# - Test 2 -

**CSE 420**
**Design of Operating Systems**
**Fall 2020**

| Question | Points Possible | Points Received |
|---|---|---|
| 1 | 20 | |
| 2 | 5 | |
| 3 | 5 | |
| 4 | 5 | |
| 5 | 10 | |
| 6 | 10 | |
| 7 | 5 | |
| 8 | 5 | |
| 9 | 5 | |
| 10 | 5 | |
| 11 | 5 | |
| 12 | 10 | |
| 13 | 10 | |
| Total | 100 | |

NAME:_____

ID:_____

**Instructions**

1. This is a closed book and closed notes exam.
2. You have 120 minutes.
3. No calculators, cellphones, or other electronics are allowed.
4. No restroom break is allowed.
5. Check the number of pages in your exam, there should be a total of 5 pages excluding this cover page.

*Easy* *Difficulty Level* *Difficult*

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1 2 3 4 5 6 7 8 9 10

1. (20 pts) Mark each of the following statements as **True** or **False**.

| | **Statement** | **True** | **False** |
|---|---|---|---|
| 1. (1 pts) | External fragmentation does not occur in a paging based memory management scheme. | | |
| 2. (1 pts) | Inverted page tables require each process to have its own page table. | | |
| 3. (1 pts) | A 32-bit logical address with 4 KB page size will have $2^{20}$ entries in a single level page table. | | |
| 4. (1 pts) | Hierarchical page tables are appropriate for 64-bit architectures. | | |
| 5. (1 pts) | Best fit is the dynamic storage-allocation algorithm which results in the largest leftover hole in memory. | | |
| 6. (1 pts) | copy-on-write allows the parent and child processes to initially share the same pages, but when either process modifies a page, a copy of the shared page is created. | | |
| 7. (1 pts) | The TLB reach is the number of entries in the TLB multiplied by the page size. | | |
| 8. (1 pts) | OPT page replacement is used mostly for comparison with other page-replacement schemes. | | |
| 9. (1 pts) | Belady's anomaly states that for some page replacement algorithms, the page-fault rate may increase as the number of allocated frames increases. | | |
| 10. (1 pts) | Data striping provides reliability for RAID systems. | | |
| 11. (1 pts) | RAID level 0 provides no redundancy. | | |
| 12. (1 pts) | Sector sparing is a technique used in HDDs for managing bad blocks that maps a bad sector to a spare sector. | | |
| 13. (1 pts) | Seek time + transfer time are the two components of positioning time in HDDs. | | |
| 14. (1 pts) | FCFS disk scheduling algorithm does not take into account the current position of the disk head. | | |
| 15. (1 pts) | An absolute path name must always begin at the root. | | |
| 16. (1 pts) | Metadata includes all of the file-system structure, including the actual data (or contents of the file). | | |
| 17. (1 pts) | On UNIX systems, the data structure for maintaining information about a file is called a superblock. | | |
| 18. (1 pts) | The file-allocation table (FAT) used in MS-DOS is an example of indexed allocation. | | |
| 19. (1 pts) | Increasing the number of context switches can improve the efficiency of I/O. | | |
| 20. (1 pts) | The status register of an I/O port is written by the host to start a command or to change the mode of a device. | | |

2. (5 pts) Briefly describe the two memory access problem in a paging based memory management scheme by explaining the role of TLB in it.

3. (5 pts) Consider a logical address with a page size of 1 KB. How many bits must be used to represent the page offset (displacement) in the logical address?

   (a) 1
   (b) 10
   (c) 1000
   (d) 1024
   (e) None of the above.

4. (5 pts) Consider a 32-bit address for a two-level paging system with an 8 KB page size. The outer page table has 512 entries. How many bits are used to represent the inner-level page table?

   (a) 9
   (b) 10
   (c) 13
   (d) 8192
   (e) None of the above.

5. (10 pts) Assume the portion of the page table for a process that is currently executing in the CPU is as follows:

Page Table

| | |
|---|---|
| 0 | 1 |
| 1 | 7 |
| 2 | 13 |
| 3 | 14 |
| 4 | 0 |
| 5 | 10 |
| 6 | 3 |
| 7 | 8 |

Page size is 4 bytes, logical addresses are 5 bits, and the physical memory is 64 bytes. Convert the logical address 20 (in decimal) to the corresponding physical address (in decimal). *To receive full credit, show your work and write your final answer inside the provided box.*

**Answer:** Corresponding physical address in decimal is: [ ]

6. (10 pts) A hypothetical machine that is using virtual memory has 48 bit virtual addresses and 1 GB physical memory. Assume page size is 4 KB and each page table entry requires 8 bytes of storage in memory. Compute the required page table size in bytes if an inverted page table is used. *To receive full credit, show your work and write your final answer inside the provided box.*

Answer in bytes: [ ]

7. (5 pts) Suppose we have the following page accesses: 1, 2, 3, 4, 3, 2, 4, 1, 2, 1, 3, 1, 4 and that there are 3 frames within our system. Using the LRU replacement algorithm, what is the number of page faults for the given reference string?

   (a) 6
   (b) 7
   (c) 8
   (d) 9
   (e) None of the above.

8. (5 pts) Given the memory reference string of page accesses: 1, 2, 3, 4, 3, 2, 4, 1, 2, 1, 3, 1, 4 and a system with 3 page frames, what is the final configuration of the 3 frames after the OPT algorithm is applied? Use LRU to break ties, if any.

   (a) 1, 3, 4
   (b) 3, 4, 1
   (c) 4, 1, 3
   (d) 1, 4, 3
   (e) None of the above.

9. (5 pts) In one sentence, explain when does thrashing occur in a paging based memory management scheme.

10. (5 pts) Consider a disk queue holding requests to the following cylinders in the listed order: 116, 22, 3, 11, 75, 185, 100, 87. Using the SCAN disk scheduling algorithm, what is the order that the requests are serviced, assuming the disk head is at cylinder 88 and moving upward through the cylinders?

    (a) 116 - 22 - 3 - 11 - 75 - 185 - 100 - 87

    (b) 100 - 116 - 185 - 87 - 75 - 22 - 11 - 3

    (c) 87 - 75 - 100 - 116 - 185 - 22 - 11 - 3

    (d) 100 - 116 - 185 - 3 - 11 - 22 - 75 - 87

11. (5 pts) Briefly describe a disadvantage of the SSTF disk scheduling algorithm.

12. (10 pts) Briefly describe polling and interrupt based I/O completion mechanisms by providing at least one advantage and disadvantage of each.

13. (10 pts) Assuming 200 sectors on each track, how much cylinder skew (in terms of number of sectors) is needed for a 10000 RPM HDD with cylinder to cylinder seek time of 0.9 milliseconds? *To receive full credit, show your work and write your final answer inside the provided box.*

    Answer in sectors: [ ]