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# Behrooz Parhami's ECE 1 Course Page for Spring 2010

## Ten Puzzling Problems in Computer Engineering

*Enrollment code:* 10892

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

*Class meetings:* R 3:30-4:45, Broida 1640

*Instructor:* Professor Behrooz Parhami

*Open office hours:* M 11:00-12:30, R 5:00-6:30, 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:

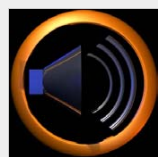
- *IEEE Computer*, Vol. 42, No. 3, Mar. 2009 ([PDF file](#))

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

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



## Course Announcements



**2010/06/07:** The spring 2010 offering of ECE 1 is officially over. Course grades have been submitted and should be available on Gold soon. Have a pleasant summer!

**2010/05/27:** Please make sure to also read the announcement that follows this one. In order to get a "pass" grade for this course, students with 2-3 absences will need to pass a final oral exam on the lectures they have missed. During the final oral exam, to be scheduled for Friday

6/4, or the weekend that follows it, I will ask questions about the missed lectures. You will need to review the lectures and stop by to ask me questions about them during my office hours. You must at least be able to describe the big picture and the connection of ideas in those lectures. You are responsible for contacting me to schedule your final oral exam. You can do this by sending me e-mail with all your free time slots during 8:00 AM to 8:00 PM on 6/4-6. Failure to schedule or pass the exam will result in a "not pass" grade for the course. So, please do not give me just a few time slots, because I may not be able to schedule the final oral if there are conflicts. A "not pass" grade can also result from a single absence if it has not been explained to the instructor in writing (e-mail will do).

**2010/05/20:** Please check the attendance record near the end of this page. If you have one absence in the 10 class sessions and have not yet sent the instructor a written explanation of why you were absent, please do so by 6/4. You will not get a pass grade without a written explanation of the single absence (explanation via e-mail will do). If you have 2 or 3 absences in the 10 class sessions, you will need to take a final oral exam on F 6/4 or during the weekend of 6/5-6. Please send me all your available time slots on F 6/4 (preferred exam day) and 6/5-6 and I will get back to you with your oral exam time. During the final oral exam, you will be asked questions about the lectures you missed, so please review the slides for those lectures and stop by to ask questions if you don't understand the puzzles discussed or how they are related to the computer engineering topics in the later slides.

**2010/04/01:** As promised in today's class, links to some applications of Fibonacci numbers have been added to the section "Summary and References for the Ten Lectures" below.

**2010/01/12:** Welcome to the ECE 1 Web page for spring 2010. 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 sheet is given out at the beginning of each lecture and lecture

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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; 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 2010, you will see a 2010 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]

R 04/01 ([ppt](#), [pdf](#), [handout](#), last updated 2010/04/01) Easy, Hard, Impossible! [Collatz's conjecture]

R 04/08 ([ppt](#), [pdf](#), [handout](#), last updated 2010/04/07) Placement and routing [Houses and utilities]

R 04/15 ([ppt](#), [pdf](#), [handout](#), last updated 2010/04/11) Satisfiability [Making change]

R 04/22 ([ppt](#), [pdf](#), [handout](#), last updated 2010/04/19) Cryptography [Secret messages]

R 04/29 ([ppt](#), [pdf](#), [handout](#), last updated 2010/04/26) Byzantine generals [Liars and truth-tellers]

R 05/06 ([ppt](#), [pdf](#), [handout](#), last updated 2010/05/04) Binary search [Counterfeit coin]

R 05/13 ([ppt](#), [pdf](#), [handout](#), last updated 2010/05/13) Task scheduling [Sudoku]

R 05/20 ([ppt](#), [pdf](#), [handout](#), last updated 2010/05/20) String matching [Word search]

R 05/27 ([ppt](#), [pdf](#), [handout](#), last updated 2010/05/20) Sorting networks [Rearranging trains]

R 06/03 ([ppt](#), [pdf](#), [handout](#), last updated 2010/05/20) 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***

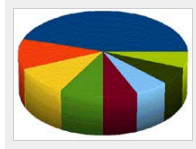
## Topic F: Circuit Value Problem

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,  $\Sigma$ , 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  $\Sigma$  Merp

