

1. (10%) Consider a system that uses both preemptive and non-preemptive scheduling policies.
 - (a) Give an example to show how a preemptive scheduling policy can improve response time for short tasks compared to non-preemptive scheduling.
 - (b) Now consider a scenario where non-preemptive scheduling might be more beneficial than preemptive scheduling. Describe such a scenario and explain why non-preemptive scheduling is preferred.
2. (10%) Explain how virtual memory works in modern operating systems.
 - (a) Describe how paging is used to manage memory, including the role of page tables in the translation of virtual addresses to physical addresses.
 - (b) What happens during a page fault, and how does the operating system resolve it?
3. (15%) Log-structured file systems are designed to improve write performance by appending data to the end of a log.
 - (a) (7%) Explain how a log-structured file system works and how it improves write performance compared to traditional file systems.
 - (b) (8%) Despite the advantages in write performance, log-structured file systems face challenges with garbage collection. Describe the garbage collection process and discuss how it impacts system performance, particularly read performance.
4. (15%) Describe the flow of execution for a system call from the perspective of both the user process and the operating system.
 - (a) (7%) Walk through the process of making a system call, starting from when a user process issues a system call (e.g., **to read from a file**) and describe the transition to kernel mode.
 - (b) (8%) Explain the role of **traps** in system call handling and how the operating system distinguishes between a regular function call and a system call
5. (10%) Assume you want to implement a web-server for YouTube by using multithreading, where each thread serves one incoming request by loading a video file from the disk. Assume the OS only provides the normal blocking read system call for disk reads, do you think user-level threads or kernel-level threads should be used? Why?

6. (20%) A system that uses the Banker's Algorithm has six processes and four types of reusable resources (R1, R2, R3 and R4). The current Allocation, Maximum needs and Available resources are as shown below.

Process	Allocation				Max				Available			
	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4
P1	1	0	0	0	3	2	1	4	0	2	3	3
P2	1	2	2	0	1	4	5	2				
P3	2	1	3	0	4	2	4	5				
P4	1	4	1	0	6	6	1	0				
P5	1	2	0	1	2	3	1	3				
P6	1	4	3	1	2	4	4	1				

- (a) (5%) Calculate the Need matrix.
- (b) (15%) Determine if this is a safe state? If so, give a sequence in which the processes can be serviced. If it is not a safe state, then list the processes which are deadlocked. Show all your work and the content of Available vector in each step clearly!
7. (20%) Are the following statements true or false? For each statement, you will get 4 points for correct answer, zero point for blank, or -2 point for incorrect answer.
- (a) A page table is a data structure used to map physical memory pages to virtual memory pages.
- (b) An inverted page table has one entry for each page
- (c) IPSec is adopted to provide Layer 3 network security.
- (d) The whois tool allows you to query the DNS to obtain the mapping between domain name and IP address.
- (e) Ordinary pipes are bidirectional.