1st exam]

##### Finite Automata and Related Concepts

- Nondeterministic Finite Automata (sec 2.3)
- Finite Automata With Epsilon Transitions (sec 2.5)
- Finite Automata and Regular Expressions (sec 3.2)
- Algebraic Laws for Regular Expressions (sec 3.4)
- Equivalence and Minimization of Automata (sec 4.4)

[2nd exam]

##### Pushdown Automata and Related Concepts

- Ambiguity in Grammars and Languages (sec 5.4)
- The Languages of a PDA (sec 6.2)
- Equivalence of PDAs and CFGs (sec 6.3)
- Deterministic Pushdown Automata (sec 6.4)
- Normal Forms for CFG's (sec 7.1)

[3rd exam]

CE 160 Timetable, 1st Semester, 2004-2005

Week		Tuesday	Thursday
1	June	15 Introduction	17 Deterministic Finite Automata (sec 2.1, 2.2) homework: Problem Set 1.1
2		22 Deterministic Finite Automata (sec 2.1, 2.2) homework: Problem Set 1.2	24 Regular Expressions (sec 3.1) homework: Problem Set 1.3
3		29 Context-Free Grammars and Parse Trees (sec 5.1, 5.2) homework: Problem Set 1.4	
3	July		1 Context-Free Grammars and Parse Trees (sec 5.1, 5.2) homework: Problem Set 1.5
4		6 Pushdown Automata (sec 6.1, 6.2) homework: Problem Set 1.6	8 Turing Machines (sec 8.1, 8.2) homework: Problem Set 1.7
5		13 Turing Machines (sec 8.1, 8.2) homework: Problem Set 1.8	15 First Exam
6		20 discussion of possible projects	22 discussion of possible projects
7		27 Nondeterministic Finite Automata (sec 2.3) homework: Problem Set 1.9 11 am: draft project proposals due	29 CE 160 Holiday
8	Aug	3 consultations on project proposals	5 consultations on project proposals
9		10 Finite Automata with Epsilon Transitions (sec 2.5) homework: Problem Set 1.10 11 am: approved project proposals due	12 Finite Automata and Regular Expressions (sec 3.2) homework: Problem Set 1.11
10		17 Algebraic Laws for Regular Expressions (sec 3.4) homework: Problem Set 1.12	19 CE 160 Holiday
11		24 Presentations of Project Proposals and Progress 11 am: progress report 1 due 11 am: progress report 2 due	26 Equivalence and Minimization of Automata (sec 4.4) homework: Problem Set 1.13
12		31 Presentations of Project Proposals and Progress 11 am: progress report 3 due	
12	Sept		2 Second Exam
13		7 Presentations of Project Proposals and Progress 11 am: progress report 4 due	9 Ambiguity in Grammars and Languages (sec 5.4) homework: Problem Set 1.14
14		14 Presentations of Project Proposals and Progress 11 am: progress report 5 due	16 The Languages of a PDA (sec 6.2) homework: Problem Set 1.15
15		21 Prefinal Project Evaluation	23 Prefinal Project Evaluation
16		28 Equivalence of PDA's and CFG's (sec 6.3) homework: Problem Set 1.16	30 Deterministic Pushdown Automata (sec 6.4) homework: Problem Set 1.17
17	Oct	5 Normal Forms for CFG's (sec 7.1) homework: Problem Set 1.18	7 Third Exam
18		Finals Week: Oct 11-16 4 pm, Oct 11: deadline for all projects and documentation; Oct 12 - 16: Final Project Evaluation	

Adjustments to the timetable will be made as needed.

Homework indicated for a given class day are homework that should have been done by class time on that day. The problem sets may be downloaded from the course website at [http://www.geocities.com/lu\\_agustin/ce160](http://www.geocities.com/lu_agustin/ce160).

## 5. Course Requirements

There will be three exams, regular homework, and one course project. The ability to present homework in class is a requirement for one to receive credit for homework done. Detailed policies are in sec. 7.

### 5.1. Exams

Three exams will be given, as indicated in the course outline and timetable. The coverage of an exam will mainly be material that has been covered before the exam, but which has not been covered by a previous exam. However, it is understood that skills needed in an earlier exam may again be required in a succeeding exam.

