

CSCI 40300/ECE 40800
Operating Systems– Fall 2016
Quiz 10
Solutions

Name: _____

Question:	1	Total
Points:	25	25
Score:		

Normalized Total to 100 = $100 \times \text{Total}/25 =$ _____ (what will appear in Canvas gradebook).

1. The Lemon company has hired you to design the virtual memory system for their new line of desktop computers, the iniM caM. Each computer will have 32 bit virtual and physical addresses, and memory will be allocated in 2 KByte pages.

- (a) For a single-level page table, how many bits will be used to index the page, and how many will be the offset within the page?

- i. (5 points) Number of bits for offset within the page?

Answer: Each page is 2 Kbytes in size which equals 2^{11} bytes, so 11 bits are needed for the offset.

- ii. (5 points) Number of bits for virtual page number?

Answer: Using the answer of 11 bits from i), the remainder is $32 - 11 = 21$ bits.

- (b) Each page table entry will also include three bits for bookkeeping (Valid, Reference, and Modify bits).

- i. (5 points) How many bytes are required for each page table entry?

Answer: The page table entry contains the physical page number (21 bits) and the 3 bookkeeping bits, so the total size is 24 bits or 3 bytes.

- ii. (5 points) How much physical memory in bytes is required to store the table ?

Answer: Since the VPN is 21 bits, the page table has 2^{21} entries, each of which is 3 bytes (from (i)). The table requires 3×2^{21} bytes (6 Mbytes).

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- (c) (5 points) If the iniM caM has 16 megabytes or less of physical memory, we can use 24 bit physical addresses (and still have 32 bit virtual addresses). How large would each page table entry and the entire table be now? (note that this question is *not* asking about using an inverted page table!)

Answer: The PTE would now require $24 - 11 = 13$ bits for the page frame portion, adding the 3 bits for bookkeeping, yields a PTE of 16 bits or 2 bytes. The table will now be 2×2^{21} bytes (4 Mbytes). This is still a regular page table, but since we know that the physical memory will not need more than 24 bits, then the physical page frame # will be smaller. This saves space in the width of the PTE, but the page table will still have the same number of entries as before since the virtual page number is still 21 bits.