CS 370: Operating Systems
Department of Computer Science
Colorado State University

Spring 2022
URL: http://www.cs.colostate.edu/~cs370

HW7 v04.19.2022.11AM

DUE DATE: Friday April 22, 2022, 11 PM. Submit MS Word or PDF file using Canvas. Name it yourlastnameHW7.docx or .pdf. **You must show how the answer was obtained by giving the main steps in the procedure.**

Problem 1 (17 points) Recall the various deadlock detection and prevention algorithms we've discussed in this course. The following is the state of a system with these processes: P1, P2, P3, P4, P5 and these resources: R1, R2, R3, R4.

There are no current outstanding queued unsatisfied requests.

Currently Available Resources

R1	**R2**	**R3**	**R4**
2	0	3	1

	Current Allocation				**Max Need**				**Still Needs**			
Process	**R1**	**R2**	**R3**	**R4**	**R1**	**R2**	**R3**	**R4**	**R1**	**R2**	**R3**	**R4**
P1	4	2	3	3	6	6	5	6				
P2	2	3	0	0	2	3	2	1				
P3	3	3	1	2	6	8	4	2				
P4	2	2	5	5	4	3	5	6				
P5	0	0	4	1	5	5	4	2				

i) Fill the table (3 pts)
ii) Is this system currently deadlocked, or can any process become deadlocked? Why or why not? If not deadlocked, give an execution order with reasoning details of the order. (6 pts)

iii) If a request from a process P2 arrives for (0, 0, 2, 2), should the request be immediately granted? Explain why or why not? If yes, show an execution sequence. (4 pts)

iii) If a request from a process P5 arrives for (1, 0, 0, 0), should the request be immediately granted? Explain why or why not? If yes, show an execution sequence. (4 pts)

Problem 2 (10 points) A system with virtual memory has these page accesses: 2 3 4 3 1 3 1 2 1 4 1 3 2 1 and that there are three frames in the system. Show how the **FIFO** replacement algorithm will work, and what will be the final contents of the three frames following the execution of the given reference string? Use the table below to the successive contents of the frames.

Answer: Filling the table (8 pts), final configuration (2 pts)

	2	3													
F0															
F1															
F2															
F/H															

*F = Fault, H = Hit

Problem 3 (12 points) Given these sequential page accesses: 2 3 4 3 1 3 1 2 1 4 1 3 2 1 and a system with three page frames, what will be the final contents of the three frames after the **LRU** algorithm is applied? Use the table below to the successive contents of the frames.

Answer: Filling the table (8 pts), final configuration (2 pts)

	2	3													
F0															
F1															
F2															
F/H															

*F = Fault, H = Hit

Problem 4 (11 points) Assume we have a demand-paged memory. Assume that the time needed to access the page table is negligible. It requires 10 milliseconds to handle a page fault if an empty page is available or the replaced page is not dirty, and 30 milliseconds if the replaced page is dirty. Memory access time is 100 nanoseconds. Assume that the page to be replaced is dirty 60 percent of the time. What is the maximum acceptable page-fault rate for an effective access time of no more than 300 nanoseconds?

Show your work here:

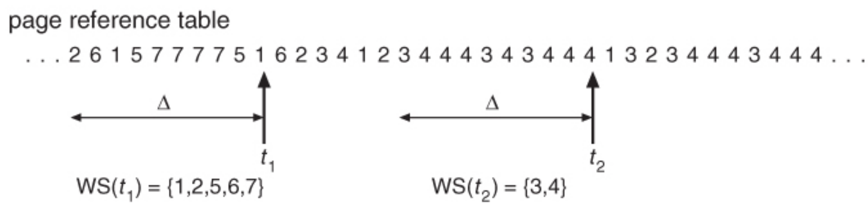
Answer:

Problem 5 (5 points)

a. A system uses 32-bit logical addresses, a 64K byte (2^{16}) page size, and 36-bit physical addresses (64 GB memory). What is the size of the page table? (2 pts):

□ 2^{20} entries (2^{36-16}).	□ 2^{4} entries (2^{36-32}).
□ 2^{16} entries (2^{32-16}).	□ 2^{14} entries

b. We had seen an example of determining the Working Sets using a given value of Δ. For that example, obtain the value of WS(t1) and WS(t2) if Δ = 3. (3 pts)



Answer:

Problem 6 (13 points) The page table below is for a system with 16-bit virtual as well as physical addresses and with 4,096-byte pages. The reference bit is set to 1 when the page has been referenced. Periodically, a thread zeroes out all values of the reference bit. A dash for a page frame indicates the page is not in memory. The LRU page-replacement algorithm is used. The numbers are given in decimal.

Page	Frame	ReferenceBit
0	9	1
1	6	1
2	11	1
3	12	0
4	–	0
5	14	0
6	7	1
7	10	1
8	–	0
9	1	0
10	5	0
11	8	1
12	–	0
13	–	0
14	15	1
15	3	0

A. Convert the following virtual addresses (in hexadecimal) to the equivalent physical addresses(hex). (5 pts)

Virtual Address	Physical Address
0xF12C	
0x5A9D	
0xA9D9	
0x7001	
0xBCA1	

B. Will these logical addresses (in hexadecimal) results in a page fault: 0x4123? 0xC000? (4 pts)

Answer:

C. Give the complete list of frames which may be chosen by the LRU page-replacement algorithm in resolving a page fault? (4 pts)

Answer:

Problem 7 (8 points) A system that uses demand-paging with a disk that has an average page access and transfer time of 10 milliseconds. Addresses are mapped using a page table in main memory, with an access time of 1 microsecond per access. To improve this time, the system designers have added an associative memory that reduces access time to one memory reference, when the page-table entry is in the associative memory. If 80 percent of the accesses result in an associative memory hit, and of those remaining, 20 percent (or 4 percent of the total) cause page faults, what is the effective memory access time?

Computations here:

Effective Memory Access Time = [must have correct units]

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Problem 8 (12) Consider the following page reference string:
6, 5, 7, 1, 4, 6, 1, 4, 7, 8, 6, 1, 0, 5, 3, 9, 2, 3, 4 , 1.
Assuming demand paging with three frames, what page fault rate would be encountered for the following replacement algorithms?

• LRU replacement
• Optimal replacement

Filling the tables (4 pts for each)

	6																				
F0																					
F1																					
F2																					

LRU: Page fault rate (2 pts): ____________ = ________

	6																				
F0																					
F1																					
F2																					

Optimal: Page fault rate (2 pts): ____________ = ________

Problem 9 (6 points)

a. Give a block diagram of a TLB. Mention where the input comes from and where does the output go. Identify where the page numbers are stored and where the corresponding frame numbers are stored. (3 pts)

b. A system has 32 bit logical and physical addresses. The frames are 1024 bytes each. What is number of bits in the TLB input and output. (3 pts)

Problem 10 (6 points) Consider a disk queue holding requests to the following cylinders in the listed order: 138, 22, 3, 41, 71, 185, 99, 87. Using the Shortest Seek Time First (SSTF) scheduling algorithm, what is the order in which the requests are serviced, assuming the disk head is at cylinder 85 and moving upward through the cylinders? The cylinders are 0 to 199.

Use the graph below for a diagram. Assume each column includes 10 cyclinders (i.e first one includes 0-9 etc)

0-19	20-39	40-59	60-79	80-99	100-119	120-139	140-159	160-179	180-199
				Initial:85					
				1:87					

What is the total head movement: ______ cylinders

Updates: Any updates/clarifications will be noted below.

Problem 5 (a). Numbers of calculations are changed to correct one.

The deadline is April 22 and not 29.