All exams shall be “open notes, open books” exams.

Each exam shall consist of five items, with each item graded over 10 points regardless of its difficulty. The exam grade shall be twice the number of points earned.

There is no comprehensive final exam. Exemptions are available for each exam.

### 5.2. Homework and Recitation

Homework for each class day is specified in the timetable. Each exercise assigned as homework is worth 2 points regardless of the difficulty.

Recitation is incorporated into homework as a requirement. One may claim credit for homework only if he is fully capable of presenting and discussing the said homework in class. Credit for homework is claimed thru homework accomplishment reports as will be described later.

Bonus points may be earned in relation to homework that has been done correctly. Demerits will be given for inaccurate claims regarding homework.

### 5.3. CE 160 Project

Possible projects and detailed project policies shall be made available at the course website.

The 100 points of the project grade are distributed as follows:

- \* 10 pts for the formulation of a project proposal
- \* 10 pts for 5 progress reports (2 pts per progress report)
- \* 10 pts for the oral presentation of the project proposal and progress made so far
- \* 10 pts for the prefinal project evaluation
- \* 60 pts for the final project defense and project documentation

## 6. Grading System

The basic class standing (BCS) is computed as

$$BCS = 0.10 H + 0.45 E + 0.45 P$$

where

H is the homework and recitation grade computed as

$$H = 100 * (\text{points earned}) / (\text{points possible}).$$

E is the average exam grade, and

P is the project grade.

The class standing (CS) is computed as

$$CS = BCS + B - D,$$

where

B is the number of bonus points earned (details later), and  
D is the number of accumulated demerits (details later).

The final grade (FG) will be determined from the class standing (CS) as follows:

FG =	F	if $CS < 50$ ,
	D	if $50 \leq CS < 60$ ,
	C	if $60 \leq CS < 69$ ,
	C+	if $69 \leq CS < 77$ ,
	B	if $77 \leq CS < 86$ ,
	B+	if $86 \leq CS < 92$ ,
	A	if $92 \leq CS$ .

Your instructor has the prerogative of giving a higher grade than that determined from the class standing.

Bonus points are points added directly to your class standing. These points are given in relation to exercises assigned as homework. Detailed policies are in sec. 7.

Demerits are points deducted from your class standing for offenses against the conduct of the course. These offenses include, but are not limited to:

- \* claiming undue credit for homework
- \* failure to discuss homework for which credit has been claimed
- \* disrupting class discussion
- \* doing work unrelated to CE 160 during class time
- \* use of cellphones during class time, cellphones ringing during class time
- \* arriving late for an exam and/or disturbing others during an exam
- \* refusal to participate in class activities
- \* insisting on staying in the classroom despite being late

One demerit is given for the first time an offense is committed. Successive offenses of the same nature shall be awarded two demerits, three demerits, and so on.

## **7. Class Policies**

### **7.1. Exams**

All exams must be accomplished using blue or black ink. Only the front of each sheet of paper should be used. No credit shall be given for anything written at the back nor for anything not written in ink.

Only the following paper may be used in exams:

- \* white intermediate pad paper
- \* white short bond paper
- \* white long bond paper
- \* yellow pad paper.

Students taking exams are required to bring 20 sheets of paper, and two pens. Students who do not have these should not proceed with the exam.

All exams, except for make-up exams, shall be "open books, open notes" exams. Students may and should bring calculators to exams. Students who do not bring calculators to exams forfeit the right to use them. Students may not pass notes, books and/or calculators among themselves during exams. Students who do so shall be asked to submit their papers immediately.

Make up exams shall be taken with closed books and notes, regardless of the nature of the regular exam. Exemptions to this rule are possible only in extreme circumstances, and subject to the discretion of your instructor.

Answers to exam questions must be arranged in sequence and exam papers stapled together on the upper left hand side when they are submitted. 20 points shall be deducted from the exam grade if answers are not arranged in sequence. 20 points shall be deducted from the exam grade if the exam papers submitted are not stapled together on the upper left hand side. The exam grade shall be 0 if these deductions result in a negative score.

