

Home & Contact

Curriculum Vitae

Research

Computer arithmetic

Parallel processing

Fault tolerance

Broader research

Research history

List of publications

Teaching

ECE1 Freshman sem

ECE154 Comp arch

ECE252B Comp arith

ECE252C Adv dig des

ECE254B Par proc

ECE257A Fault toler

Student supervision

Math + Fun!

Textbooks

Computer arithmetic

Parallel processing

Dependable comp

Comp architecture

Other books

Service

Professional activities

Academic service

Community service

Industrial consulting

Files & Documents

Useful Links

Personal

Behrooz Parhami's ECE 1 Course Page for Spring 2012

Ten Puzzling Problems in Computer Engineering

Enrollment code: 11270

Prerequisite: Open to (pre-)computer engineering students only

Class meetings: M 2:00-3:15, Webb Hall 1100

Instructor: Professor Behrooz Parhami

Open office hours: MW 3:30-5:00, HFH 5155

Course announcements: Listed in reverse chronological order

Grading scheme: Pass/Fail grade is assigned based on attendance

Course calendar: Schedule of lectures and links to lecture slides

The ten lectures: Lecture summaries and references

Additional lecture topics: May replace some current topics in future

Attendance record: Please check regularly for possible errors

Miscellaneous information: Motivation, catalog entry, history

Note: The design and goals of this innovative freshman seminar are described in a brief article, a short paper, and a full paper, as follows:

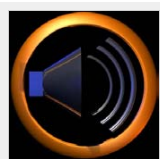
- *IEEE Computer*, Vol. 42, No. 3, Mar. 2009 ([PDF file](#))

- *IEEE Trans. Education*, Vol. 52, No. 3, Aug. 2009 ([PDF file](#))

- *Computer Science Education*, Vol. 18, No. 4, Dec. 2008 ([PDF file](#))



Course Announcements



2012/06/13: This class is officially over and all grades have been reported to the Registrar. Hope you enjoyed the previews of challenging computer engineering problems provided by this seminar in the context of fun puzzles. Have a pleasant summer!

2012/06/04: Attendance record was updated after lecture 10 today (there was no lecture 9 last week due to the Memorial Day holiday). Please check the attendance record near the end of this page and follow the instructions given there and under the next item below.

2012/05/21: Attendance record was updated after lecture 8 today. There will be no lecture on Monday 5/28 (Memorial Day observance). Make sure you send me your explanation for a single absence, or your availability on R-F June 7-8 for a 15-minute final oral exam in the case of 2-3 absences, immediately after Lecture 10 on M 6/4. In the case of final oral exam, please indicate your availability on both days, from 8:00 AM to 8:00 PM; otherwise, I may not be able to accommodate you.

2012/05/14: Attendance record was updated after lecture 7 today.

2012/05/07: Attendance record was updated after lecture 6 today.

2012/04/30: Attendance record was updated after lecture 5 today.

2012/04/23: Attendance record was updated after lecture 4 today.

2012/04/16: Attendance record was updated after lecture 3 today.

2012/04/09: Attendance record was updated after lecture 2 today.

2012/03/09: Welcome to the ECE 1 Web page for spring 2012. Please read the grading scheme below very carefully to ensure that you can earn a "pass" at the end of the quarter. ECE 1 requires no textbook and has no homework assignments or exams. A handout containing a worksheet is given out at the beginning of each lecture and complete lecture slides are made available on-line.

Grading Scheme

Pass/Fail grading is based on attendance and class participation. There will be no homework or exam.

0 absence: Automatic "Pass."

1 absence: "Pass" if you submit a written statement to explain the absence.

2 absences: "Pass" if you submit a written explanation and had prior instructor approval for your 2nd absence;

[Blog & books](#)[Favorite quotations](#)[Poetry](#)[Pet peeve](#)[Virtual retirement](#)[CE Program](#)[ECE Department](#)[UCSB Engineering](#)[UC Santa Barbara](#)

strong participation in class or via e-mail will work in lieu of prior approval. Otherwise, taking an oral final exam covering the two missed lectures is required.

3 absences: Can earn a "Pass" grade by taking an oral final exam covering the three missed lectures.

4 or more absences: Automatic "Fail."

Attendance will be taken as follows. Attendance slips are distributed at the beginning of each class session, with additional slips supplied to those arriving up to 10 minutes late. Students write their names and perm numbers on the slips and turn them in before leaving the classroom at the end of the lecture.

