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Computer Science

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CS 330 - Assignment 4

Question 1:

a. Optimal (OPT)

1	1	1	1	3	3	2	1	7										
	0	0	0	0	0	0	0	0										
		7	2	2	4	4	4	4										

b. Least recently used (LRU)

1	1	1		1		1	0		4		4	4		2	2		7		
	0	0		0		3	3		3		0	0		0	0		0		
		7		2		2	2		2		2	3		3	1		1		

c. Additional-reference-bits

1		2	2		3	3		4	4		2	2	7						
0		0	0		0	0		0	0		0	0	0						
7		7	1		1	2		2	3		3	1	1						

d. Clock (Second-chance)

1		1		1		0		4	4	4		2		2	7				
0		0		3		3		3	0	0		0		0	0				
7		2		2		2		2	2	3		3		1	1				

e. Enhanced second-chance

1		1		1	0		4	0		0	0								
0		0		3	3		3	3		1	1								
7		2		2	2		2	2		2	7								

Question 2:

a. 32 MBs = 32 * 1024 * 1024 bytes = 2 ^ 25 ==> 25 bits length of the virtual address.

b. 256 KBs = 256 * 1024 bytes = 2 ^ 18 ==> 18 bits length of the physical address.

c. The size of a page is 512 bytes = 2 ^ 9 ==> 9 bits length of the offset into a page or frame.

d. Number of pages = 32 * 1024 * 1024 / 512 = 2 ^ 16 ==> 16 bits length of the page number.

e. Number of page frames = 256 * 1024 / 512 = 512 frames.

Question 3:

a. effective memory access time = (1 - p) * memory access time + p * page fault time, where p is the probability of a page fault (0 <= p <= 1).

= (1 - p) * 125 ns + p * 4 500 000 ns

= 125 ns + 4,499,875p ns

b. p = 1/1750 = 0.00057 ==> effective memory access time $\approx 2689.9ns \approx 2.7\mu s$

c. effective memory access time is approximately 22 * 125 ==> the access time for a page not in memory is approximately 22 times that of a page already in memory.

d. for performance degradation of no more than 8.5% ==> no more than 125 ns + 10.625 ns

==> 125 ns + 10.625 ns > 125 ns + 4,499875p ns

==> 10.625 ns > 4,499875p ns ==> p < 0.00000236

e. No more than one memory access in 1 / 0.00000236 = 423,518 can cause a page fault.