Air University
Department of Cyber Security
(Final-Term Examination: Spring 2025)

Subject: Operating System
Class: BS-Cyber Security
Code: CS-325
Section: A & B
FM Name: Ms. Maryam Malik

FM Signature: ....

Total Marks: 100
Time Allowed: 3hr
Date:

HoD Signature: ....

Instructions:

- You are required to attempt **ALL Questions**.
- This is a closed book/notes exam.
- **Return question paper with the answer sheet**

Q. No	Questions	CLO	Marks
1		1	30

a) Consider a logical address space of 256 pages with a 4-KB page size, mapped onto a physical memory of 64 frames. How many bits are required in the logical address and how many bits are required in the physical address? **(10 marks)**

b) The BTV operating system has a 21-bit virtual address, yet on certain embedded devices, it has only a 16-bit physical address. It also has a 2-KB page size. How many entries are there in each of the following? **(10 marks)**

    I.   A conventional, single-level page table
    II.   An inverted page table.

c) Discuss how buffer-overflow attacks occur and explain how programming practices and hardware mechanisms can help mitigate such attacks. Why are both approaches necessary in some systems? **(10 marks)**

Q. No	Questions	CLO	Marks
2		2	30

a) Assume that there are 5 processes, P0 through P4, and 4 types of resources. At T0 we have the following system state:

Max Instances of Resource Type A = 3
Max Instances of Resource Type B = 17
Max Instances of Resource Type C = 16
Max Instances of Resource Type D = 12

process	Allocation A B C D	Max A B C D	Available A B C D
P0	0 1 1 0	0 2 1 0	1 5 2 0
P1	1 2 3 1	1 6 5 2	
P2	1 3 6 5	2 3 6 6	
P3	0 6 3 2	0 6 5 2	
P4	0 0 1 4	0 6 5 6	

I.   Create the need matrix. (10 marks)

II. Is the system in a safe state? If yes, then what is the safe sequence?

b) Consider a computer system that runs 5,000 jobs per month and has no deadlock-prevention or deadlock-avoidance scheme. Deadlocks occur about twice per month, and the operator must terminate and rerun about ten jobs per deadlock. Each job is worth about two dollars (in CPU time), and the jobs terminated tend to be about half done when they are aborted. A systems programmer has estimated that a deadlock-avoidance algorithm (like the banker's algorithm) could be installed in the system with an increase of about 10 percent in the average execution time per Practice Exercises 345 job. Since the machine currently has 30 percent idle time, all 5,000 jobs per month could still be run, although turnaround time would increase by about 20 percent on average.

I. What are the arguments for installing the deadlock-avoidance algorithm? (10 marks)
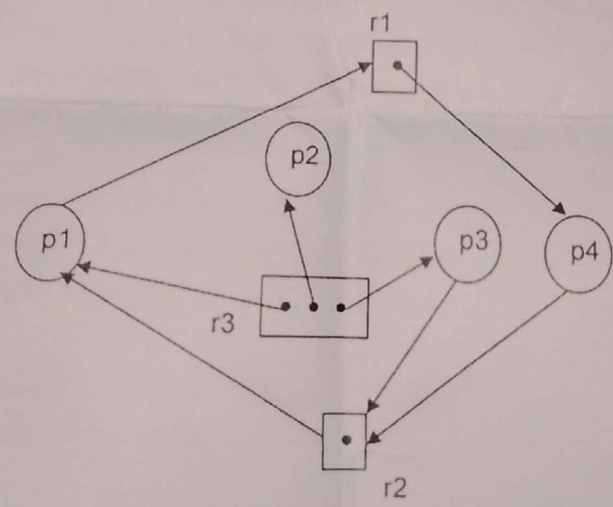
II. What are the arguments against installing the deadlock-avoidance algorithm?

c) Consider the following Access Matrix, which shows the access rights of three domains (D1, D2, D3) over three objects (F1, F2, Printer): (10 marks)

	F1	F2	Printer
D1	read, write	—	print
D2	read	write	—
D3	—	read	print

Write the access matrix using a **global table, access lists, and capability lists**

a) Given six memory partitions of 100 MB, 170 MB, 40 MB, 205 MB, 300 MB, and 185 MB (in order), how would the first-fit, best-fit, and worst-fit algorithms place processes of size 200 MB, 15 MB, 185 MB, 75 MB, 175 MB, and 80 MB (in order)? Indicate which if any requests cannot be satisfied.

| | 3 | 40 |

b) Analyze the behavior of the FIFO and Optimal (OPT) page replacement algorithms when applied to the following page-reference string. Identify the number of page faults in each case and compare the efficiency of the algorithms. Explain why one performs better than the other based on the characteristics of the reference string.

4, 2, 1, 7, 9, 8, 3, 5, 2, 6, 8, 1, 0, 7, 2, 4, 1, 3, 5, 8

c) Consider the ring-protection scheme in MULTICS. If we were to implement the system calls of a typical operating system and store them in a segment associated with ring 0, what should be the values stored in the ring field of the segment descriptor? What happens during a system call when a process executing in a higher-numbered ring invokes a procedure in ring 0?

d) The list of all passwords is kept within the operating system. Thus, if a user manages to read this list, password protection is no longer provided. Suggest a scheme that will avoid this problem.

e) For the following resource allocation graphs, find out and explain whether there is a deadlock or not.

****************************End of Paper *********************