Each exam will have the same weight in the final grade. No exam will be canceled in computing the final grade.

Corrections to exam scores will only be entertained up to one week after exam papers have been returned in class, regardless of whether one was in class or not. Exam papers will typically be returned on the class day following the exam.

## **7.2. Exemptions from Exams**

A student shall be exempted from the first exam and given a grade of 100 for the exam if the student meets ALL of the following conditions on the day of the exam:

- \* must have no cuts
- \* must have no demerits for any offense whatsoever
- \* must have a homework standing of at least 80
- \* must have earned at least 5 bonus points

A student shall be exempted from the second exam and given a grade of 100 for the exam if the student meets ALL of the following conditions on the day of the exam:

- \* must have no cuts
- \* must have no demerits for any offense whatsoever
- \* must have a homework standing of at least 80
- \* must have earned at least 8 bonus points, with at least 5 bonus points earned after the first exam
- \* must have a grade of at least 60 for the first exam

A student shall be exempted from the third exam and given a grade of 100 for the exam if the student meets ALL of the following conditions on the day of the exam:

- \* must have at most 1 cut
- \* must have no demerits for any offense whatsoever
- \* must have a homework standing of at least 80
- \* must have earned at least 11 bonus points, with at least 5 bonus points earned after the second exam
- \* must have an average grade of at least 60 for the past exams

### 7.3. Homework

The fundamental rule in claiming credit for homework should be:

**CLAIM CREDIT ONLY FOR WORK YOU HAVE REALLY DONE.**

The homework accomplishment report form in sec. 9 of this syllabus shall be used for claiming credit for homework assigned. Printed, photocopied, and handwritten versions of the form are all acceptable. The paper used shall be one whole sheet of any of the following:

- \* white intermediate pad paper
- \* white short bond paper
- \* white long bond paper
- \* yellow pad paper.

Only blue or black ink may be used.

Homework accomplishment reports are due when they are called for in class. The usual practice shall be for reports to be collected soon after class has started. Students are expected to have their homework accomplishment reports ready and filled out before class starts. Only those physically present in class may submit homework accomplishment reports. Late reports will not be accepted. Those who choose to submit handwritten homework accomplishment reports must have finished writing them by the time class starts.

Students claiming credit for any assigned exercise must be able to produce on demand their answers to the exercise, including any and all scratch paper used in working on that exercise.

A student may claim full credit for an assigned exercise if he has completed the exercise and would be able to present all details of his work in class if called upon to do so. It is the student's responsibility to ensure that all instructions for a given exercise have been complied with.

A student may claim half credit for an assigned exercise if he has not completed the exercise, but has done a significant amount of work on the exercise, and would be able to present all details of his work in class if called upon to do so, as well as justify his claim that a significant amount of work has been done. Typically, a claim for half credit for an exercise is valid if a student can present much of the work called for, and could actually discuss what work remains to be done for the exercise to be completed or if a student can discuss in detail various nontrivial attempts to do the exercise, and can defend his claim that these attempts were nontrivial.

Merely starting an exercise or merely deciding that an exercise is too difficult does NOT entitle anyone to claim half credit for the exercise.

Full or half credit claimed for homework is NOT valid under circumstances similar to the following, among others:

- \* a student can only present photocopies of accomplished homework for which credit is claimed (except for those who have submitted printed answers for possible bonus points)
- \* a student can only present copies --whether photocopied or hand copied-- of someone else's homework but claims credit for it
- \* a student is unable to discuss in class what he claims to be his homework
- \* a student has been copying homework from someone else a few minutes before class, and then claims credit for it

Students called to discuss their work, must be able to justify all details of homework they claim credit for. Inability to do so shall be penalized with a zero for homework, along with demerits.

A homework accomplishment report that has the wrong date, claims credit for the wrong exercises, lacks a signature, or has any error of a similar nature to these, shall be considered defective. Students who submit defective reports on a given day get a zero for homework for that day.

The penalty for claiming undue credit in a homework accomplishment report on a given day shall be a 0 for all exercises assigned for that day, demerits, forfeiture of any and all bonus points already earned, and disqualification from earning any more bonus points.

