Name _____

Exam Three

CS160 - Operating Systems
Drake University - Spring, 2004

Directions: This is an open book/open notes examination. Do all of the following problems. They have equal weight. Show all work. Please work first on problems with which you are more comfortable.

Problem 1. A 128-byte computer uses 128 physical addresses to reference each of its individual bytes. The current contents of this memory are described in the following table, where the notation $nn : mm$ means that address nn contains the byte mm.

00 : 07	10 : 04	20 : 09	30 : 07	40 : 0C	50 : 0A	60 : 04	70 : 02
01 : 04	11 : 07	21 : 0B	31 : 0D	41 : 0C	51 : 03	61 : 02	71 : 07
02 : 02	12 : 09	22 : 04	32 : 00	42 : 00	52 : 0A	62 : 02	72 : 05
03 : 07	13 : 0B	23 : 07	33 : 03	43 : 02	53 : 02	63 : 01	73 : 05
04 : 00	14 : 04	24 : 02	34 : 06	44 : 0D	54 : 02	64 : 09	74 : 0D
05 : 09	15 : 03	25 : 08	35 : 07	45 : 03	55 : 00	65 : 08	75 : 03
06 : 0B	16 : 02	26 : 0F	36 : 04	46 : 09	56 : 01	66 : 08	76 : 04
07 : 01	17 : 0C	27 : 01	37 : 01	47 : 00	57 : 07	67 : 0B	77 : 00
08 : 03	18 : 01	28 : 00	38 : 01	48 : 00	58 : 06	68 : 04	78 : 00
09 : 05	19 : 00	29 : 05	39 : 07	49 : 05	59 : 04	69 : 04	79 : 0A
0A : 00	1A : 07	2A : 05	3A : 03	4A : 07	5A : 04	6A : 05	7A : 06
0B : 0F	1B : 0E	2B : 03	3B : 02	4B : 02	5B : 03	6B : 04	7B : 02
0C : 06	1C : 09	2C : 00	3C : 0C	4C : 08	5C : 0E	6C : 06	7C : 00
0D : 04	1D : 04	2D : 09	3D : 06	4D : 08	5D : 02	6D : 09	7D : 09
0E : 0A	1E : 00	2E : 0F	3E : 00	4E : 0B	5E : 07	6E : 0A	7E : 04
0F : 04	1F : 02	2F : 00	3F : 03	4F : 01	5F : 0B	6F : 0A	7F : 00

Now, assume that a two-tiered (two-level) virtual memory paging system is used to convert twelve-bit virtual addresses into seven-bit prysical addresses, based on sixteen byte pages. The first four (high-order) bits of a virtual address are the primary table field, the next four are the secondary table field, and the last four (low-order) bits are an offset. Assume that the primary table for this system begins at memory location 00. Assume that each table entry is a single byte, and that the three lowest order bits of each table entry give a frame number, and the next higher bit is set to one if the page sought is currently loaded in physical memory. For each of the following virtual addresses (given in hexadecimal), either convert it to a physical address (and explain), or else explain clearly why this is not currently possible.

(a) Virtual addess 573

(b) Virtual addess $EB8$

(c) Virtual addess $F29$

Problem 2. Imagine adding a transfer lookaside buffer consisting of four entries to the system in Problem 5. It might contain entries consisting of a pair of bytes which are used to convert a virtual page numbers to a physical frame. The first byte would be the page number. The second byte would agree with the listing in the appropriate secondary page table in main memory. So its three lowest order bits would be the frame number, as long as the next bit was set. (The four remaining higher order bits would include a modified bit presumably.)

(a) Suppose the TLB currently looks like this

$1st$	$2nd$
61	$0D$
52	09
$B9$	$0A$
$E6$	$0F$

(a) Explain what will happen when the virtual address 526 (which at present has a corresponging physical address) needs to be converted to a physical address.

(b) Assume at some moment that the TLB is loaded with valid conversions, that the primary page and two secondary tables are currently loaded in memory, and that the other five frames of memory currently hold valid pages. Assuming no page faults occur, but that 100,000 otherwise random address translations are made. Suppose a translation that can be made via the TLB takes 10 nanoseconds but that a translation involving a TLB miss takes 100 nanoseconds. How much total time would we expect the 100,000 translations to take? (*Hint:* You need to think about the TLB hit rate. What fraction of the time will a translation be found in the TLB?)

Problem 3. Assume that the operating system maintains a linked list of available blocks of free memory, and that currently this begins with a 9K block followed by a 5K block followed by a 7K block followed by an 11K block. Assume that requests are made for a 5K block, followed by a 7K block, followed by an 8K block. Show exactly how the link list will change as these requests are fulfilled assuming the following allocation strategies:

(a) Best-Fit

(b) Worst-Fit

(c) Next-Fit

Problem 4. Do Problem 13 on page 398, except make it 64-bit virtual addresses and 40-bit physical addresses.

Problem 5. Carefully describe in your own words how "Second Chance" replacement strategy works? Which two simpler strategies does it blend?

Problem 6. Do Problem 16 on page 398, but assume that the R bits are described at each clock tick via the nibbles 1100, 0011, 0101, 1111, 0000, 1000, 0001, 1110, 0110, 0101, 1010, 0111. (Note that the nibble `wxyz` is Tanenbaum's way of saying that page 0 has R bit w, page 1 has R bit x, page 2 has R bit y and page 3 has R bit z.)

Problem 7.