Course Calendar



Course lectures have been scheduled as follows. PowerPoint presentations (up to 2+ MB), and equivalent PDF files, are updated periodically. Note that any animation in PowerPoint presentations is lost in the PDF versions. When a particular presentation or handout file has been updated for spring 2012, you will see a 2012 date in front of it; otherwise, it is from a previous offering of the course and may have slight differences with this year's version.

Day & Date (Lecture slides, ppt + pdf, and ppt handout) Lecture topic [Lead puzzle]

M 04/02 ([ppt](#), [pdf](#), [handout](#), last updated 2012/03/27) Easy, Hard, Impossible! [Collatz's conjecture]

M 04/09 ([ppt](#), [pdf](#), [handout](#), last updated 2012/03/27) Placement and routing [Houses and utilities]

M 04/16 ([ppt](#), [pdf](#), [handout](#), last updated 2012/03/28) Satisfiability [Making change]

M 04/23 ([ppt](#), [pdf](#), [handout](#), last updated 2012/04/20) Cryptography [Secret messages]

M 04/30 ([ppt](#), [pdf](#), [handout](#), last updated 2012/04/20) Byzantine generals [Liars and truth-tellers]

M 05/07 ([ppt](#), [pdf](#), [handout](#), last updated 2012/05/03) Binary search [Counterfeit coin]

M 05/14 ([ppt](#), [pdf](#), [handout](#), last updated 2012/05/03) Task scheduling [Sudoku]

M 05/21 ([ppt](#), [pdf](#), [handout](#), last updated 2012/05/17) String matching [Word search]

M 05/28 ([ppt](#), [pdf](#), [handout](#), last updated 2012/05/17) Sorting networks [Rearranging trains]

* No lecture on M 05/28 due to the Memorial Day observance. There will be no make-up lecture or substitute assignment for this topic.

M 06/04 ([ppt](#), [pdf](#), [handout](#), last updated 2012/05/17) Malfunction diagnosis [Logical reasoning]

Summary and References for the Ten Lectures

A one-page summary for each of the ten lectures is included in the following paper; additional print and on-line references are given below.

Parhami, B., "A Puzzle-Based Seminar for Computer Engineering Freshmen," *Computer Science Education*, Vol. 18, No. 4, pp. 1-17, Dec. 2008. ([PDF file](#))

Lecture 1: Easy, Hard, Impossible

[Some applications of the Fibonacci series \(thinkquest.org\)](#)

[Another application of Fibonacci numbers in nature: family trees for bees \(BP's Math + Fun page, MS Word doc file\)](#)

[Wikipedia article on Collatz's conjecture](#)

[Feinstein, C. A., "The Collatz \$3n + 1\$ Conjecture is Unprovable," 2006](#)

Lecture 2: Placement and Routing

[Houses-and-utilities puzzle](#)

[Nineteen Proofs of Euler's Formula: \$V - E + F = 2\$](#)

Lecture 3: Satisfiability

[Making \\$5 Using 50 Coins](#)

[Roussel, O., "The SAT Game"](#)

Lecture 4: Cryptography

[Gutmann, P., "Cryptography and Security Tutorial"](#)

[Sale, T., "The Enigma Cipher Machine"](#)

Lecture 5: Byzantine Generals

[Saka, P., *How to Think About Meaning*, Springer, 2007](#)

[Montalban, A., and Y. Interian, "Liars and Truth-Teller Puzzles"](#)



Lecture 6: Binary Search

Du, D.-Z., and F.K. Hwang, *Combinatorial Group Testing and Its Applications*, 2nd ed., World Scientific, 2000 (See Chapter 16, pp. 295-318)

[Programs for solving counterfeit-coin problems](#)

Lecture 7: Task Scheduling

Aaronson, L., "Sudoku Science: A Popular Puzzle Helps Researchers Dig into Deep Math," *IEEE Spectrum*, Vol. 43, No. 2, pp. 16-17, February 2006

[Online Sudoku and other interesting logic puzzles](#)

Lecture 8: String Matching

[Website with free online tools for creating word-search and other puzzles](#)

Lecture 9: Sorting Networks

[Hayes, B., "Trains of Thought: Computing with Locomotives and Box Cars Takes a One-Track Mind," *American Scientist*, Vol. 95, No. 2, pp. 108-113, March-April 2007](#)

Parhami, B., *Introduction to Parallel Processing: Algorithms and Architectures*, Plenum Press, 1999 (See Chapter 7, pp. 129-147, for an introduction to sorting networks)

Lecture 10: Malfunction Diagnosis

[Logic problems](#)

