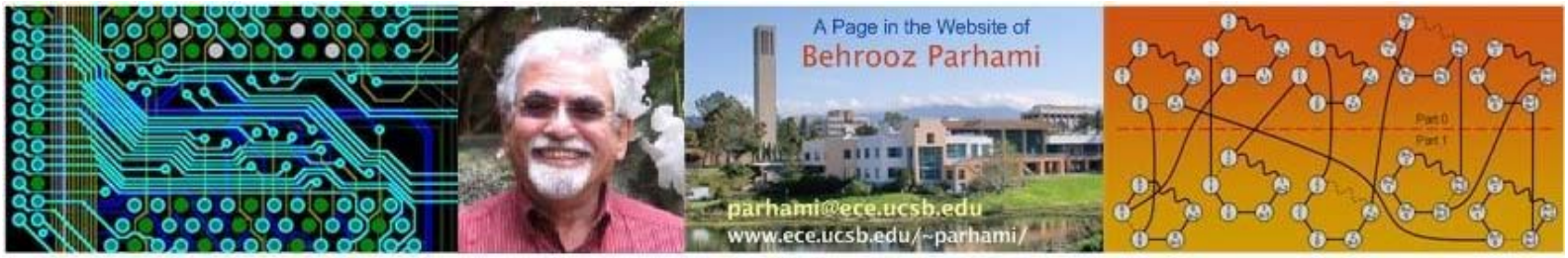

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Behrooz Parhami's ECE 1 Course Page for Spring 2013

Ten Puzzling Problems in Computer Engineering

Page last updated on 2013 June 08

Enrollment code: 11460
Prerequisite: Open to (pre-)computer engineering students only
Class meetings: M 3:30-4:45, Buchanan 1910
Instructor: Professor Behrooz Parhami
Open office hours: M 9:00-10:30, W 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

2013/06/08: The spring 2013 offering of ECE 1 is now officially over and grades have been reported to the Registrar's Office. All 77 enrolled students satified the course requirements and received "pass" grades. Good luck in the finals week, and have a pleasant summer!
2013/06/03: Attendance record for Lecture 10 (June 3, 2013) has been posted below. Please check your attendance and report any problems to me immediately. If you have one absence and there is no note in the attendance table that indicates you have explained your absence, please send me an e-mail explanation. If you have 2 or 3 absences (whether or not they have been explained), please e-mail me by T 6/4 all of your available times on R 6/6 and F 6/7, and I will get back to you with the time of your oral final exam, covering the topics in the missed lectures. You will not get a "pass" grade without explaining a single absence or taking a final oral exam in the case of 2-3 absences.
2013/05/20: Attendance record for Lecture 8 (May 20, 2013) has been posted below. There will be no lecture on Monday 5/27 (Memorial Day observance).
2013/05/13: Attendance record for Lecture 7 (May 13, 2013) has been posted below.
2013/05/06: Attendance record for Lecture 6 (May 06, 2013) has been posted below.
2013/04/29: Attendance record for Lecture 5 (April 29, 2013) has been posted below.
2013/04/22: Attendance record for Lecture 4 (April 22, 2013) has been posted below.
2013/04/15: Attendance record for Lecture 3 (April 15, 2013) has been posted below.
2013/04/09: Attendance record for Lecture 2 (April 8, 2013) has been posted below.
2013/04/02: Attendance record for Lecture 1 (April 1, 2013) has been posted below.
2013/03/28: Welcome to the ECE 1 Web page for spring 2013. 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

Blog & books
Favorite quotations
Poetry
Pet peeve
Virtual retirement
CE Program
ECE Department
UCSB Engineering
UC Santa Barbara

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."
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. Please note that any animation in PowerPoint presentations is lost in the PDF versions. No systematic updating of the PPT and PDF presentation files is planned for spring 2013, so the spring 2012 editions should be considered up to date for the current quarter.

Day & Date (Lecture slides, ppt + pdf, and ppt handout) Lecture topic [Lead puzzle]
M 04/01 (**ppt**, **pdf**, **handout**, last updated 2012/03/27) Easy, Hard, Impossible! [Collatz's conjecture]
M 04/08 (**ppt**, **pdf**, **handout**, last updated 2012/03/27) Placement and routing [Houses and utilities]
M 04/15 (**ppt**, **pdf**, **handout**, last updated 2012/03/28) Satisfiability [Making change]
M 04/22 (**ppt**, **pdf**, **handout**, last updated 2012/04/20) Cryptography [Secret messages]
M 04/29 (**ppt**, **pdf**, **handout**, last updated 2012/04/20) Byzantine generals [Liars and truth-tellers]
M 05/06 (**ppt**, **pdf**, **handout**, last updated 2012/05/03) Binary search [Counterfeit coin]
M 05/13 (**ppt**, **pdf**, **handout**, last updated 2012/05/03) Task scheduling [Sudoku]
M 05/20 (**ppt**, **pdf**, **handout**, last updated 2012/05/17) String matching [Word search]
M 05/27 (**ppt**, **pdf**, **handout**, last updated 2012/05/17) Sorting networks* [Rearranging trains]
* No lecture on M 05/27 due to the Memorial Day observance. This topic will be covered on Monday 06/03.
M 06/03 (**ppt**, **pdf**, **handout**, last updated 2012/05/17) Malfunction diagnosis** [Logical reasoning]
** This topic is removed for spring 2013 ("Sorting networks," listed under M 05/27 will be covered instead).
There will be no make-up lecture or substitute assignment for "Malfunction diagnosis."

