1. What is the function of SPIN externalized references? (5 points) How are they implemented? (5 points)

SPIN externalized references are used to pass pointers to kernel data structures to user-level applications in a safe manner. To prevent any tampering with the pointer, the user-level application is given an index into a per-application table of safe references to kernel data structures.

2. What is the difference between a logical clock and a physical clock? (10 easy points)

Unlike physical clocks, logical clocks do not measure the passing of time.

3. What is the function of Totem guaranteed vector messages? (10 easy points)

Totem guaranteed vector messages let processes in a multiple ring protocol keep delivering the messages they receive when one of the rings does not forward any messages.

4. Which are the respective strong points of (a) Kerberos and (b) one–time password systems for controlling remote access to computing services? (2×5 points)

The strong point of Kerberos is Kerberos does not require any additional hardware such as a smart card.

The strong point of one-time password is One-time passwords allow secure remote access from untrusted workstations (and dumb terminals too).

5. How does Nooks recover from an extension failure? (5 points)

It restarts the extension.

What is the main limitation of this approach? (5 points)

It does not work for all extensions.
6. Consider a RAID-5 system with four data blocks \((b_0, b_1, b_2, b_3)\) and one parity block \(p\) per stripe.

   a) How much of the total disk space is used by parity blocks? (5 easy points) \(20\) percent

   b) How can we reconstitute the contents of block \(b_0\) after the disk holding that block has failed? (5 points)

   \[ b_0 = b_1 \oplus b_2 \oplus b_3 \oplus p \]

7. Consider a single-ring Totem system comprising two processors A and B. Assuming that each of these two processors has received the following messages:

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

   Which messages will be delivered by each processor if all messages are agreed delivery messages? (2×5 points and no partial credit)

   A will deliver messages numbered \(3\) and \(4\)

   B will deliver messages numbered \(3, 4\) and \(5\)

8. Consider the following CSP program:

   \( \text{ch} : \text{char}; *[\text{one} ? c \rightarrow \text{two} ! c]; \)

   a) What is the program doing? (5 points)

   _ It sends to process two the characters it gets from process one. ___________

   b) When will it terminate? (5 points)

   _ When process one terminates. ____________________________

9. What is a Content Distribution Network (CDN)? (10 easy points)

10. What is the function of a Coral Distributed Sloppy Hash Table (DSHT)? (10 points for the function and no need to describe its operation)