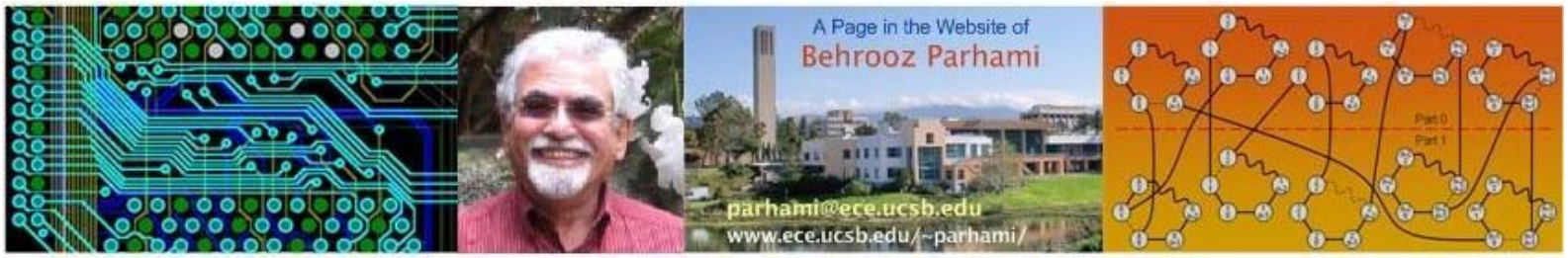

- Home & Contact
- Curriculum Vitae
- Research
  - Computer arithmetic
  - Parallel processing
  - Fault tolerance
  - Broader research
  - Research history
  - List of publications
- Teaching
  - ECE1 Freshman sem
  - ECE154 Comp arch
  - ECE252B Comp arith
  - ECE252C Adv dig des
  - ECE254B Par proc
  - ECE257A Fault toler
  - Student supervision
  - Math + Fun!
- Textbooks
  - Computer arithmetic
  - Parallel processing
  - Dependable comp
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  - Other books
- Service
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- Files & Documents
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Behrooz Parhami's ECE 257A Course Page for Fall 2012

Fault-Tolerant Computing

Page last updated on 2012 December 11

Enrollment code: 49973
Prerequisite: ECE 154 (or equivalent)
Class meetings: MW 10:00-11:30, Phelps 1431
Instructor: Professor Behrooz Parhami
Open office hours: MW 3:30-5:00; HFH 5155
Course announcements: Listed in reverse chronological order
Course calendar: Lecture, homework, and exam schedules
Homework assignments: Four assignments, worth a total of 20%
Exams: Open-book midterm and final, each worth 40%
Research paper: Does not apply to fall 2012
Research paper guidlines: Brief guide to format and contents
Grades: Statistics for homework and exam grades
References: Textbook and other sources (**Textbook's web page**)
Lecture slides: Via the textbook's Web page; for Lecture 0, see below
Miscellaneous information: Motivation, catalog entry, history

Course Announcements

2012/12/11: The fall 2012 offering of ECE 257A is officially over. Grades have been reported to the Registrar's office. Have a wonderful holiday break and a happy and propsperous 2013!
2012/11/24: Homework 4 has been posted to the homework area below. Textbook chapters and presentation slides are now up to date for fall 2012 up to the end of Part VI (Chapter 24). Part VII chapters and slides will be updated no later than Friday 11/30.
2012/11/07: All but one of the problem statements for Homework 3 have been posted below.
2012/11/06: The grade stats have been updated. Homework 3 (due on W 11/21) has been posted to the homework area below. Most problems do not exist in the old textbook chapters from 2009. I will post an updated version of the PDF file for Part IV by F 11/09 and Part V by F 11/16. I will also provide a hard-copy handout containing the problem statements.
2012/10/28: Please note the corrections to Problem 6.2 posted for Homework 2.
2012/10/20: Homework 2 has been posted to the homework area below. On the course's textbook page, the first two parts (Chapters 1-8) are now up to date for fall 2012.
2012/10/03: Homework 1 will be posted to the homework area below by Saturday 10/06. The schedule of lectures between M 11/12 and W 12/05 and the due dates of HW3 and HW4 have been adjusted to accommodate the Veterns' Day holiday on 11/12, which was overlooked in the original plan.
2012/09/29: The contents of this page are now final. Please pay attention to the following announcement from July 18.
2012/07/18: Welcome to the ECE 257A web page for fall 2012. The following information is provided for planning purposes only. Details will be finalized in late September and updated regularly thereafter. I will be updating and improving the on-line course textbook and lecture slides over the summer, so the fall 2012 contents will be different from the current version. Please pay attention to the associated posting date when downloading material for the course.

