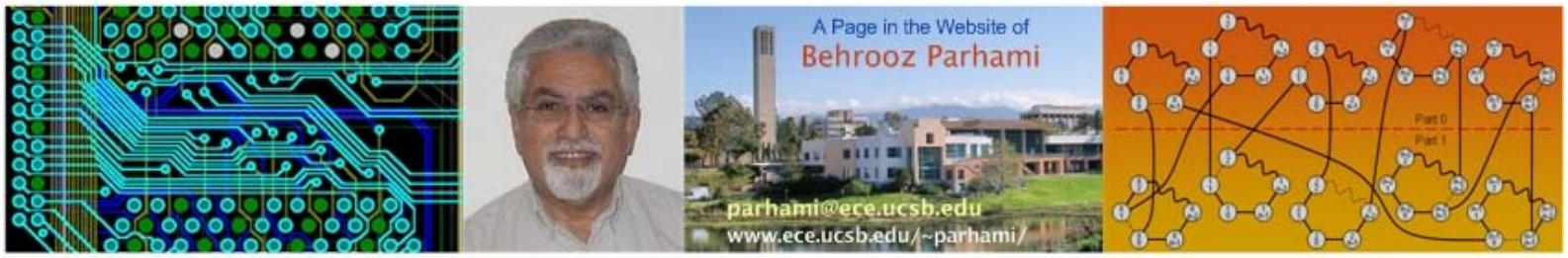


- Home & Contact
- Curriculum Vitae
- Research
  - Computer arithmetic
  - Parallel processing
  - Fault tolerance
  - Broader research
  - Research history
  - List of publications
- Teaching
  - ECE1 Freshman sem
  - ECE154 Comp arch
  - ECE252B Comp arith
  - ECE252C Adv dig des
  - ECE254B Par proc
  - ECE257A Fault toler
  - Teaching experience
  - Student supervision
  - Math + Fun!
- Textbooks
  - Computer arithmetic
  - Parallel processing
  - Fault tolerance
  - Comp architecture
  - Other books
- Service
  - Professional activities
  - Academic service
  - Community service
  - Industrial consulting
- Files & Documents
- Useful Links

Behrooz Parhami's ECE 1 Course Outline and Schedule

Ten Puzzling Problems in Computer Engineering, Spring 2009

Enrollment code: 10496
Prerequisite: Open to (pre-)computer engineering students only
Class meetings: W 5:00-6:15, Phelps 1260
Instructor: Professor Behrooz Parhami
Open office hours: T 2:00-3:30, R 10:00-11:30, 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*, a future issue (PDF file forthcoming)
- *Computer Science Education*, Vol. 18, No. 4, Dec. 2008 (**PDF file**)

Course Announcements

2009/06/11: The spring 2009 offering of ECE 1 is now officially over and course grades have been reported to the Registrar's Office. There will be no further updates to this Web page. Have a pleasant summer!
2009/06/03: All students with one missed class, who have not yet submitted a written explanation for the absence, should e-mail the instructor right away. A "pass" grade won't be assigned without this explanation. Students with two or three missed classes should send their available time slots on R 6/4 and F 6/5, between 8:00 AM and 9:00 PM, to the instructor for scheduling of an oral final exam covering the missed lectures.
2009/05/28: Please check the attendance record below and contact the instructor immediately if (when including the last class session on 6/3) you have 2 or 3 absences. Oral exams for the course will be held on R 6/4 and F 6/5. Students with 2 or 3 absences should e-mail a full list of their available time slots between 8:00 AM and 9:00 PM on 6/4-5 and check their e-mail frequently for notification of exam time and place. Alternatively, such students can contact the instructor immediately after the last class session on W 6/3.
2009/03/13: For course add code and petition requirements, please contact the ECE Student Affairs Undergraduate Office, located in Room 101 of Trailer 380, across from the south face of Broida Hall.
2009/01/06: The following tentative information is presented for planning purposes only. Details will be finalized in late March 2009 and updated weekly thereafter.

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; 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."

Personal
- Blog & books
- Favorite quotations
- Poetry
- Pet peeve
- Virtual retirement

CE Program

ECE Department

UCSB Engineering

UC Santa Barbara

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 2009, you will see a 2009 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]
W 04/01 (**ppt**, **pdf**, **handout**, last updated 2009/04/01) Easy, Hard, Impossible! [Collatz's conjecture]
W 04/08 (**ppt**, **pdf**, **handout**, last updated 2009/04/08) Placement and routing [Houses and utilities]
W 04/15 (**ppt**, **pdf**, **handout**, last updated 2009/04/15) Satisfiability [Making change]
W 04/22 (**ppt**, **pdf**, **handout**, last updated 2009/04/21) Cryptography [Secret messages]
W 04/29 (**ppt**, **pdf**, **handout**, last updated 2009/04/29) Byzantine generals [Liars and truth-tellers]
W 05/06 (**ppt**, **pdf**, **handout**, last updated 2009/05/06) Binary search [Counterfeit coin]
W 05/13 (**ppt**, **pdf**, **handout**, last updated 2009/05/13) Task scheduling [Sudoku]
W 05/20 (**ppt**, **pdf**, **handout**, last updated 2009/05/20) String matching [Word search]
W 05/27 (**ppt**, **pdf**, **handout**, last updated 2009/05/28) Sorting networks [Rearranging trains]
W 06/03 (**ppt**, **pdf**, **handout**, last updated 2009/05/28) 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
Wikipedia article on Collatz's conjecture
Feinstein, C.A., "The Collatz 3*n* + 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 games, in four levels of difficulty

