

Computer Science Department  
Stanford University  
Comprehensive Examination in Software Systems  
Autumn 1995

**READ THIS FIRST!**

- 1) You should write your answers for this part of the Comprehensive Examination in a **BLUE BOOK**. Be sure to write your **MAGIC NUMBER** on the cover of every blue book that you use.
- 2) The number of **POINTS** for each problem indicates how elaborate an answer is expected. For example, an essay-type question worth 6 points or less doesn't deserve an extremely detailed answer, even though a person can expound at length on just about any topic in computer science.
- 3) The total number of points is 60, and the exam takes 60 minutes. This "coincidence" can help you plan your time.
- 4) This exam is **CLOSED BOOK**. You may **NOT** use notes, articles, books, computer, etc.
- 5) Show your work, since **PARTIAL CREDIT** will be given for incomplete answers. For example, you can get credit for making a reasonable start on a problem even if the idea doesn't work out; you can also get credit for realizing that certain approaches are incorrect.
- 6) If you are convinced you need to make an assumption to answer a question, state your assumption(s) as well as the answer.
- 7) Be sure to provide justification for your answers.

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## Comprehensive Exam: Software Systems (60 points)

- 1) (10 points) Describe the purpose of device drivers in modern operating systems. (Hint: I'm looking for something more than "they drive devices.")
- 2) (18 points) The algorithms and data structures used in operating systems are frequently a function of the hardware technology. As hardware technology has changed so have operating systems. For the following hardware technology changes, describe the operating system algorithms and data structures that might need to be changed.
  - (a) A very large (multiple order-of-magnitude) increase in physical memory size.
  - (b) A large increase in the number of bits in a virtual address.
  - (c) An increase in the number of CPUs in the system from one to many tens of CPUs.
- 3) (12 points) The UNIX operating system has a file buffer cache that uses a writeback policy with a 30 second timeout. This means that changes to file blocks can sit in the buffer cache for up to 30 seconds before being written back to the disk. What are motivations for and drawbacks of this scheme?
- 4) (8 points) Describe what an atomic operation is. Give examples and describe why they are useful.
- 5) (12 points) Describe the necessary and sufficient conditions for deadlock. For each condition describe a practical deadlock prevention technique that works by preventing the condition from arising.