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KIRIRI WOMEN'S UNIVERSITY OF SCIENCE AND TECHNOLOGY
UNIVERSITY EXAMINATION, 2024/2025 ACADEMIC YEAR
FIRST YEAR, FIRST SEMESTER EXAMINATION
FOR THE DIPLOMA IN INFORMATION & COMMUNICATION TECHNOLOGY
DIT 1004 – OPERATING SYSTEMS

Date: 13TH December 2024
Time: 11:30PM – 1:30PM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS

QUESTION ONE (30 MARKS)

a) A university uses a multitasking operating system on a shared server for students and faculty to run programs simultaneously. The operating system uses a **preemptive multitasking** mechanism to ensure that multiple processes can run concurrently. However, during exam periods, many students run large data analysis tasks, leading to slowdowns and even system crashes due to the large number of processes in the system.

i. What function of the operating system is being overwhelmed, and why? (3 Marks)
ii. How does preemptive multitasking work, and what are its advantages in this scenario? (3 Marks)
iii. Suggest a solution to improve system performance during peak load times. (3 Marks)
iv. What role does the Operating System's process synchronization function play in this context? (3 Marks)

b) A data analysis company runs a batch processing system where multiple data processing jobs are submitted to the server. The jobs have different execution times, and the system uses the **Shortest Job First (SJF)** scheduling algorithm to minimize the average waiting time. However, some large jobs are experiencing significant delays in execution, while smaller jobs are quickly completed.

i. How does the Shortest Job First (SJF) scheduling algorithm work, and why are larger jobs delayed? (3 Marks)
ii. What are the benefits of using SJF scheduling in a batch processing environment? (3 Marks)

c) In a multi-user operating system, two processes are involved in document printing. Process A first locks a file to read it, then requests access to a printer to print the document. Process B locks the printer to prepare for printing, then requests access to a file to attach a footer. Occasionally, a deadlock occurs when Process A holds the file lock and waits for the printer, while Process B holds the printer lock and waits for the file. Explain why deadlock occurs in this situation. (4 Marks)

d) A company's server hosts a file-sharing system used by employees to store, retrieve, and share large files. Over time, users have reported slower file retrievals and occasional data corruption. The server is using a **File Allocation Table (FAT32)** file system, and many files are fragmented across the disk. What operating system function is being challenged here, and why is the file system performing poorly? (4 Marks)

e) A software company is developing a memory-intensive application that requires large amounts of RAM. The operating system uses **virtual memory** to manage processes larger than the available physical memory. However, developers notice that the application frequently slows down when handling large datasets, and the system seems to be accessing the disk too often. What operating system function is primarily responsible for managing large memory requirements, and how does it work? (4 Marks)

QUESTION TWO (20 MARKS)

a) Consider the following processes (P1, P2, P3 and P4) arriving in the ready queue in the order of **arrival time** as indicated below. Each process is estimated to take a specific time frame to execute once allocated a CPU as indicated by their respective **burst time** below**.** Using First Come First Served (FCFS) scheduling algorithm

Process	Arrival Time	Burst Time
P1	0	8
P2	1	4
P3	2	9
P4	3	5

i) Compute the waiting time for each process (3 Marks)
ii) Compute the turnaround time for each process (3 Marks)
iii) Calculate the average waiting time for the schedule (2 Marks)
iv) Calculate the average turnaround time for the schedule (2 Marks)

b) A multimedia production company uses a system to edit and process high-definition (HD) video files. The operating system must handle multiple **I/O devices** (displays, storage devices, audio equipment). However, during video editing, the system occasionally freezes or stutters, especially when playing large files.

i) How does the OS manage I/O devices, and what might be causing performance issues with large files? (4 Marks)
ii) Suggest a method to improve I/O performance for the video editing system. (6 Marks)

QUESTION THREE (20 MARKS)

A university computer lab has a multi-user system where students can log in and run programs. The system administrator has implemented the **Round Robin (RR)** scheduling algorithm to ensure fairness, with a time quantum of 10 milliseconds per process. During peak times, when many students are logged in, some users complain that their programs are taking too long to complete, especially programs with intensive CPU requirements.

a) How does the Round Robin scheduling algorithm work, and why might it be causing delays for CPU-intensive programs? (6 Marks)
b) What are the advantages and disadvantages of Round Robin scheduling in a multi-user environment? (10 Marks)
c) Why might Round Robin be preferred in environments with a large number of I/O-bound tasks? (4 Marks)

QUESTION FOUR (20 MARKS)

A banking application allows multiple clients to transfer money between accounts. Each transaction locks both the source and destination accounts to prevent inconsistencies. However, a deadlock occurs when two clients attempt to transfer money simultaneously between the same pair of accounts but in opposite directions. For example, Client A tries to transfer money from Account X to Account Y while Client B is trying to transfer money from Account Y to Account X.

a) What are the four conditions necessary for a deadlock to occur, and how are they present in this scenario? (8 Marks)
b) Suggest two methods to prevent or avoid deadlock in this banking transaction system. (4 Marks)
c) How would using a timeout mechanism help resolve or avoid deadlocks in this scenario? (4 Marks)
d) How could the use of optimistic concurrency control help prevent deadlocks in this scenario? (4 Marks)

QUESTION FIVE (20 MARKS)

A web hosting company runs multiple web servers that allocate memory dynamically to host several websites. They use a **fixed-size partitioning** memory allocation technique, but over time, the memory usage becomes inefficient, with small blocks of memory being left unused between allocated blocks. This is causing **external fragmentation** and reducing the system's performance.

a) What is **external fragmentation**, and why does it occur in this scenario? (5 Marks)

b) How can **compaction** be used to address the external fragmentation issue? (5 Marks)

c) Suggest an alternative memory allocation technique that would minimize fragmentation in this scenario. (5 Marks)

d) Explain the difference between **internal** and **external** fragmentation and how each applies to this case. (5 Marks)