0 0 0 0 0 0 0 0 0 1 1 03 Absence in lecture 10 has been explained  
 0 0 0 0 0 0 0 0 0 1 1 05 Absence in lecture 10 has been explained  
 0 0 0 0 0 1 0 0 0 0 1 092 Absence in lecture 6 has been explained  
 0 0 0 0 0 0 0 0 0 0 0 093  
 0 0 0 0 0 0 1 0 0 0 1 120 Absence in lecture 7 has been explained  
 0 0 0 1 0 0 0 0 0 0 1 121 Absence in lecture 4 has been explained  
 0 0 0 0 1 0 0 0 0 1 2 125 Oral final exam taken and passed on M 6/7, 11:00 AM  
 0 0 0 1 0 0 0 0 0 0 1 15 Absence in lecture 4 has been explained  
 0 0 0 0 0 0 0 0 0 0 0 17  
 0 1 0 0 0 0 0 0 0 0 1 181 Absence in lecture 2 explained; Submitted bonus cryptogram's solution  
 0 0 0 0 0 0 0 0 0 0 0 185  
 0 0 0 0 0 0 0 0 0 1 1 19 Absence in lecture 10 has been explained  
 0 0 0 0 1 1 0 0 0 0 2 204 Oral final exam taken and passed on F 6/4, 6:00 PM  
 0 0 0 0 0 0 0 0 1 0 1 206 Absence in lecture 9 has been explained  
 0 0 0 0 0 0 0 0 1 0 1 22 Absence in lecture 9 has been explained  
 0 0 0 0 0 0 0 0 1 0 1 26 Absence in lecture 9 has been explained  
 0 0 1 0 0 0 0 0 0 0 1 27 Absence in lecture 3 has been explained  
 0 0 0 0 0 0 0 0 0 0 0 357  
 0 0 0 0 0 0 0 0 0 0 0 359  
 0 0 1 0 0 0 0 0 0 0 1 36 Absence in lecture 3 has been explained  
 0 0 0 0 0 0 0 0 0 0 0 37  
 0 0 0 0 0 0 0 0 1 0 1 39 Absence in lecture 9 has been explained  
 0 0 0 0 0 0 0 0 0 0 0 40  
 0 0 0 0 0 0 0 0 0 0 0 41  
 0 0 0 0 0 0 0 0 0 0 0 42  
 0 0 0 0 0 0 0 0 0 0 0 43  
 0 0 0 0 0 0 0 0 1 0 1 44 Absence in lecture 9 has been explained  
 0 0 0 0 0 0 0 0 0 1 1 457 Absence in lecture 10 has been explained  
 0 0 0 1 0 0 0 0 0 0 1 459 Absence in lecture 4 has been explained  
 0 0 0 0 0 0 0 0 0 0 0 46  
 0 0 0 0 0 0 0 0 0 0 0 47  
 0 0 0 0 0 0 0 0 0 0 0 50  
 0 0 0 0 0 1 0 0 0 0 1 51 Absence in lecture 6 has been explained  
 0 0 1 0 0 0 0 0 0 0 1 53 Absence in lecture 3 has been explained  
 0 0 0 0 0 0 0 1 1 0 2 55 Oral final exam taken and passed on F 6/4, 1:30 PM  
 1 1 0 0 0 0 0 0 0 0 2 56 Oral final exam taken and passed on M 6/7, 11:30 AM  
 0 0 0 0 0 0 0 0 0 0 0 57  
 0 0 0 0 0 0 1 0 0 1 2 62 Excused from oral exam due to solving a bonus puzzle  
 0 0 0 1 0 0 0 0 0 0 1 64 Absence in lecture 4 has been explained  
 0 0 0 0 0 0 0 0 1 0 1 65 Absence in lecture 9 has been explained  
 1 0 0 0 0 0 0 0 0 0 1 66 Absence in lecture 1 has been explained



0 0 0 0 0 0 0 0 0 0 0 0 0 70  
 0 0 1 0 0 0 0 0 0 0 1 71 Absence in lecture 3 has been explained  
 0 0 0 0 0 0 0 0 0 0 0 776  
 0 0 0 0 0 0 1 0 0 0 1 778 Absence in lecture 7 has been explained  
 0 0 0 0 0 0 0 0 0 0 0 78  
 0 0 0 0 1 0 0 0 0 0 1 795 Absence in lecture 5 has been explained  
 0 0 0 0 0 0 0 0 0 0 0 798  
 0 0 0 0 0 0 0 0 0 1 1 810 Absence in lecture 10 has been explained  
 0 0 0 0 0 0 0 0 0 1 1 815 Absence in lecture 10 has been explained  
 0 0 0 0 0 0 0 0 0 0 0 816  
 0 0 0 0 0 0 0 0 0 0 0 82  
 0 0 0 0 0 0 0 0 0 0 0 844  
 1 0 0 0 0 0 0 0 1 0 2 98 Oral final exam taken and passed on F 6/4, 6:30 PM

## 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 2009 \(PDF file\)](#)

[Offerings of ECE 1 in 2007 and 2008 \(PDF file\)](#)