CSE 3320 Operating Systems
Fall 2022

Final Exam

Score: _____ / 100

Gondor Edition

Name: _____

Student ID: _____

"I certify that the following work is my work alone and I will follow the highest standards of integrity and uphold the spirit of the Honor Code"

Signature: _____

This is a closed book, closed notes exam. You may use one hand written 3x5 index card with notes. Please answer the questions briefly but completely. Write your answers legibly. Unreadable answers will be counted wrong. You may write on back if needed. There is a powers of two tables on the last page

1. (4 points) You are given an index allocated file system with disk blocks that are 4 KB in size and a pointer to a disk block is 16 bit. This file systems index nodes have 10 direct disk blocks, as well as 4 indirect disk blocks, 2 double indirect blocks and 1 triple indirect block. What is the largest file that can be held using this inode layout?

2. Suppose you had a computer that supported virtual memory and had 64-bit virtual addresses with 1 KB pages.
   (a) (5 points) How many bits are allocated for the page index in a single level page table?

   (b) (5 points) How many bits are allocated for each level in a triple level page table?

3. Consider a reference string 1,3,5,6,4,2,3,5,2,1,6,3,7,1,2,3,4,5,2; and a system with only 4 frames, pure demand paging, and all frames initially empty.

   (a) (2 points) How many page faults would occur with an Optimal replacement scheme?

   (b) (2 points) How many page faults would occur with a LRU replacement scheme?

4. (4 points) A disk rotates at 5000 RPM. It has 1000 sectors of 1024 bytes each round the outer cylinder. Given a seek time of 4 ms, calculate the time to read 65,535 bytes from the disk.

5. (4 points) What are some examples of instructions that should only be run in kernel mode?

   A. Accessing protected system resources

   B. Interrupting other processes

   C. Allocating memory for a new process

   D. All of the above

   E. None of the above

6. (10 points) What is a digital signature, and how does it help to ensure the authenticity and integrity of a digital message or document?

7. (6 points) What factors make up multi-factor authentication?

8. (4 points) What is authentication and authorization?

9. (2 points) Which of the following is a key advantage of a monolithic kernel over a microkernel?
    A. It is more modular and easier to update
    B. It is more efficient and has better performance
    C. It is more flexible and can support a wider range of devices and hardware

10. (2 points) Which of the following is a key advantage of a monolithic kernel over a microkernel?
    A. It is more modular and easier to update
    B. It is more efficient and has better performance
    C. It is more flexible and can support a wider range of devices and hardware

11. (2 points) How does a monolithic kernel differ from a hybrid kernel?
    A. A monolithic kernel is a single, static binary file, while a hybrid kernel is composed of multiple, separate modules
    B. A monolithic kernel is composed of multiple, separate modules, while a hybrid kernel is a single, static binary file
    C. A monolithic kernel is a type of microkernel, while a hybrid kernel is a type of monolithic kernel

12. (2 points) How does a TLB improve the performance of virtual memory?
    A. By increasing the size of the virtual memory address space
    B. By decreasing the amount of time it takes to access virtual memory
    C. By reducing the number of page faults that occur

13. (2 points) Which of the following is a disadvantage of using a monolithic kernel?
    A. It is less efficient and has poorer performance than a microkernel
    B. It is less flexible and cannot support as many devices and hardware configurations
    C. It is more difficult to develop and maintain than a microkernel

14. (2 points) Which of the following operating systems use a monolithic kernel?
    A. Android
    B. IOS
    C. Ubuntu

15. (2 points) Which of the following is a key difference between a monolithic kernel and a modular kernel?

    A. A monolithic kernel is a single, static binary file, while a modular kernel is composed of multiple, separate modules

    B. A monolithic kernel is composed of multiple, separate modules, while a modular kernel is a single, static binary file

    C. A monolithic kernel is a type of microkernel, while a modular kernel is a type of monolithic kernel

16. (2 points) What is the primary function of a translation look aside buffer (TLB)?

    A. To store data in memory for quick access

    B. To store the address translation information for virtual memory

    C. To improve the performance of the cache

17. (14 points) List the 7 layers of the OSI Network Model and give an example of each.

18. (9 points) Given the following table of tasks determine the average run time, average response time and average turnaround time for Priority with Preemption algorithm

PID	Arrival	Runtime	Priority
1	0	9	1
2	1	7	3
3	3	5	2
4	6	5	4
5	6	3	1
6	10	5	3
7	11	3	2
8	12	1	1

Extra Space If Needed

19. (4 points) For the following two TLB, calculate the effectice access time.

