Final Exam

CS 423 / 523 – Principles of Operating Systems

Start: X pm, Stop: Y pm (1 hour and 15 minutes)

Name:

NetId:

<table>
<thead>
<tr>
<th>Section</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Answer</td>
<td>/ 40</td>
</tr>
<tr>
<td>Memory Management</td>
<td>/ 20</td>
</tr>
<tr>
<td>Storage Management</td>
<td>/ 20</td>
</tr>
<tr>
<td>Protection, Virtual Machines, and Distributed Systems</td>
<td>/ 20</td>
</tr>
<tr>
<td></td>
<td>/ 100</td>
</tr>
</tbody>
</table>

Total Score:
1. **Short Answer (40 points)**

Briefly answer the following questions (16 points):

1. How are network link failures detected? Describe a protocol that accomplishes this. [5]
2. What is the optimal page replacement algorithm? [2]
3. How can we avoid cycles when using general graph directories? [3]
4. What are the main challenges faced in building a distributed file system? [3]
5. What is the difference between internal and external fragmentation? How can one reduce fragmentation? [3]

Define (2 points each x 7 = 14):

1. Inverted page table
2. Absolute code
3. Virtual memory
4. Protection domain
5. DNS
6. Hypervisor
7. RAID

State whether the following statements are true or false with a short explanation (merely stating true/false is not enough, 2 points each x 5 = 10):

1. While a single page table would be too long, multi-level paging allows us to feasibly address a 64 bit logical address space.
2. Using a linked list for keeping track of free space on a disk makes it easy to get contiguous space.
3. Free-behind and read-ahead are techniques used to optimize random access.
4. The NFS (Network File System) mounting protocol modifies the server side directly, instead of merely changing the user’s view of the remote directory.
5. Among circuit, message, and packet switching, the first requires the most initial setup time.

2. **Memory Management (20 points)**

2. Under what circumstances are clustered page tables most useful? [2]
3. What are translation look-aside buffers, and what are they used for? [2]
4. How does copy-on-write increase process creation efficiency? [2]
5. What is Belady’s Anomaly? [3]
6. Describe the second-chance “clock” page replacement algorithm. What are its advantages and disadvantages compared to LRU? [5]
7. What is the working set model, and what is it used for? [4]
3. **Storage Management** (20 points)

1. Describe the SCAN disk scheduling algorithm. How is it different from C-SCAN? [5]
3. What is linked allocation? List some of its advantages and disadvantages. [4]
5. When would you use the page cache instead of the buffer (disk) cache? [3]

4. **Protection, Virtual Machines, and Distributed Systems** (20 points)

1. What are the different kinds of routing strategies, and what are their relative advantages and disadvantages? [6]
2. Between OSI and TCP/IP, which is preferred and why? [4]
3. What is an access matrix, and how does it represent domains and objects? [4]
4. List some benefits of having virtual machines. [3]
5. What is “trap and emulate”? [3]