Somani, A.K., V.K. Agarwal, and D. Avis, "A Generalized Theory for System Level Diagnosis," *IEEE Trans. Computers*, Vol. 36, No. 5, pp. 538-546, May 1987

Additional Lecture Topics for Possible Future Use

The following additional topics are being considered for inclusion as future lecture topics:

Topic A: Computational Geometry

Puzzles based on visual tricks and optical illusions

[Eppstein, D., "The Geometry Junkyard," website devoted to discrete and computational geometry](#)

Topic B: Loss of Precision

Puzzles based on logical paradoxes and absurdities

Parhami, B., *Computer Arithmetic: Algorithms and Hardware Designs*, Oxford University Press, 2000 (See Problems 1.1-1.3)

Topic C: Secret Sharing

Puzzles based on anonymous complainers and whistle blowers

Shamir, A., "How to Share a Secret," *Communications of the ACM*, Vol. 22, No. 11, pp. 612-613, 1979

[Wikipedia article on secret sharing](#)

Topic D: Amdahl's Law

Puzzles on river and bridge crossings

Parhami, B., *Computer Architecture: From Microprocessors to Supercomputers*, Oxford University Press, 2005 (See Section 4.3)

[Wikipedia article on Amdahl's law](#)

Topic E: Predicting the Future

Puzzles based on determining the next term in a series

Sloane, N.J.A., "Find the Next Term," *J. Recreational Mathematics*, Vol. 7, No. 2, p. 146, Spring 1974

[Sloane, N.J.A., *Online Encyclopedia of Integer Sequences*](#)

Topic F: Circuit Value Problem

Puzzles based on parallelization of hopelessly sequential problems

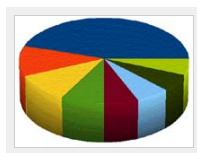
Greenlaw, R., H.J. Hoover, and W.L. Ruzzo, *Limits to Parallel Computation: P-Completeness Theory*, Oxford University Press, 1995 (See Section 4.2, pp. 75-76)

Topic G: Maps and Graphs

Puzzles based on map/graph coloring and graph properties

Feeman, T.G., *Portraits of the Earth: A Mathematician Looks at Maps*, American Mathematical Society, 2002

Student Attendance Record



In the following table, absence is marked with a "1" and presence with a "0". The first ten columns correspond to Lectures 1-10, the next column, Σ , is the total number of absences, and "Mrep" is the first few digits of the reversed Perm Number. For example, a student with the Perm Number 9876543 will have a Mrep code of 3, 34, 345, 3456, ... , depending on whether other students have Perm Numbers with the same ending.

Attendance record at the end of the quarter

<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>0</u>	<u>Σ</u>	<u>Mrep</u>
0	0	0	0	0	0	0	0	0	1	1	01 Pass
0	0	0	0	0	0	0	0	0	1	1	05 Pass
0	0	0	0	0	0	0	0	0	0	0	07 Pass
0	0	0	0	0	0	0	0	0	1	1	09 Pass
0	0	0	0	0	0	0	0	0	0	0	10 Pass
0	0	0	1	0	0	0	0	0	0	1	11 Pass
0	0	0	1	0	1	0	0	0	0	2	13 Pass, via oral exam taken on F 6/8, 2:30 PM
0	0	0	0	0	0	0	0	0	0	0	14 Pass
0	0	0	0	0	0	0	0	0	0	0	16 Pass
0	0	0	0	0	1	0	0	0	0	1	23 Pass
0	0	0	0	0	0	0	0	0	0	0	252 Pass
1	1	0	0	0	0	0	0	0	0	2	259 Pass, via oral exam taken on F 6/8, 3:15 PM
0	0	0	0	0	0	0	0	0	0	0	26 Pass
0	0	0	0	0	0	0	0	0	0	0	28 Pass
0	0	0	0	0	0	0	0	0	1	1	312 Pass
0	0	0	0	0	0	0	0	0	0	0	316 Pass
0	0	0	0	0	0	0	0	0	1	1	324 Pass
0	0	0	0	0	0	0	0	0	1	1	326 Pass
0	0	0	0	0	0	0	0	0	1	1	327 Pass
0	0	0	0	0	0	1	0	0	0	1	36 Pass
0	0	0	0	0	0	0	0	0	0	0	382 Pass
0	0	0	0	0	0	0	0	0	1	1	389 Pass
0	0	0	0	0	0	0	0	0	0	0	39 Pass
0	0	0	0	0	1	0	0	0	0	1	40 Pass
0	0	0	0	0	0	1	0	0	0	1	41 Pass
1	1	1	0	0	0	1	0	1	0	5	421 NP, due to excessive absences
0	0	0	0	0	0	0	0	0	0	0	426 Pass
0	0	0	0	0	0	0	0	0	0	0	44 Pass
0	0	1	0	0	0	0	0	0	0	1	47 Pass
0	0	0	0	1	0	0	0	1	2	50	50 Pass, via oral exam taken on R 6/7, 11:15 AM
0	0	0	0	0	0	0	0	0	0	0	51 Pass
0	0	0	0	0	0	0	0	0	0	0	5236 Pass
0	0	0	0	0	0	0	0	0	1	1	5239 Pass
0	0	0	0	0	0	0	0	0	0	0	525 Pass
0	0	0	0	0	0	0	0	0	1	1	542 Pass
0	0	0	0	0	0	0	0	0	0	0	5442 Pass
0	0	0	0	1	0	0	0	0	0	1	5445 Pass
0	0	0	0	0	0	0	0	0	0	0	545 Pass
0	0	0	0	0	0	1	0	1	2	59	59 NP, due to not scheduling a final oral exam
0	0	0	0	0	0	0	0	0	0	0	604 Pass
0	0	0	0	1	1	0	0	0	2	606	606 Pass, via oral exam taken on R 6/7, 8:30 AM
0	0	0	0	0	0	0	0	0	0	0	608 Pass
0	0	0	0	0	0	0	0	0	1	1	62 Pass
1	0	0	0	0	0	0	0	0	0	1	64 Pass
0	0	0	1	0	0	0	0	0	0	0	70 Pass

