**Assignment 3**

**CSC 4420 Computer Operating System**

**Chapter 3 and Chapter 4**

**Due: Mar. 24, 2025**

**50 Points**

1. **In this problem, you are to compare the storage needed to keep track of free memory using a bitmap versus using a linked list. The 8‐GB memory is allocated in units of n bytes. For the linked list, assume that memory consists of an alternating sequence of segments and holes, each 1MB. Also assume that each node in the linked list needs a 32‐bit memory address, a 16‐bit length, and a 16‐bit next-node field. How many bytes of storage is required for each method? Which one is better? (2.5 points)**
2. **What is the difference between a physical address and a virtual address? Explain the difference between internal fragmentation and external fragmentation. Which one occurs in paging systems? Which one occurs in systems using pure segmentation? (5 points)**
3. **Suppose that a machine has 48‐bit virtual addresses and 32‐bit physical addresses**

**a). If pages are 4KB, how many entries are in the page table if it has only a single level? Explain.**

**b). Suppose this same system has a TLB (Translation Lookaside Buffer) with 32 entries. Furthermore, suppose that a program contains instructions that fit into one page and it sequentially reads long integer elements from an array that spans thousands of pages. How effective will the TLB be for this case? (5 points)**

1. **A computer with an 8-KB page, a main memory, and a virtual address space uses an inverted page table to implement its virtual memory. How big should the hash table be to ensure a mean hash chain length of less than 1? Assume that the hash table size is a power of two. (2.5 points)**
2. **Write a program that simulates a paging system using the aging algorithm in Fig. 3-17. The number of page frames is 4 and the number of pages is 8. The sequence of page references is (4, 1, 5, 6, 2, 1, 2, 7, 6, 3, 2, 1). Output a page table for each referred page with page miss or hit, replaced page number for miss and clock tick as well as total number of hits and misses. Partial outputs are shown below (Please submit your .c file 10 points)**

**A screenshot of a computer screen

AI-generated content may be incorrect.**

1. **Explain contiguous allocation and block-based strategies in file systems. Some digital consumer devices need to store data, for example as files. Name a modern device that requires file storage and for which contiguous allocation would be a fine idea (5 points)**
2. **The beginning of a free-space bitmap looks like this after the disk partition is first formatted: 1000 0000 0000 0000 (the first block is used by the root directory). The system always searches for free blocks starting at the lowest-numbered block, so after writing file *A*, which uses six blocks, the bitmap looks like this: 1111 1110 0000 0000. Show the bitmap after each of the following additional actions: (5 points)** 
   1. File *B* is written, using five blocks.
   2. File *A* is deleted.
   3. File *C* is written, using eight blocks.
   4. File *B* is deleted.
3. **Give the definition of incremental logical backup in file systems. Suppose that file 21 in Fig. 4-27 was not modified since the last dump. In what way would the four bitmaps of Fig. 4-28 be different? (5 points)**

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| **A diagram of a tree  AI-generated content may be incorrect.** |  |
| **Fig. 4.27** | **Fig. 4.28** |

1. **Explain what writethrough cache and block cache are. For an external USB hard drive attached to a computer, which is more suitable: a writethrough cache or a block cache? (5 points)**
2. **Discuss the design issues involved in selecting the appropriate block size for a file system. Explain why a file reading requires more block accesses in i-node based file system compared to a FAT file system. (5 points)**