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B.TECH. V SEM (NEW SCHEME) MAIN ACAD. SESSION 2023-24

ARTIFICIAL INTELLIGENCE & DATA SCIENCE-V AND OTHER BRANCHES

5AD4-01 - OPERATING SYSTEMS

COMMON TO CS, AI,AD, AM, CA, CD, DS, IO, IT, MC, CM, CY

Time : 3 Hours] **[Max. Marks :** 70

[Min. Passing Marks :

Instructions to Candidates :

Part–A : Short Answer Type Qu ions (up to 25 words) 10 × 2 = 20 marks. All 10 questions are compulsor

Part–B : Analytical/Problem Sol g questic 5 × 4 = 20 marks. Candidates have to answer 5 questions out of 7.

Part–C : Descriptive/Analytical/Problem Solving questions 3 × 10 marks = 30 marks. Candidates have to answer 3 questions out of 5.

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used/ calculated must be stated clearly.

Use of the following supporting materials is permitted during examination. (Mentioned in form no. 205).

1_____NIL_____ 2_____NIL_____

Part–A

10×2=20

1. What are the two main functions of an operating system ?
2. Provide two programming examples in which multithreading does not provide better performance than a single-threaded solution.
3. What system calls have to be executed by a command interpreter or shell in order to start a new process ?
4. In what ways does the Linux setuid feature differ from the setuid feature in standard Unix ?
5. How are the access-matrix facility and the role-based access-control facility similar ? How do they differ ?
6. In what situations would using memory as a RAM disk be more useful than using it as a disk cache ?
7. Show that, if the wait() and signal() semaphore operations are not executed atomically, then mutual exclusion may be violated.
8. Describe two kernel data structures in which race conditions are possible. Be sure to include a description of how a race condition can occur.
9. Is it possible to have a deadlock involving only a single process ? Explain your answer.
10. Why are segmentation and paging sometimes combined into one scheme ?

Part–B

5×4=20

1. What is the purpose of interrupts ? What are the differences between a trap and an interrupt ? Can traps be generated intentionally by a user program ? If so, for what purpose ? What is the meaning of the term busy waiting ? What other kinds of waiting are there in an operating system ? Can busy waiting be avoided altogether ? Explain your answer.

2. What are two differences between user-level threads and kernel-level threads ? Under what circumstances is one type better than the other ? What is the difference between kernel and user mode ? Explain how having two distinct modes aids in designing an operating system. Describe the actions taken by a kernel to context- switch between processes.

3. A CPU-scheduling algorithm determines an order for the execution of its scheduled processes. Given n processes to be scheduled on one processor, how many different schedules are possible ? Give a formula in terms of n. What advantage is there in having different time-quantum sizes at different levels of a multilevel queueing system ?

4. Consider a logical address space of 64 pages of 1,024 words each, mapped onto a physical memory of 32 frames.

   (a) How many bits are there in the logical address ?

   (b) How many bits are there in the physical address ?

5. Consider a logical address space of 32 pages with 1,024 words per page, mapped onto a physical memory of 16 frames.

   (a) How many bits are required in. the logical address ?

   (b) How many bits are required in the physical address ?

6. Consider the scheduling algorithm in the operating system for time-sharing threads.

   (a) What is the time quantum (in milliseconds) for a thread with priority 10 ? With priority 55 ?

   (b) Assume that a thread with priority 35 has used its entire time quantum without blocking. What new priority will the scheduler assign this thread ?

   (c) Assume that a thread with priority 35 blocks for I/0 before its time quantum has expired. What new priority will the scheduler assign this thread ?

7. A shared variable x, initialized to zero, is operated on by four concurrent processes W, X, Y, Z as follows. Each of the processes W and X reads x from memory, increments by one, stores it to memory and then terminates. Each of the processes Y and Z reads x from memory, decrements by two, stores it to memory, and then terminates. Each process before reading x invokes the P operation (i.e. wait) on a counting semaphore S and invokes the V operation (i.e. signal) on the semaphore S after storing x to memory. Semaphore S is initialized to two.

(a) What is the maximum possible value of x after all processes complete execution ?

(b) what is the minimum possible value of x after all processes complete execution ?

Part–C

3×10=30

8. Consider the following set of processes, with the length of the CPU burst given in milliseconds :

Process	Burst Time	Priority
Pi	10	3
P2	1	1
P3	2	3
P4	1	4
P5	5	2

(a) Draw four Gantt charts that illustrate the execution of these processes using the following scheduling algorithms : FCFS, SJF, non-preemptive priority (a smaller priority number implies a higher priority), and RR (quantum = 1).

(b) What is the turnaround time of each process for each of the scheduling algorithms in part a ?

(c) What is the waiting time of each process for each of these scheduling algorithms ?

(d) Which of the algorithms results in the minimum average waiting time (over all processes) ?

2. Consider the following resource-allocation policy. Requests for and releases of resources are allowed at any time. If a request for resources cannot be satisfied because the resources are not available, then we check any processes that are blocked waiting for resources. If a blocked process has the desired resources, then these resources are taken away from it and are given to the requesting process. The vector of resources for which the blocked process is waiting is increased to include the resources that were taken away. For example, consider a system with three resource types and the vector Available initialized to (4, 2, 2). If process P_0 asks for (2, 2, 1), it gets them. If P_1 asks for (1, 0, 1), it gets them. Then, if P_0 asks for (0, 0, 1), it is blocked (resource not available). If P_2 now asks for (2, 0, 0), it gets the available one (1, 0, 0) and one that was allocated to P_0 (since P_0 is blocked). P_0's Allocation vector goes down to (1, 2, 1), and its Need vector goes up to (1, 0, 1).

(a) Can deadlock occur ? If you answer "yes," give an example. If you answer "no," specify which necessary condition cannot occur.

(b) Can indefinite blocking occur ? Explain your answer.

3. Consider the following page reference string : 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6. How many page faults would occur for the following replacement algorithms, assuming one, two, three, four, five, six, and seven frames ? Remember that all frames are initially empty, so your first unique pages will cost one fault each.

(a) LRU replacement

(b) FIFO replacement

(c) Optimal replacement.

4. Assume that we have a demand-paged memory. The page table is held in registers. It

takes 8 milliseconds to service a page fault if an empty frame is available or if the replaced page is not modified and 20 milliseconds if the replaced page is modified. Memory-access time is 100 nanoseconds. Assume that the page to be replaced is modified 70 percent of the time. What is the maximum acceptable page-fault rate for an effective access time of no more than 200 nanoseconds ?

5. Some file systems allow disk storage to be allocated at different levels of granularity. For instance, a file system could allocate 4 KB of disk space as a single 4-KB block or as eight 512-byte blocks. How could we take advantage of this flexibility to improve performance ? What modifications would have to be made to the free-space management scheme in order to support this feature ? Discuss the reasons why the operating system might require accurate information on how blocks are stored on a disk. How could the operating system improve file system performance with this knowledge ?

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