This exam is closed book. You can have one sheet (i.e., two pages) of notes. Please be specific and answer every part of every question.

1. Consider a RAID-5 system with four data blocks per stripe (b₀, b₁, b₂ and b₃) and one parity block p.
   (a) How much of the total disk space is used by the parity blocks? (5 points)
   _____20___ percent

   (b) What is the minimum number of disk drives required to implement this organization? (5 points)
   ______5____ drives

   (c) What is the most efficient way to update block b₃? (10 points)

   Read block(s) old block b₃ and old parity block p ______________________________

   Compute new parity block = old block b₃ XOR new block b₃ XOR old parity block p

   Write new block b₃ and new parity block p ______________________________

2. What is the major disadvantage of logical clocks over physical clocks? (10 points)

3. What are replays? (5 points) What can they be used for? (5 points) What does Kerberos to allow servers to distinguish them from authentic messages? (10 points)

4. Why are guarded commands an essential part of CSP's design? (5 points) Why do UNIX IPC packages not require them? (5 points)

5. What is the function of Totem’s guaranteed vector messages? (10 points) (Hint: explain what would happen without them.)

6. Give two techniques that could be used by a mischievous extension to circumvent the measures taken by Nooks to protect the kernel. (2×5 points)

7. Spring treats the thread issuing a cross-domain call and all downstream threads as a single scheduling entity called a shuttle. Why does it not merge them instead into a single thread within the calling domain? (2×5 points) (Hint: I expect two reasons.)

8. What is the function of a software abstraction in xOK? (5 points)

9. What is the performance advantage of using a type-safe programming language in your kernel rather than relying on dynamic checks? (5 points) (Hint: The answer is rather short.)