CSCI 3753: Operating Systems
Homework Three Solutions

Please write your answers in the space provided.
Due date: Tuesday, April 22 in class. No extensions will be given, except at the instructor's discretion in documented cases of extreme hardship or emergencies.

Problem 1. [40 Points] A memory manager for a variable-sized region strategy has a free list of blocks of size 600, 400, 1000, 2200, 1600, and 1050 bytes. What block will be selected to honor a request for:

a. 1603 bytes using a best-fit policy?
2200

b. 949 bytes using a best-fit policy?
1000

c. 1603 bytes using a worst-fit policy?
2200

d. 349 bytes using a worst-fit policy?
2200

e. 1603 bytes using a first-fit policy? (Assume that the free list is ordered as listed above)
2200

f. 1049 using a first-fit policy?
2200

Problem 2. [30 Points] Given a memory of size 3 frames, and the following sequence of page references 3 2 4 3 4 2 2 3 4 5 6 7 7 6 5 4 5 6 7 2 1, and assuming that no page is initially loaded in the three frames, show the page faulting behavior using the following page replacement policies. How many page faults are generated by each page replacement algorithm?

a. FIFO

	3	2	4	3	4	2	2	3	4	5	6	7	7	6	5	4	5	6	7	2	1
frame 0:	3	3	3	3	3	3	3	3	3	5	5	5	5	5	5	4	4	4	7	7	7
frame 1:		2	2	2	2	2	2	2	2	2	6	6	6	6	6	6	5	5	5	2	2
frame 2:			4	4	4	4	4	4	4	4	4	7	7	7	7	7	7	6	6	6	1
fault? :	*	*	*							*	*	*				*	*	*	*	*	*

12 page faults

b. OPT

	3	2	4	3	4	2	2	3	4	5	6	7	7	6	5	4	5	6	7	2	1
frame 0:	3	3	3	3	3	3	3	3	3	5	5	5	5	5	5	5	4	4	4	4	1
frame 1:		2	2	2	2	2	2	2	2	2	6	6	6	6	6	6	5	6	6	6	6
frame 2:			4	4	4	4	4	4	4	4	4	7	7	7	7	4	7	7	7	2	2
fault? :	*	*	*							*	*	*				*				*	*

9 page faults

c. LRU

	3	2	4	3	4	2	2	3	4	5	6	7	7	6	5	4	5	6	7	2	1
frame 0:	3	3	3	3	3	3	3	3	3	3	6	6	6	6	6	5	4	4	4	2	2
frame 1:		2	2	2	2	2	2	2	2	5	5	5	5	5	5	6	5	6	6	6	1
frame 2:			4	4	4	4	4	4	4	4	4	7	7	7	7	4	7	7	7	7	7
fault? :	*	*	*							*	*	*				*				*	*

9 page faults

Problem 3. [**30 Points]** Suppose on-demand paging is employed in addition to TLB caching. The time for a TLB access (hit or miss) is T = 1 ns, a memory read M = 10 ns, and a disk read D = 10 ms. Let p_TLB = the probability of a TLB hit, and p = the probability of a page fault given a TLB miss.

a. What is a general formula for the average memory access time expressed as a function of T, M, D, p, and p_TLB?

Three scenarios:
(1) TLB hit and no page fault: one memory read (to read the data)
(2) TLB miss and no page fault: two memory read (access page table + read data)
(3) TLB miss and page fault: one disk read (get page from disk to memory) and three memory read (access page table, update page table, read data)

p_TLB * (1 + 10) +
(1 – p_TLB) * (1 – p) * (1 + 10 + 10) +
(1 – p_TLB) * p * (1 + 10000 + 10 + 10 + 10)

b. Once parameter values are substituted, and assuming p = .001 and p_TLB = 90%, what is the average memory access time?

0.9 * 11 +
0.1 * 0.999 * 21 +
0.1 * 0.001 * 10031
= 13.001 ns