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MAIN EXAMINATION

JANUARY – APRIL 2022

FACULTY OF SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

REGULAR PROGRAMME

CMT 206/PHY 314: OPERATING SYSTEMS

Date: APRIL 2022

Duration: 2 Hours

INSTRUCTIONS: Answer Question ONE and any TWO Questions

Q1. a) 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 with 5 empty page frames using the following page replacement algorithms?

- i) Least Recently Used **(4 marks)**
- ii) First-In First-Out **(4 marks)**
- iii) Optimal **(4 marks)**

b) Consider the following snapshot of a system.

	Allocation				Max				Need				Available			
	U	V	W	X	U	V	W	X	U	V	W	X	U	V	W	X
A	0	0	1	4	1	2	4	4	1	1	2	0	0	1	1	0
B	1	1	2	0	1	2	3	0	0	1	1	0				
C	1	3	0	0	4	3	0	0	3	0	0	0				
D	2	0	1	0	4	6	6	2	2	2	5	2				
E	1	3	2	6	1	4	6	9	0	1	4	3				

i) Using Banker's algorithm, calculate the steps to find a safe sequence. **(8 marks)**

- ii) Is this system in a safe state? (Show the sequence) **(2 marks)**
- c) What is a bootstrap program, and where is it stored? **(2 Marks)**
- d) What role do device controllers and device drivers play in a computer system? **(2 Marks)**
- e) Explain why an operating system can be viewed as a resource allocator. **(2 Marks)**
- f) Describe the operating system's two modes of operation. **(2 Marks)**

Q2. a) Consider a logical address space of eight pages mapped onto a physical memory of 32 frames. Given that the frame size is 1024 bytes, calculate the following:

- a) How many bits for page number? **(2 Marks)**
- b) How many bits offset? **(2 Marks)**
- c) How many bits are there in the logical address? **(2 Marks)**
- d) The logical address space? **(2 Marks)**
- e) The physical address space? **(2 Marks)**

b) Consider a simple segmentation system that has the following segment table:

Process X		
Segment	Base	Limit
0	660	248
1	1752	422
2	222	198
3	996	604

For each of the following logical addresses, determine the physical address or indicate if a segment fault occurs:

- a) 0, 198 **(2 Marks)**
- b) 2, 156 **(2 Marks)**
- c) 1, 530 **(2 Marks)**

- d) 3, 444 (2 Marks)
e) 0, 222 (2 Marks)

Q3. a)i) What is the purpose of Amdahl's Law ? (2 Marks)

ii) If an application is 50% parallel and 50% serial, moving from 1 to 2 cores results in what overall system speedup? (2 Marks)

b)) i) What is a critical section problem? (2 marks)

ii) Define the three conditions that must be satisfied for a critical section problem to be solved. (6 marks)

c)i) When several processes access the same data concurrently and the outcome of the execution depends on the particular order in which the access takes place is called _____ (1 Mark)

ii) If a process is executing in its critical section, then no other processes can be executing in their critical section. What is this condition called? (1 Mark)

iii) When high priority task is indirectly pre-empted by medium priority task effectively inverting the relative priority of the two tasks, the scenario is called _____ (1 Mark)

iv) A situation in which a process is ready to execute but is continuously denied access to a processor in deference to other processes. (1 mark)

d) i) What are the two types of semaphores? (2 Marks)

ii) What are the two functions that control the critical section? (2 Marks)

Q4. a) Assume that the list of holes in a variable partition memory system contains the following entries (in the given order) 190KB, 550KB, 220KB, 420KB, 650KB, 110KB. Consider the following sequence of requests: A = 210KB, B = 430KB, C = 100KB, D = 420KB

Determine which holes would be allocated to which request by each of the following schemes:

- i) First-Fit (2 marks)
ii) Next-Fit (2 marks)
iii) Best-Fit (2 marks)
iv) Worst-Fit (2 marks)

- b) List the four major categories of the benefits of multithreaded programming. Briefly explain each. **(4 marks)**
- c) In the context of multicore programming, what is the difference between parallelism and concurrency? **(2 marks)**
- d) Describe the dining-philosophers problem and how it relates to operating systems.. **(4 marks)**
- e) Write two short functions that implement the simple semaphore wait() and signal() operations on global variable S. **(2 Marks)**

Q5. a) i) Describe two advantages and one disadvantage of using a microkernel approach?

(3 Marks)

ii) Explain why a modular kernel may be the best of the current operating system design techniques. **(2 Marks)**

b) i) Name and describe the different states that a process can exist in at any given time.

(5 Marks)

ii) Explain two main differences between a short-term and long-term scheduler. **(2 Marks)**

c) Explain the concept of a context switch. **(2 Marks)**

d) Multicore systems present certain challenges for multithreaded programming. Briefly describe four challenges. **(4 Marks)**

e) What role does the dispatcher play in CPU scheduling? **(2 Marks)**

END