Course Calendar

Course lectures, homework assignments, and exams, have been scheduled as follows. This schedule will be strictly observed. In particular, no extension is possible for homework due

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

dates. Please begin work on your assignments early. Each lecture corresponds to topics in 1-2 chapters of the instructor's forthcoming textbook on dependable computing. Chapter numbers are provided in parentheses, after day & date.

Day & Date (book chapters) Lecture topic [Homework posted/due] {Special notes}
M 10/01 (0) Course introduction: Goals, pretest, class survey {Lecture included in the slides for chs. 1-4}
W 10/03 (1) Background and motivation {class surveys due}

M 10/08 (2) Dependability attributes [HW1 posted, chs. 1-4]
W 10/10 (3) Combinational modeling

M 10/15 (4) State-space modeling
W 10/17 (5, 7) Defect avoidance; Shielding and hardening [HW1 due]

M 10/22 (6, 8) Defect circumvention; Yield enhancement [HW2 posted, chs. 5-12]
W 10/24 (9, 11) Fault testing; Design for testability

M 10/29 (10, 12) Fault masking; Replication with voting
W 10/31 (13, 15) Error detection; Self-checking modules [HW2 due]

M 11/05 (1-12) Midterm exam, open-book/notes, 10:00-11:45
W 11/07 (14, 16) Error correction; Redundant disk arrays [HW3 posted, chs. 13-20]

M 11/12 No lecture: Veterans' Day holiday
W 11/14 (17, 19) Malfunction diagnosis; Standby redundancy

M 11/19 (18, 20) Malfunction tolerance; Robust parallel processing
W 11/21 (21-22) Degradation allowance; Resilient algorithms [HW3 due]

M 11/26 (23-24) Degradation management; Software redundancy [HW4 posted, chs. 21-28]
W 11/28 (25, 27) Failure confinement; Agreement and adjudication

M 12/03 (26, 28) Failure recovery; Fail-safe systems {Instructor and course evaluations?}
W 12/05 (A) Conclusion: Past, present, and future [HW4 due]
F 12/07 {Extra office hours, 3:30-5:00, HFH 5155}

M 12/10 (13-A) Final exam, open-book/notes, 9:00-11:00

W 12/19 Course grades due by midnight

Homework Assignments

-Turn in solutions in class before the lecture begins.
-Because solutions will be handed out on the due date, no extension can be granted.
-Use a cover page that includes your name, course name, and assignment number.
-Staple the sheets and write your name on top of each sheet in case they are separated.
-Although some cooperation is permitted, direct copying will have severe consequences

Homework 1: Dependability and its modeling (ch. 1-4, due W 2012/10/17, 10:00 AM)
Do problems 1.6, 1.16, 2.9, 3.10, and 4.4 from the textbook.

Homework 2: Defects and faults (ch. 5-12, due W 2012/10/31, 10:00 AM)
Do problems 5.7, 6.2*, 8.3, 9.4, 10.5, and 11.2ab from the textbook.
* Corrections to Problem 6.2: All references to the parameter p should be replaced with $1 - p$, that is, the relay reliability. In part e, comparison with part b, rather than part c, is intended.

Homework 3: Errors and malfunctions (ch. 13-20, due W 2012/11/21, 10:00 AM)

Do problems 13.4, 14.3, 16.4, 17.2, 19.1, and 20.4 from the textbook.

Homework 4: Degradations and failures (ch. 21-28, due W 2012/12/05, 10:00 AM)
Do problems 21.2, 24.4, 24.6, 26.1, and 27.5 from the textbook.

Sample Exams and Study Guide

The following sample exam problems are meant to indicate the types and levels of problems, rather than the coverage (which is outlined in the course calendar). Students are responsible for all sections and topics in the textbook and class handouts that are not explicitly excluded in the study guide that follows each sample exam, even if the material was not covered in class lectures.

Sample Midterm Exam (105 minutes)
Problems 3.12, 4.4, 9.4, and 12.1 from the textbook.

Midterm Exam Study Guide
Nothing specific; just study Chapters 1-12 and review the problems in homework assignments 1-2.

Sample Final Exam (120 minutes)
Problems 13.5, 15.5, 17.1, and 21.2 from the textbook.

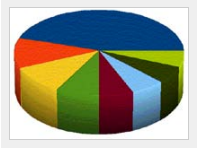
Final Exam Study Guide
Study Chapters 13-28. There will be one problem from each of the four parts. Pay special attention to the problems in homework assignments 3-4. Note that the coverage in the sample final exam above is more limited than that of the current quarter.