The accuracy of homework accomplishment reports may be verified more thoroughly for some students, possibly taking into account such factors as their number of cuts, previous demerits, suspicious behavior, complaints from other students, large differences between homework grades and exam grades, and others.

#### **7.4. Bonus Points**

Bonus points are points added directly to the class standing.

Each item in the problem sets assigned as homework is also considered a bonus problem. Individual students who submit correct answers to these exercises may earn bonus points, provided certain conditions are met.

Students who submit answers to bonus problems should expect them to be checked very strictly.

Students must submit answers individually. Each student may submit at most one answer for each item. A student who submits more than one answer to a given bonus problem is disqualified from earning a bonus point for that problem.

Answers to bonus problems must have been submitted by 11 a.m. of the school day prior to the day for which the exercise was assigned; Saturdays, Sundays, and holidays shall not count as school days. Answers must have been typeset electronically or digitally and printed --NOT HANDWRITTEN-- on short white bond paper, and must not have any part handwritten, nor have any erasures. Handwritten answers are not acceptable. Where appropriate, answers must include graphs, figures and diagrams produced by software. Each exercise in the problem sets is a separate bonus problem. (There is no need to have answers to all exercises in a given problem set.) Each exercise must be started on a new sheet of paper. If several sheets of paper are required, these must all be stapled together. The student's name must appear clearly on the upper left hand side of the first sheet. The exercise being answered must be clearly identified. Submitted answers that do not meet all these conditions will not be evaluated.

Only students with at most one cut may earn bonus points. Students with more than two cuts forfeit any and all bonus points already earned. Students with exactly 2 cuts get to keep any bonus points already earned, but may not earn additional bonus points.

No information will be given as to whether answers have already been submitted for a given exercise. Submitted answers are evaluated only after the corresponding classes for which they have been assigned. No feedback regarding their correctness should be expected before the day for which they were assigned.



Answers that have been submitted for a given exercise shall be evaluated in the order they were submitted. Bonus points will be awarded for the first answer, if any, that meets ALL of the following conditions:

- \* the answer must be correct, and must have no noticeable errors of whatever nature (whether logical, grammatical, typographical, etc.); solutions and computations must be sufficiently detailed
- \* the answer must be nicely typeset, nicely presented, and appropriately explained
- \* the one who submitted the answer must have no cut on the day the exercise was assigned for
- \* the one who submitted the answer must have had at most one cut on the day the exercise was assigned for
- \* the one who submitted the answer must have claimed full credit for it in the corresponding homework accomplishment report

One bonus point will be given for each answer that qualifies.

### **7.5. Attendance**

The usual practice shall be for attendance to be checked soon after homework accomplishment reports have been collected. Students who arrive in class while attendance is being checked shall be considered present, but shall not be allowed to submit homework accomplishment reports.

Attendance may be checked at any time during class, any number of times. Absence from class at any time attendance is checked shall be considered a cut. No definite grace period is required before attendance is checked.

Students who arrive after attendance has been checked shall be barred from class. Those who insist on staying shall be given demerits.

Students who have exceeded the allowed number of cuts shall be given a grade of W, and shall be barred from class for the rest of the semester.

### **8. CE 160 Discussion Group**

A discussion group for CE 160 will be organized if there is sufficient interest among students. The discussion group shall serve as a forum for discussing various matters related to the course. Students might conduct review sessions, organize study groups, present advanced material of interest to the group, present details regarding their projects, or present interesting software and other material that may be useful in the course. Other ideas are welcome.

Participation in the discussion group shall not be a requirement of the course. However, those who contribute significantly to the discussion group may be given higher grades than those determined from the class standing.

### **9. Homework Accomplishment Report Form**

See next page.

## Homework Accomplishment Report

date: \_\_\_\_\_

I, \_\_\_\_\_, hereby claim full credit for the following exercises  
(printed name)

assigned as homework for today:

Furthermore, I claim half credit for the following exercises assigned as homework for today:

I hereby affirm that I make all these claims in accordance with the policies set forth in the course syllabus for CE 160 for this first semester of school year 2004-2005.

\_\_\_\_\_  
(signature over printed name)