0 0 0 0 0 1 0 0 0 0 1 710 Pass
 0 0 0 0 0 0 0 0 0 1 1 717 Pass
 0 0 0 0 0 0 0 0 0 0 0 719 Pass
 0 0 0 0 0 0 0 0 0 0 0 74 Pass
 0 0 0 0 0 0 0 0 0 1 1 75 Pass
 0 0 0 0 0 0 0 0 0 0 0 76 Pass
 0 0 0 0 0 0 0 0 0 0 0 80 Pass
 0 0 0 0 0 0 1 0 0 0 1 84 Pass
 0 0 0 0 0 0 0 0 0 0 0 85 Pass
 0 0 0 0 0 0 0 0 0 1 1 86 Pass
 0 0 0 0 0 0 0 0 0 0 0 88 Pass
 0 0 0 0 0 0 0 0 0 0 0 89 Pass
 0 0 0 0 0 0 0 0 0 0 0 94 Pass
 0 0 0 0 0 1 0 1 0 0 2 960 Pass, via oral exam taken on F 6/8, 4:15 PM
 0 0 0 0 0 1 0 0 0 0 1 961 Pass
 0 1 0 0 0 0 0 0 0 0 1 98 Pass

Miscellaneous Information

Motivation: Whether they work in the industry or in academic research settings, computer engineers face many challenges in their quest to design or effectively employ faster, smaller, lower-energy, more reliable, and cost-effective systems. Most computer engineering students do not begin tackling such problems, and more generally are not exposed to specific challenges of their field of study, until they enroll in upper-division major courses. Meanwhile, during their freshman- and sophomore-year experiences with foundational courses in mathematics, physics, electrical circuits, and programming, they wonder about where they are headed and what types of problems they will encounter as working professionals. This course is intended to provide an introduction to day-to-day problems and research endeavors in computer engineering via their connections to familiar mathematical and logical puzzles.

Catalog entry: 1. Ten Puzzling Problems in Computer Engineering. (1) PARHAMI. *Prerequisite: Open to pre-computer engineering only. Seminar, 1 hour.* Gaining familiarity with, and motivation to study, the field of computer engineering, through puzzle-like problems that represent a range of challenges facing computer engineers in their daily problem-solving efforts and at the frontiers of research.

History: This 1-unit freshman seminar (offered for the first time in spring 2007) was proposed and developed by Professor Parhami. The main goal of the seminar is to expose incoming students to challenging computer engineering problems, faced by practicing engineers and research scientists, in a way that is both entertaining and motivating. The course is useful because CE students have very limited exposure to key concepts in their chosen major during their initial studies that involve mostly foundational, basic science, and general-education courses.

[Offering of ECE 1 in spring 2011 \(PDF file\)](#)
[Offering of ECE 1 in spring 2010 \(PDF file\)](#)
[Offering of ECE 1 in spring 2009 \(PDF file\)](#)
[Offerings of ECE 1 in 2007 and 2008 \(PDF file\)](#)