CPS 536: Exam 1 **Name:**_____

Instructor: Dr. Clark March 25, 1996

This test is closed book and closed notes. You may use a calculator. Answer the questions in the space provided. When answering questions, please state any and all assumptions you are making. For questions involving calculation, indicate your final answer by circling it.

Part 1 (30 points)

1. **(25)** Compare the *contiguous allocation* and *paging* memory management techniques. Be sure to include at least the following items in your comparison:
   - Memory utilization
   - Overhead for a memory access
   - Overhead for a context switch
   - Specialized hardware requirements
   - Support of protection

2. **(5)** Which approach does Nachos use? How does this affect the way we access memory when writing operating systems code in Nachos?

Part 2 (20 points)

1. **(15)** Describe the actions taken when a page fault occurs in a virtual memory system. Include both the case where a frame is available and the case where a frame is not available.

2. **(5)** We discovered that the Least Recently Used page replacement algorithm did a pretty good job of reducing the page fault rate in a virtual memory system. Given this good behavior, why wouldn't we use it everywhere?

Part 3 (30 points)

Consider the following page access sequence on a page based virtual memory system.

1 2 3 4 5 2 3 1 2 3 4

1. **(6)** With demand paging, what is the absolute minimum number of page faults for this sequence on any system?

2. **(24)** For the following replacement algorithms, determine the **page fault rate** for a system with 3 frames. Show your work for full credit.

   - FIFO
   - LRU
   - FIFO Second Chance.

Part 4 (20 points)

1. **(10)** Describe the *page size* tradeoff in a virtual memory system based on paging. What are the advantages and disadvantages of large versus small pages?

2. **(10)** What is the cause of thrashing? How can it be corrected while a system is running? What should we buy to help reduce thrashing in our system?