Problem Set 4

Due at the end of Unit 4: _____

This is a set of study questions that are concepts that will be on the exam as essay questions or filling in the blanks for the scheduling algorithms.

The problem sets questions about important concepts from the reading and lecture materials. Each question should be answered in less than 4 paragraphs (no more than 150 words).

We are looking for answers in your own words, NOT copies of the explanation given online, in the book, or in lecture material. Please explain your answers as if we are sitting together at a table discussing computer science concepts.

1. (15 pts) Describe at least 3 general approaches in memory management that can help solve the external fragmentation problem.

2. (10 pts) 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?
    b. 949 bytes using a best-fit policy?
    c. 1603 bytes using a worst-fit policy?
    d. 349 bytes using a worst-fit policy?
    e. 1603 bytes using a first-fit policy? (assume the free list is ordered as listed above)
    f. 1049 using a first-fit policy?

3. (15 pts) Suppose two processes need to be mapped into main memory using pages. Assume main memory consists of 16 frames, a logical page is the same size as a physical frame, and that 4 entries in a page table fills up a frame of memory.

    - Process P1 consists of 7 pages
    - Process P2 consists of 4 pages
    - There are two pages of shared code 'X' and 'Y' common to both address spaces

    a. Design a memory management system that can store these two processes and their page tables in RAM.
    b. Identify which frames you have chosen to assign to which process pages and page tables in main memory/RAM.
    c. Show possible page tables for P1 and P2 (e.g. page table for P1 should have 7 entries).

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4. (15 pts) Suppose on-demand paging is employed in addition to TLB caching. The time for a TLB hit 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. What is a general formula for the average memory access time expressed as a function of T, M, D, p, and p_TLB? Once parameter values are substituted, and assuming assuming p = .001 and p_TLB = 90%, what is the calculated average memory access time?

5. (15 pts) The Least Recently Used (LRU) page replacement policy does not suffer from Belady's Anomaly. Explain intuitively why this is the case. Construct an example page fault sequence to illustrate your point.

6. (15 pts) Given a frame allocation of 3, 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 main memory is initially unloaded, show the page faulting behavior using the following page replacement policies. How many page faults are generated by each page replacement algorithm? Which generates the fewest page faults?
   a. FIFO
   b. OPT
   c. LRU

7. (15 pts) Assume the same sequence of page references as in problem #6, and assume memory is initially unloaded, but now assume that a dynamic paging working-set algorithm is applied to the same sequence of page references, with a window size of 6. Draw the page faulting behavior. Your solution chart should show the frame allocation at any given time to the process.