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 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 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

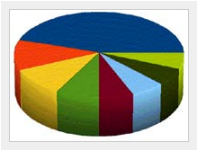
Topic D: Amdahl's Law
Puzzles on river and bridge crossings
Parhami, B., *Computer Architecture: From Microprocessors to Supercomputers*, Oxford University Press, 2005 (See Section 4.3)
Wikipedia article on Amdahl's law

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 presense 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

1 2 3 4 5 6 7 8 9 0 **Σ** Mrep
0 0 0 0 0 0 0 1 0 0 **1** 00 Absence in Lecture 8 has been explained
1 0 0 0 0 0 0 0 0 0 **1** 010 Absence in Lecture 1 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 017
0 0 0 0 0 0 0 0 0 0 **0** 02
0 0 0 0 0 0 0 0 0 0 **0** 03
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0 0 0 0 0 0 0 0 0 0 **0** 13
0 0 0 0 1 0 0 0 0 0 **1** 141 Absence in Lecture 5 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 144
0 0 0 0 0 0 0 0 0 0 **0** 153
0 0 0 0 0 0 0 1 0 0 **1** 159 Absence in Lecture 8 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 17
0 0 0 0 0 0 0 0 0 0 **0** 19
0 0 0 0 0 0 0 0 0 1 **1** 21 Absence in Lecture 10 has been explained
0 0 0 0 0 0 1 0 0 0 **1** 24 Absence in Lecture 7 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 26
1 0 0 0 0 0 0 0 0 0 **1** 30 Absence in Lecture 1 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 310
0 0 0 0 0 0 0 0 0 0 **0** 318
0 0 0 0 0 0 0 0 0 0 **0** 32
0 0 0 0 0 1 0 0 0 0 **1** 332 Absence in Lecture 6 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 336
0 0 0 0 0 0 0 0 0 0 **0** 35
1 0 0 0 0 0 0 0 0 0 **1** 36 Absence in Lecture 1 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 372
0 0 0 0 0 0 0 0 0 0 **0** 379
0 0 0 0 0 1 0 0 0 0 **1** 40 Absence in Lecture 6 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 42
0 0 0 0 0 0 1 0 0 0 **1** 445 Absence in Lecture 7 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 449
0 0 0 0 0 0 0 0 0 1 **1** 47 Absence in Lecture 10 has been explained
1 0 0 0 0 0 1 0 0 1 **3** 492 Oral final exam taken and passed on F 2013/06/07
0 0 1 0 0 0 0 0 0 0 **1** 494 Absence in Lecture 3 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 53

0 0 0 0 0 0 0 1 0 0 **1** 54 Absence in Lecture 8 has been explained
1 0 0 0 0 0 0 0 0 0 **1** 56 Absence in Lecture 1 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 57
1 0 0 0 0 0 0 0 0 0 **1** 590 Absence in Lecture 1 has been explained
0 0 0 0 0 0 0 0 0 1 **1** 593 Absence in Lecture 10 has been explained
1 0 0 0 0 0 0 0 0 0 **1** 595 Absence in Lecture 1 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 598
0 0 0 0 0 0 0 0 0 1 **0** 601 Absence in Lecture 10 has been explained
0 0 0 0 0 0 0 0 0 1 **1** 603 Absence in Lecture 10 has been explained
0 0 0 0 0 0 0 1 0 0 **1** 6113 Absence in Lecture 8 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 6119
0 0 0 0 0 0 0 0 0 1 **1** 63 Absence in Lecture 10 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 66
0 0 0 0 0 0 0 0 0 1 **1** 672 Absence in Lecture 10 has been explained
0 0 0 0 0 0 1 0 0 0 **1** 676 Absence in Lecture 7 has been explained
0 0 1 0 1 0 0 0 0 0 **2** 682 Oral final exam taken and passed on 2013/06/06
0 0 0 0 0 0 0 0 0 0 **0** 688
0 0 0 0 0 0 0 1 0 0 **1** 70 Absence in Lecture 8 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 717
0 0 0 0 0 0 0 1 0 0 **1** 718 Absence in Lecture 8 has been explained
1 0 0 0 0 0 0 0 0 0 **1** 731 Absence in Lecture 1 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 734
0 0 0 0 0 0 0 1 0 0 **1** 742 Absence in Lecture 8 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 744
0 0 0 0 1 0 0 0 0 0 **1** 764 Absence in Lecture 5 has been explained
0 0 0 0 0 1 0 0 0 0 **1** 768 Absence in Lecture 6 has been explained
0 0 0 0 0 0 0 0 0 1 **1** 78 Absence in Lecture 10 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 790
0 0 0 0 0 0 0 0 0 1 **1** 798 Absence in Lecture 10 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 80
0 0 0 0 0 0 0 1 0 0 **1** 84 Absence in Lecture 8 has been explained
0 0 0 0 0 0 1 0 0 0 **1** 85 Absence in Lecture 7 has been explained
0 0 0 0 0 0 0 0 0 1 **1** 88 Absence in Lecture 10 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 89
0 0 0 0 0 0 0 0 0 1 **1** 90 Absence in Lecture 10 has been explained
0 0 0 0 0 0 0 1 0 0 **1** 94 Absence in Lecture 10 has been explained
0 0 0 0 0 0 0 0 0 0 **0** 96
0 0 0 0 0 0 0 0 0 0 **0** 98

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 students to challenging computer engineering problems, faced by practicing engineers and research scientists, in a motivating and entertaining way. 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 2013 (PDF file)
Offering of ECE 1 in spring 2012 (PDF file)
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)