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

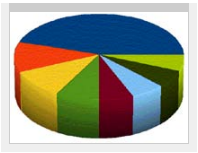
Topic E: Predicting the Future
Puzzles based on determining the next term in a series
Sloane, N.J.A., "Find the Next Term," *J. Recreational Mathematics*, Vol. 7, No. 2, p. 146, Spring 1974
Sloane, N.J.A., *Online Encyclopedia of Integer Sequences*

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 presense with a "0". The first ten columns correspond to Lectures 1-10, the next column, **Σ**, is the total number of absences, and "Merp" is the first few digits of the reversed Perm Number. For example, a student with the Perm Number 9876543 will have a Merp code of 3, 34, 345, 3456, ... , depending on



whether other students have Perm Numbers with the same ending.

1 2 3 4 5 6 7 8 9 0 **Σ** Merp
0 0 0 0 0 0 0 0 0 0 **0** 00
0 0 0 1 0 0 0 0 0 0 **1** 02 [Absence 4 has been explained]
0 0 0 0 0 0 0 0 0 0 **0** 05
0 0 0 0 0 0 0 0 0 0 **0** 06
0 0 0 0 0 0 0 0 0 0 **0** 10
0 0 0 0 0 0 0 0 0 1 **1** 190 [Absence 10 has been explained]
0 0 0 0 0 0 0 0 1 0 **1** 194 [Absence 9 has been explained]
0 0 0 0 0 0 0 0 0 1 **1** 198 [Absence 10 has been explained]
0 0 0 0 0 0 0 0 0 0 **0** 220
0 0 0 0 0 0 0 0 0 0 **0** 224
0 1 1 0 1 0 0 0 0 0 **3** 229 [Oral final exam taken on F 6/5]
0 0 0 0 0 0 0 0 0 0 **0** 25
0 0 0 0 1 0 0 0 0 0 **1** 26 [Absence 5 has been explained]
0 0 0 0 0 0 0 0 1 0 **1** 27 [Absence 9 has been explained]
0 0 0 0 0 0 0 0 0 0 **0** 28
0 0 0 0 0 0 0 0 0 0 **0** 29
0 1 0 0 0 0 0 0 0 0 **1** 30 [Absence 2 has been explained]
0 0 0 0 0 0 0 0 0 0 **0** 320
0 0 0 0 0 1 0 0 0 0 **1** 325 [Absence 6 has been explained]
0 0 0 0 0 0 0 0 1 0 **1** 329 [Absence 9 has been explained]
0 0 0 0 0 0 0 0 0 0 **0** 33
0 0 0 0 0 0 1 1 1 1 **4** 34 [Earned N/P due to 4 absences]
0 0 0 0 0 1 0 0 0 0 **1** 35 [Absence 6 has been explained]
0 0 0 0 0 0 0 0 0 0 **0** 36
0 0 0 0 0 0 0 0 0 0 **0** 38
0 0 0 1 0 0 0 1 0 0 **2** 461 [Oral final exam taken on F 6/5]
0 0 0 0 1 0 0 0 0 1 **2** 468 [Oral final exam taken on F 6/5]
0 0 0 0 0 0 0 0 0 0 **0** 48
1 1 0 0 0 0 0 0 0 0 **2** 51 [Oral final exam taken on F 6/5]
1 0 0 0 0 0 0 0 0 0 **1** 52 [Absence 1 has been explained]
0 0 0 0 0 0 0 0 1 0 **1** 57 [Absence 9 has been explained]
0 0 0 0 0 0 0 0 0 0 **0** 602
0 0 0 0 0 0 0 0 0 0 **0** 607
0 0 0 0 0 1 0 0 0 0 **1** 609 [Absence 6 has been explained]
0 0 1 0 0 0 0 0 0 0 **1** 65 [Absence 3 has been explained]
0 0 0 0 0 0 0 0 0 0 **0** 66
0 0 0 0 0 0 0 0 0 0 **0** 67
0 0 0 0 0 0 0 0 0 0 **0** 71
0 0 1 0 0 0 0 0 0 0 **1** 72 [Absence 3 has been explained]
0 0 0 0 0 1 0 0 0 1 **2** 73 [Oral final exam taken on R 6/11]
0 0 0 0 0 0 0 0 0 0 **0** 744
0 0 0 0 0 0 0 0 0 0 **0** 745
0 0 0 0 0 0 0 0 0 1 **1** 79 [Absence 10 has been explained]
0 0 0 0 0 0 0 1 0 0 **1** 80 [Absence 8 has been explained]
0 0 0 0 0 0 0 0 0 0 **0** 81
0 0 0 0 0 0 0 0 0 0 **0** 84
0 0 0 0 0 0 0 1 0 0 **1** 85 [Absence 8 has been explained]
0 0 0 0 0 0 0 0 0 1 **1** 86 [Absence 10 has been explained]
0 0 1 1 0 0 0 0 0 0 **2** 90 [Oral final exam taken on F 6/5]
0 0 0 0 0 0 0 0 0 0 **0** 918
0 0 0 0 0 0 0 0 0 1 **1** 919 [Absence 10 has been explained]

0 0 0 0 0 0 0 0 0 0 **0** 92
0 0 0 0 0 0 0 0 0 0 **0** 98
0 0 0 0 0 0 0 0 0 0 **0** 99

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.

Offerings of ECE 1 in 2007 and 2008 (PDF file)