Solutions to these problems will be made available for all on March 25. People who got less than 72 on the first midterm will get their solutions individually graded if they turn them in class on that day. There will be no exception to this policy.

1. When does the **ARC cache replacement policy** (a) increase and (b) decrease target_T1?

2. Explain why the **ARC cache replacement policy** is scan-resistant?

3. Explain how **MapReduce** applications can benefit from **Corey address ranges**.

4. A system of physical clocks consists of two clocks, namely, one that is slow and loses 5 minutes every hour and another that is fast and advances by 10 minutes every hour. Assuming that the clocks are managed by Lamport’s physical clock protocol, what will be the time marked by each clock at 2:00 PM given that (a) both clocks indicated the correct time at noon; (b) the processors on which the clock reside continuously exchange messages between themselves; and (c) the message transmission delays are negligible.

5. Why do neither C nor C++ include any statements comparable to the CSP guarded command and alternative command?

6. What would happen if Totem did not have **guaranteed vector messages**?

7. Consider a **single-ring** Totem system comprising three processors A, B and C. Assuming that each of these two processors has received the messages with the following sequence numbers:

<table>
<thead>
<tr>
<th>Processor</th>
<th>Messages</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3, 4, 6, 8</td>
</tr>
<tr>
<td>B</td>
<td>3, 4, 5, 7, 8</td>
</tr>
<tr>
<td>C</td>
<td>3, 4, 5, 8</td>
</tr>
</tbody>
</table>

Which messages will be delivered by each processor if all messages are (a) **agreed delivery** and (b) **safe delivery messages**?

8. A Totem system has three rings A, B and C. Which messages will a processor X be able to deliver using **agreed** and **delivery** assuming that it has received but not yet delivered messages with the following timestamps?

   - From ring A: 4:50 PM and 4:52 PM
   - From ring B: 4:55 PM and 5:00 PM
   - From ring C: 4:45 PM and 5:05 PM.

9. What would be the consequences of having an intruder penetrate (a) the Kerberos server, (b) the Kerberos Ticket Granting Service, and (c) any other server? (**Hint:** Think about which keys would be compromised and which tickets would have to be reissued.)

10. What could happen if a malicious intruder rolled back the clock of a Kerberos service?

11. Explain BitTorrent **rarest first** policy.

12. How does the tracker of a BitTorrent select the **peers** of a new downloader?
Answers

1. (a) The ARC cache replacement policy increases target T1 each time a cache miss occurs and the missing page appears in B1. (b) It decreases target T1 each time a cache miss occurs and the missing page appears in B2.

2. The ARC cache replacement policy is scan-resistant because cache pages that are only accessed can only reside in the T1 portion of the cache. As a result, they cannot force the expulsion of all older pages.

3. Corey address ranges improve the performance of MapReduce applications because they let applications specify which parts of their address space are shared and which are private. As a result, each MapReduce application can specify that each core will have a private stack and a shared result area.

4. Both clocks will display twenty after two.

5. Neither C nor C++ has the equivalent of a guarded command because the message passing primitives they support all use indirect naming.

6. Without guaranteed vector messages, processes in a multiple ring protocol would not be able keep delivering the messages they receive whenever one of the rings does not send any messages.

7. If the messages are agreed delivery messages, processor A will deliver messages 3 and 4 while processors B and C will deliver messages 3, 4 and 5. If they are safe delivery messages, the three processors will only deliver messages 3 and 4.

8. The processor will deliver the two messages from ring A and the first message from ring C.

9. (a) Since all passwords would have been compromised, all users would have to obtain new passwords. (b) Since all tickets would have been compromised, all users currently logged on the system would have to reenter their logins and passwords.

10. Should a malicious intruder roll back the clock of a Kerberos service, its Ticket Granting Server would start accepting replays of older requests.

11. Under BitTorrent rarest first policy, peers attempt to download first the pieces that the fewest of their own peers have. This ensures that each peer has the pieces that most of its peers want.

12. Randomly.