Operating Systems – 22CS207

Module 2 Question bank

1.

a) Define paging. Hoe does logical address mapping works in paging?

b) A system uses a two-level paging system where the first level page table has 512 entries, and each second level page table has 1024 entries. If the page size is 4KB, determine the logical address structures (division of bits for page table indices and offset).

c) A system uses paging with a page size of 4 KB. The virtual address space is 16 MB, and the physical memory is 8 MB. The system experiences frequent page faults due to high memory contention. Propose a solution to reduce the number of page faults, and explain how your solution would improve system performance.

2. Let us consider a scenario where a 64-bit system running an OS that uses hierarchical page tables to manage virtual memory. Assume that logical and physical pages are of size 4KB and each page table entry is 4 bytes in size.

a) Indicate which bits of the virtual address are used to index into each of the levels ofthe page table.

b) Design an algorithm to compute maximum number of levels in the page table of a process, including both the outermost page directory and the innermost page tables?

c) Develop a code to calculate the maximum number of pages that may be required to store all the page table entries of a process across all levels of the page table.

3.a) What is a page table, and discuss the primary purpose of a page table in a paging system?

b) Consider a computer system has the segmented paging architecture for virtual memory. The memory is byte addressable. Both virtual and physical address space contain 2^{18} bytes each. The virtual –address space is divided into 8 non-overlapping equal size segments. The memory management unit(MMU) has a hardware segment table, each entry of which contain the physical address of the page table of the segment.page tables are stored in the main memory and consist of 2-byte page table entries. Write code to find the minimum page size in bytes so that page table for a segment requires at most one page to store it.

c) A machine has a 32-bit address space and an 8-KB page. The page table is entirely in hardware, with one 32-bit word per entry. When a process starts, the page table is copied to the hardware from memory, at one word every 100 nsec. If each process runs for 100 msec (including the time to load the page table), what fraction of the CPU time is devotedto loading the page tables?

4. Consider a Linux-like operating system running on a 48-bit CPU hardware. The OS uses hierarchical paging, with 8 KB pages and 4-byte page table entries.

a) Design an algorithm that compute maximum number of levels in the page table of a process, including both the outermost page directory and the innermost page tables?

b) Indicate which bits of the virtual address are used to index into each of the levels of the page table.

c) Write a code to Calculate the maximum number of pages that may be required to store all the page table entries of a process across all levels of the page table.

5.

a) Differentiate between segmentation and paging with a real-world analogy**.**
b) A program has three segments**:** Code (10 KB), Data (5 KB), and Stack (8 KB)**.** If the segment table contains base addresses 1000, 5000, and 12000**,** calculate the physical address for the logical address (2, 2000)**.**
c) Design a new memory allocation strategy that combines segmentation and paging for better performance.

6.

a) Discuss internal and external fragmentation. Which type of partitioning suffers from which fragmentation?
b) Consider memory partitions as 120 KB, 500 KB, 300 KB, 700 KB, 250 KB and Processes sizes as: 100 KB, 470 KB, 280 KB, 690 KB, 230 KB. **C**ompare First Fit, Best Fit, and Worst Fit in terms of number of allocations and wastage.
c) Develop the code that simulates both fixed and dynamic partitioning for the same set of processes (sizes: 3 KB, 7 KB, and 12 KB). For fixed partitioning, use partitions of sizes 5 KB, 10 KB, and 15 KB. For dynamic partitioning, allocate exactly what is required.

7. Consider a file system that uses the index –allocation technique, with block size of 1 KB(file block size and disk block size are the same). The disk partition holding the file system has size 200KB. The file system keeps one i-node for each file and one d-node for each directory. Each i-node has some file attributes ,6 direct blocks ,3 single indirectblock ,2 double indirect block and 1 triple indirect block. Each d-node has some directory attributes and linear list of files/subdirectories under it. The maximum file/directory name size is 15 character. The maximum number of files and sub directories under a single directory is 50. The maximum number of directories in the system can be 500.However, the maximum number of files in the system can be 20000. The file system support read/write/execute permission for each file and directory, and hard links for both file and directories.
   (a) What is the maximum size of the file that can be supported?
   (b) Implement how the file system components are organized in the disk partition (showingthe exact size and order of the components). Assume that bit method is used to managefree space for i-nodes d-nodes and data blocks.
   (c) List the steps that occur when the call write (fd,buff,size) is made, which write size

bytes starting from memory address buff to the end of an already open file with file descriptor fd. Assume that the system supports both a peer process and a system widen–open file table.

8. The file and directory attributes you choose must support the above operation efficiently. Align all the fields in the data structure define to byte boundaries. You can assume that routine read /write block from /to disk already exit that you can call.

a) A system uses demand paging with a page size of 4 KB. A process generates the following sequence of virtual addresses: 0x1000, 0x2000, 0x3000, 0x4000, 0x1000, 0x2000, 0x5000, 0x1000, 0x2000, 0x3000, 0x4000, 0x5000. The system has 3 frames in memory.

b) Illustrate how demand paging improves memory utilization compared to traditional paging.

c) Design a sequence of page replacements using the **LRU** algorithm. How many page faults occur, and how does this compare to the FIFO algorithm?

d) Propose a new page replacement algorithm that combines the strengths of FIFO and LRU. Explain how your algorithm would handle this sequence and reduce page faults.

9. Elementary physics states that when an object is subjected to a constant acceleration, the relationship between distance d and time t is given by = 0.5 at^2. Suppose that a disk drive has 5,000 cylinders, numbered 0 to 4999. During a seek, the disk accelerates the disk arm at a constant rate for the first half of the seek, then decelerates the disk arm at the same rate for the second half of the seek. Assume that the disk can perform a seek to an adjacent cylinder in 1 millisecond and a full-stroke seek over all 5000 cylinders in 18 milliseconds. The disk drive is currently serving a request at cylinder 2,150, and the previous request was at cylinder 1,805. The queue ofpending requests, in FIFO order, is: 2,069, 1,212, 2,296, 2,800, 544, 1,618, 356, 1,523,4,965, 3681.

   a) The distance of a seek is the number of cylinders that the head moves. Explain why the seek time is proportional to the square root of the seek distance.

   b) Calculate the total seek time for each of the schedules: FCFS, SSTF, SCAN, LOOK, C-SCAN, C-LOOK. the drive is currently serving a request at cylinder 2,150, and the previous request was at cylinder 1,805. The queue of pending requests, in FIFO order,is: 2069, 1212, 2296, 2800, 544, 1618, 356, 1523, 4965, 3681

   c) Develop the code for finding fastest scheduling algorithm. (i.e., has the smallest total seek time). Explain.

10. Now a days Disk partitions are very common on your computer or smartphone for storing data in an organized manner. Different Operating system like windows, Unix, Solaris, will follow different mounting mechanism on secondary storage devices.

a) Discuss different mounting mechanisms used for any 3 different operating systems?

b) Develop different file sharing Algorithms used in distributed and local networks?

c) Simulate various file protection procedures when content is sharing in any streaming applications like jio cinema, Netflix, voot, sonyLiv.