Name ______________________________

Midterm — March 9, 2006

ECE 428 / CS 425 / CSE 424
Spring 2006

Academic Honesty Policies:

- This exam is open book and open note. No other external sources may be used other than nonelectronic aids (notes and books) you bring with you into the exam.
- You must not give or receive assistance to any other person taking this exam, nor may you talk about the exam with your classmates who have not taken it until the midterm is returned to you. **Some students will take a conflict exam later.**
- Electronics are NOT allowed, and must remain off for the duration of the test. The three exceptions to this rule are:
  - Medically necessary life support devices
  - Simple calculators that cannot display characters
  - Watches that cannot store, transmit, or receive alphanumeric data

  This rule prohibits the use of devices including, but not limited to, general purpose computing devices (laptops, PDAs, graphing calculators, etc.), telephones of any kind (cellular, VoIP, wireless, wired, or satellite), pagers, radios, and music players are not permitted and must remain off at all times during the exam. Storage or communications of any data regarding the class on any electronic device is prohibited.

General Instructions:

- Show your work for all problems. Correct answers with no (or incorrect) work shown may result in partial credit.
- Draw a [box] around all final answers less than one sentence long.
- You must not write your answer in red.
- If there is any confusion as to the question being asked, request clarification from the proctor. If you need to make additional assumptions to complete the problem, state them.
- Unless otherwise specified, *why* is a technical question.
- If you cannot fit your work in the space provided, use the back side of the same page to complete your work to the extent practicable. **Do not write on the back of this sheet.**

Question	1	2	3	4	5	6	EC	Total
Possible	7	7	6	10	10	10	2	50 (+2)
Score								

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1. (7 Points) In the context of this class, for each of the following terms, specify the general topic area it is used in, and briefly (one sentence) define it.

a. Client Delay

b. Causal Ordering (**not multicast**)

c. Serial Equivalence

d. I-Read and I-Write Lock

e. Classless InterDomain Routing (CIDR)

f. Man-in-the-Middle Attack

g. One-Way Hash Function

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2. (7 Points) Will Chandry-Lamport work in the following network?

- all pairs of processes are connected by a pair of unidrectional channels (one in each direction)
- each channel is FIFO
- each channel is unreliable, and to cope with losses:
  - each message is separately acknowledged
  - unacknowledged packets are retransmitted
  - a magical form of duplicate detection is performed on each received packet (magical in this context doesn't mean impossible, it just means the technique is perfect and you don't need to worry about the details)
- each unique received packet is processed in the order received.

If so, explain why; if not, give a counterexample.

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3. (6 Points) The result that proves the impossibility of distributed consensus in an asynchronous system assumes both asynchrony and the possibility of single-node failure.

a. (1 Point) Show what step(s) of the proof depend on asynchrony

b. (5 Points) Show what step(s) of the proof depend on the possibility of single-node failure

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4. (10 Points) This question is about mutual exclusion.

   a. (6 Points) Other than centralized control, what mutual exclusion algorithm discussed in class should you use in the following cases and why:

      (i) High load (almost all nodes waiting for the lock at all times), Optimize message count. If two algorithms have equal message count, pick the one with lower delay.

      (ii) Low load (few nodes wait for the lock at any time), Optimize delay. If two algorithms have equal delay, pick the one with lower message count.

   b. (4 Points) What is the worst-case client delay and synchronization delay of Raymond's algorithm when a balanced binary tree structure is used?

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5. (10 Points) In this transaction, x, y, z are shared variables with initial values of 150, 75, and 80 respectively. Three transactions T, U, and V run interleaved in time as shown below (Each operation is attempted at the time shown. It may not complete at that time):

T	U	V
openTransaction		
$x \leftarrow x + 50$		
	openTransaction	
		openTransaction
	$y \leftarrow x$	
		$z \leftarrow y$
$x \leftarrow x \times 1.03$		
commit		
	commit	
		commit

a. Under timestamp ordering:

(i) Which transactions commit?

(ii) What are the final values of x, y, and z?

(iii) What sequential order of the committed transactions is this equivalent to?

b. Under optimistic concurrency, assuming that when forward validation fails, the transaction is buffered until forward validation can succeed:

(i) Which transactions commit?

(ii) What are the final values of x, y, and z?

(iii) What sequential order of the committed transactions is this equivalent to?

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6. (10 Points) This problem refers to your MP1 project.

a. Describe the function of each of the following system calls, and what order each call should be done in for the client and the server: `accept()`, `bind()`, `connect()`, `listen()`.

b. Explain your group's approach to mutual exclusion, including a complete list of system calls used to implement it.

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EC. (2 Points) **Hint: These questions take more time per point than the others. Do not attempt this problem until you have finished the others. No partial credit on individual questions.**

a. The triangle inequality says that the distance from host A to B plus the distance from host B to C is greater than or equal to the distance from A to C. Distance can be any *monotone* metric (meaning that as you add segments to a path, the distance gets larger).

   (i) Why does Internet routing not preserve the triangle inequality for *any* monotone metric? Explain why from both a technical and business standpoint.

   (ii) Suppose a group of nodes are served by a different set of ISPs. How can those nodes, without influencing the ISP, ensure that the triangle inequality holds between themselves for some metric that they jointly select? You may use latency as a sample metric.

b. (**0 Points**, but I'll be impressed) You are given a collection of rectangles (in a 2D space) with sides parallel to the x- and y-axes. For each rectangle, you get the (x, y) coordinates of the upper left hand corner, plus the height (y-extent) and width (x-extent). Give an asymptotically optimal algorithm to calculate the total area covered by the [union of the] rectangles, and analyze its worst-case running time. You may assume that the rectangles are provided to you in an array or in a linked list, whichever fits your algorithm better. *Hint: rectangles may intersect, and a polynomial time solution is possible*