Research Paper and Presentation

This section does not apply to the fall 2012 offering of the course. Please ignore.
Each student will review a subfield of dependable computing or do original research on a selected and approved topic. A tentative list of research topics is provided below; however, students should feel free to propose their own topics for approval. A publishable report earns an "A" for the course, regardless of homework and midterm grades. See the course calendar for schedule and due dates and **Research Paper Guidlines** for formatting tips.

1. Topic 1 (Assigned to: TBD)
2. Topic 2 (Assigned to: TBD)
3. Topic 3 (Assigned to: TBD)
4. Topic 4 (Assigned to: TBD)
5. Topic 5 (Assigned to: TBD)
6. Topic 6 (Assigned to: TBD)
7. Topic 7 (Assigned to: TBD)
8. Topic 8 (Assigned to: TBD)

Grade Statistics



All grades listed are in percent, unless otherwise noted.
HW1 grades: Range = [44, 87], Mean = 68, Median = 73
HW2 grades: Range = [56, 98], Mean = 81, Median = 81
HW3 grades: Range = [61, 85], Mean = 77, Median = 81
HW4 grades: Range = [58, 100], Mean = 88, Median = 91
Midterm exam grades: Range = [45, 91], Mean = 69, Median = 75
Final exam grades: Range = [57, 87], Mean = 74, Median = 78
Course grades, A-F: Range = [3.0, 4.0], Mean = 3.6, Median = 3.7

References

Required text: B. Parhami, *Dependable Computing: A Multilevel Approach*, chapters will be posted as they become available. Please visit the **textbook's web page** for general information. Lecture slides and (preliminary) sample chapters are also available there.

Some useful books (not required):
Koren/Krishna, *Fault-Tolerant Systems*, Morgan Kaufmann, 2007 (ISBN 0-12-088525-5)
Shooman, *Reliability of Computer Systems and Networks*, Wiley, 2002 (ISBN 0-471-29342-3)
Siewiorek/Swarz, *Reliable Computer Systems*, Digital Press, 1992 (ISBN 1-55558-075-0)
Johnson, *Design and Analysis of Fault-Tolerant Digital Systems*, Addison Wesley, 1989 (ISBN 0-201-07570-9)

Research resources:
Proc. IEEE/IFIP Int'l Conf. Dependable Systems and Networks (DSN), formerly known as Fault-Tolerant Computing Symp. (FTCS), annual, since 1971.
IEEE Trans. Dependable and Secure Computing, quarterly journal, published since 2004
IEEE Trans. Reliability, Quarterly journal, published since 1955
IEEE Trans. Computers, monthly journal, published since 1952
UCSB library's electronic journals, collections, and other resources
UCSB library's research guide in ECE

Miscellaneous Information

Motivation: Dependability concerns are integral parts of engineering design. Ideally, we would like our computer systems to be perfect, always yielding timely and correct results. However, just as bridges collapse and airplanes crash occasionally, so too computer hardware and software cannot be made totally immune to unpredictable behavior. Despite great strides in component reliability and programming methodology, the exponentially increasing complexity of integrated circuits and software systems makes the design of prefect computer systems nearly impossible. In this course, we study the causes of computer system failures (impairments to dependability), techniques for ensuring correct and timely computations despite such impairments, and tools for evaluating the quality of proposed or implemented solutions.

Catalog entry: **257A. Fault-Tolerant Computing. (4) PARHAMI.** *Prerequisites: ECE 154. Lecture, 3 hours*. Basic concepts of dependable computing. Reliability of nonredundant and redundant systems. Dealing with circuit-level defects. Logic-level fault testing and tolerance. Error detection and correction. Diagnosis and reconfiguration for system-level malfunctions. Degradation management. Failure modeling and risk assessment.

History: Professor Parhami took over the teaching of ECE 257A in the fall quarter of 1998. Previously, the course had been taught primarily by Dr. John Kelly, who instituted the two-course sequence ECE 257A/B, the first covering general topics and the second (now discontinued) devoted to his research focus on software fault tolerance. Borrowing from his experience in teaching dependable computing at other universities and based on an extensive survey of the field that he published in 1994, Professor Parhami oriented the course toward an original multilevel view of impairments to computer system dependability and techniques for avoiding or tolerating them. The levels of this models, in increasing order of abstraction, are: defects, faults, errors, malfunctions, degradations, and failures. A textbook based on this multilevel model of dependable computing is in preparation.
Offering of ECE 257A in fall 2009 (PDF file)
Offering of ECE 257A in fall 2007 (PDF file)
Offerings of ECE 257A in 1998 and 2006 (PDF file)