Serial
$\epsilon = 6$ milliseconds
Memory access time is 80 nanoseconds
$\alpha = 70\%$

EAT: _____

Parallel
$\epsilon = 6$ milliseconds
Memory access time is 100 nanoseconds
$\alpha = 60\%$

EAT: _____

20. (6 points) A computer provides each process with 65,536 bytes of address space divided into pages of 1024 bytes each. A particular program has a text size of 32,768 bytes, a data size of 16,386 bytes, and a stack size of 15,870 bytes. Will this program fit in the machines address space in a non-demand paging solution? Suppose that instead of 1024 bytes, the page size were 512 bytes, would it then fit? Each page must contain either text, data, or stack, not a mixture of two or three of them.

True / False

21. (1 point) ___ Demand paging is a method of virtual memory management that allows a computer to transparently support the execution of programs that are larger than the available physical memory.

22. (1 point) ___ In demand paging, the operating system maintains a page table that tracks the location and status of each page of a program, as well as the mapping between virtual memory addresses and physical memory addresses.

23. (1 point) ___ Demand paging can improve system performance by reducing the amount of time spent waiting for data to be loaded from slow storage devices, but it also introduces additional overhead in the form of disk accesses and page fault handling.

24. (1 point) ___ In demand paging, the operating system uses a page replacement algorithm to determine which pages should be swapped out of physical memory when new pages need to be loaded.

25. (1 point) ___ Demand paging is often used in virtual memory systems, where the available physical memory is supplemented by a larger virtual memory space that is implemented using a combination of physical memory and secondary storage.

Not Quite Impossibly Hard, But Pretty Close, Bonus Questions

(1pt) Given the following list of Star Wars movies, list them in order of greatness with # 1 being the greatest.

A: Star Wars
B: The Empire Strikes Back
C: Return of the Jedi
D: The Phantom Menace
E: Attack of the Clones
F: Revenge of the Sith
G: The Force Awakens
H: Rogue One
I: The Last Jedi
J: Solo: A Star Wars Story
K: The Rise of Skywalker

1: _____

2: _____

3: _____

4: _____

5: _____

(1pt) In 1995, a company founded by Jean-Louis Gassée released this operating system _____

(1pt) This operating system was originallt written for the Hobbit architecture _____

(1pt) This operating system was named after a 1957 Ed Wood movie. _____

(1pt) Who directed the SuperBowl "1984" commerical introducing the Macintosh? _____

(1pt) The PlayStation 4 operating system is based on what operating system? _____

(0pt) Since there's a lot of leftover space here. I'm looking for a recommendation for a tattoo artist in the area for a black and white full sleeve:

n	2^n	n	2^n	n	2^n	n	2^n
0	1	16	65,536	32	4,294,967,296	48	281,474,976,710,656
1	2	17	131,072	33	8,589,934,592	49	562,949,953,421,312
2	4	18	262,144	34	17,179,869,184	50	1,125,899,906,842,624
3	8	19	524,288	35	34,359,738,368	51	2,251,799,813,685,248
4	16	20	1,048,576	36	68,719,476,736	52	4,503,599,627,370,496
5	32	21	2,097,152	37	137,438,953,472	53	9,007,199,254,740,992
6	64	22	4,194,304	38	274,877,906,944	54	18,014,398,509,481,984
7	128	23	8,388,608	39	549,755,813,888	55	36,028,797,018,963,968
8	256	24	16,777,216	40	1,099,511,627,776	56	72,057,594,037,927,936
9	512	25	33,554,432	41	2,199,023,255,552	57	144,115,188,075,855,872
10	1,024	26	67,108,864	42	4,398,046,511,104	58	288,230,376,151,711,744
11	2,048	27	134,217,728	43	8,796,093,022,208	59	576,460,752,303,423,488
12	4,096	28	268,435,456	44	17,592,186,044,416	60	1,152,921,504,606,846,976
13	8,192	29	536,870,912	45	35,184,372,088,832	61	2,305,843,009,213,693,952
14	16,384	30	1,073,741,824	46	70,368,744,177,664	62	4,611,686,018,427,387,904
15	32,768	31	2,147,483,648	47	140,737,488,355,328	63	9,223,372,036,854,775,808