CS342 Operating Systems
Spring 2024
Homework #3

Assigned: May 7, 2024.
Due date: May 18, 2024. Document version: 1.0

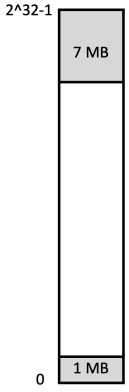
Q1. There are 5 processes P1, P2, P3, P4, P5 in a system. There are 3 resources types (A, B, C); and we have 5 A, 3 B, and 5 C in the system in total (all available initially). The system can detect deadlocks. The current Allocation and Request matrices are shown below. Is there a deadlock at the moment? Prove your answer.

	Alloc			Request		
P1	1	0	0	0	1	0
P2	1	0	0	0	3	0
P3	1	2	0	0	0	0
P4	1	0	1	1	0	2
P5	1	1	3	0	0	2

Q2. We have a system with 3 resource types: A, B, C. There are (exist) 7 A, 5 B, and 9 C in the system in total. Then, some of these resources are allocated and we have the following system state. There are 5 processes. Is this a safe state or not? Prove your answer.

	Alloc			MaxDemand		
P1	1	0	3	5	1	5
P2	1	1	1	1	2	1
P3	1	2	1	2	6	3
P4	1	2	1	2	2	3
P5	2	0	1	3	3	1

Q3. Assume a computer is using 32 bit virtual addresses and two-level paging. Address division scheme is: (10, 10, 12). That means offset is 12 bits long. What is the page size? Find out the amount of physical memory (in KB) required for the page table information of a program with the following address space layout. The gray areas are used VM regions.



Q4. Consider the following single-level page table. All numbers in the table are decimal. Logical (virtual) addresses are 16 bits long. Physical addresses are 20 bits long.

0	
1	
2	25
3	
4	
5	17
6	
7	
8	95
9	
10	3
11	8
12	
13	45
14	
15	

Convert the following virtual addresses to the physical addresses (the given addresses are in hexadecimal). You answer should be in hexadecimal.

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a) 0xa30d    b) 0x5023 c) 0x8a1f  d) 0x301e
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Q5. Assume TLB access takes 4 ns. Ordinary memory access takes 160 ns (1 physical memory access time). We have 3-level paging used in a system. Hit rate of the TLB is 80%. What is the effective memory access time?

Q6. Consider the following page reference string.

3 5 2 4 5 2 7 6 3 4 9 0 4 3 6 0

Clock page replacement algorithm is used. We have 4 frames that can be used by a process. R bits are clearing after *every* 6 page references (after the 6th reference is completely processed, so that the effect of clearing will be seen in the 7th reference).

a) Find out the memory state (i.e., the pages and their R bits) after each reference. Show also if the reference causing a page fault or not. Assume that a newly loaded page will have its R bit set to 1.

b) Solve the same question for LRU (exact).

Q7. Consider a hard disk (HDD) of size 256 GB. Assume block size is 16 KB (for all the questions below).

a) If bitmap method is used to keep track of free space, how many disk blocks are occupied by the bitmap?

b) If FAT table method is used by the file system on this disk, how many disk blocks are occupied by the FAT table? Assume a FAT entry is 8 bytes

long. Also assume that each block of the disk needs to have an entry in the FAT table.

c) Assume indexed allocation is used in the file system (not FAT), like the Linux file system (Combined/mixed scheme). We have 12 direct data block pointers in the inode of a file. If needed, we can use a single index block (1-level index structure); if needed we can also use a two-level index structure; and if needed, we can additionally use a 3-level index structure, as in Linux file system. Pointer size is 8 bytes.

i) How many index blocks are required for files A, B, C, D of the following sizes: File A: 40 KB, File B: 1 MB, File C: 128 MB, File D: 4 GB?

ii) What is the maximum file size supported?