CSE 3320 Operating Systems
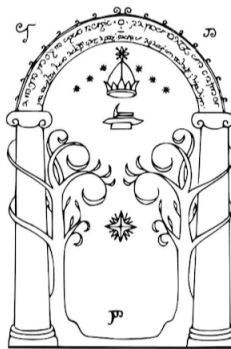## Fall 2023

Exam 2

Score: _____ / 100

Mines of Moria 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: _____

1. (6 points) Given a file system that uses inodes to represent files. Disk blocks are 8192 bytes in size, and a pointer to a disk block is 16 bits. This file systems index nodes have 12 direct disk blocks, 2 indirect blocks, 1 double indirect disk block and a triple indirect block. What is the largest file that can be held using this in inode layout?

2. Describe:

   (a) (3 points) Internal Fragmentation

   (b) (3 points) External Fragmentation:

3. (9 points) Explain the three different disk allocation schemes we discussed. Make sure to explain if they suffer from external fragmentation and if they support random access.

4. (5 points) What is a critical region and how is it guarded?

5. (10 points) Given a page request reference string of F A B C B D A E C D B B D A C F G B and a page table size of four, calculate how many page faults will occur with the optimal page replacement algorithm. If all pages are equally replaceable pick the first available.

6. (8 points) A 64-bit computer has 16GB of RAM. Given a page table of 134,217,728 entries how large is each page table entry in bytes?

7. (6 points) A parallel translation lookaside buffer, A, has a lookup time of 18 nanoseconds. The memory cycle time is 50 nanoseconds. Its hit ratio is 90%. A serial TLB, B, has a lookup time of 15 nanoseconds. The memeory cycle time is 50 nanoseconds. Its hit ratio is 94%. From a performance perspective which TLB is most desireable. You must quantify your answer.

8. (8 points) A computer provides each process with 1,048,576 bytes of address space divided into pages of 4096 bytes each. A particular program has a text size of 262,160 bytes, a data size of 750,146 bytes, and a stack size of 41,240 bytes. Will this program fit in the machines address space in a non-demand paging solution? Suppose that instead of 4096 bytes, the page size were 2048 bytes, would it then fit? Each page must contain either text, data, or stack, not a mixture of two or three of them. Answers without quantifying the reasons will be counted wrong.

9. (8 points) What are the four conditions for a deadlock?

10. (4 points) Give a page table of 134,217,728 entries and each page being 65,536 bytes in size, what is the maximum addressable memory of this table?

11. (10 points) On a 53-bit CPU with 16 GB of physical RAM split into 4,194,304 frames, how many entries are in the page table?

12. (10 points) Consider a system with seven processes, A though G, and 8 resources, 1 through 8. The state of which resources are currently owned and which ones are currently being requested is as follows:

Process A holds 6 and wants 1
Process B holds 1 and wants 2
Process C holds 2 and wants 4 and 5
Process D holds 3 and wants 4 and 8
Process E holds 1 and wants 3
Process F wants 7
Process G holds 8 and wants 6

Is it deadlocked?

13. (10 points) Is the following system deadlocked. You must show your work:
    Existing:

$$\begin{bmatrix} 6 & 4 & 2 & 3 \end{bmatrix}$$

Allocated:

$$\begin{bmatrix} 1 & 1 & 0 & 1 \\ 2 & 0 & 0 & 0 \\ 3 & 2 & 0 & 0 \\ 0 & 0 & 2 & 2 \end{bmatrix}$$

Available:

$$\begin{bmatrix} 0 & 1 & 0 & 2 \end{bmatrix}$$

Needed:

$$\begin{bmatrix} 2 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 4 & 2 & 1 & 3 \\ 0 & 1 & 0 & 0 \end{bmatrix}$$

Extra Space If Needed

Not Quite Impossibly Hard, But Pretty Close, Lottery Bonus Question

1. 6 non-repeating numbers, of values 0 through 99 inclusive, have been selected. For an automatic A in the course, pick 6 non-repeating numbers that match my selected numbers.

The winning numbers have been randomly generated by random.org, encrypted and digitally signed and posted to GitHub https://github.com/CSE3320-Fall-2023/Exam-2-Bonus-Answer.git. The numbers will be revealed during the class on encryption 11/01/23. You may also write your numbers on the last page of the exam and take that page with you. If you are taking this exam in the SAR, since you can not leave with the exam papers, I will email you the numbers you wrote on this page.

The numbers you write on this page will be considered your official submission. Good Luck!

1.

2.

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Your Copy of Your Bonus Submission

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The numbers you wrote on the page you turned in will be considered your official submission. Good Luck!

1.

2.

3.

4.

5.

6.

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