YOUR NAME: _____

CSC 345 Final Exam Spring 2021

Monday May 17, 2021

11:00 am – 01:50 pm (170 minutes)

- PLEASE PRINT YOUR FULL NAME IN THE FIRST PAGE.
- PLEASE PUT YOUR INITIALS ON EVERY ODD NUMBERED PAGE.
- THIS IS AN OPEN-BOOK TEST. YOU ARE ALLOWED TO USE ANY EXTERNAL RESOURCES AND ELECTRONIC DEVICES, SUCH AS CALCULATORS.
- PLEASE **PRINT** YOUR ANSWER IF POSSIBLE. UNREADABLE ANSWERS WILL NOT BE GRADED. PENCILS ARE DISCOURAGED. PLEASE USE PENS AND BE CONCISE.
- **IMPORTANT**: INCORRECT STATEMENTS TO CONCEPT QUESTIONS WILL NEGATIVELY IMPACT YOUR SCORE. WRITE ONLY YOU KNOW FOR SURE.

No	Points	Out of	Topic
I		10	General Concepts
II		10	Process / Threads
III		25	Synchronization, Deadlocks
IV		25	Scheduling
V		35	Memory
VI		35	Virtual Memory
VII		25	Mass Storage
VIII		25	File System
IX		20	I/O Support
X		40	VM, Network and Distributed OS
Total		250	

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I. General Concepts / OS Structures

(I-1) [10 points; 5 points each] Define and explain in detail, with examples, following concepts.

a) System Call and System Program:

_____

_____

_____

_____

_____

b) Interrupt and Interrupt Service Routine (ISR):

_____

_____

_____

_____

_____

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II. Process / Threads

(II-1) [10 points; 5 point each] Define and explain in detail, with examples, following concepts.

a) fork(), exec(), wait(), exit():

b) Pipe, named/unnamed pipe, anonymous pipe:

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III. Synchronization, Deadlocks

(III-1) [5 points] Give an example scenario when you must use a semaphore rather than a mutex.

_____

_____

_____

(III-2) [12 points; 3 points each] What are the four conditions that will incur a deadlock situation if they were satisfied simultaneously?

a) _____

b) _____

c) _____

d) _____

(III-3) [8 points; 4 points for each correct answer] Briefly explain when each of the following methods can be used to monitor deadlock situation and how. Effective answers need just 2 sentences each.

Resource Allocation Graph: _____

_____

Banker's Algorithm: _____

_____

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IV. Scheduling

The following processes are being scheduled using a preemptive, round-robin scheduling algorithm. Each process is assigned a numerical priority, with a smaller number indicating a higher relative priority. In addition to the processes listed below, the system also has an idle task (which consumes no CPU resources and is identified as P*idle*). This task has priority 0 and is scheduled whenever the system has no other available processes to run. The length of a time quantum is 5. If a process is preempted by a higher-priority process, the preempted process is placed at the end of the queue.

Thread	Priority	Burst	Arrival
P1	30	20	0
P2	10	25	25
P3	5	20	30
P4	5	15	60
P5	20	10	80

(IV-1) [5 points] Which process yields the **shortest turnaround** time? _____

(IV-2) [5 points] Which process yields the **longest waiting** time? _____

(IV-3) [5 points] What is the CPU **utilization rate**? _____ %

(IV-4) [10 points] Which of the following scheduling algorithm(s) can result in starvation? You need to mark **all** that apply (if any). Do not mark more than needed. No partial credit.

(a) FCFS (b) SJF (c) RR (d) Priority

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V. Memory

(V-1) [15 points; 5 points each] Briefly explain what each of the following memory allocation method is.

a) Continuous allocation:

_____

b) Segmentation:

_____

c) Paging:

_____

(V-2) [10 points; 5 points for each row] For the three different ways of memory assignment strategies: contiguous, segmentation, and paging, mark (v) which strategy may suffer which fragmentation type.

	Contiguous	Segmentation	Paging
Internal			
External			

(V-3) [10 points; 5 points each] Explain what **inverted page table** is and identify its merit(s) over others.

Definition: _____

Merits: _____

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VI. Virtual Memory

(VI-1) [10 points; 5 points each] Consider the following page reference string:

7, 2, 3, 1, 2, 5, 7, 7, 0

Assuming demand paging with **three** frames, how many page faults would occur for the **LRU** and **optimal** (= you know the future) replacement algorithms?

LRU: _____ times

Optimal: _____ times

(VI-2) [10 points; **NO** partial credit] Consider a demand-paging system with the following time-measured utilizations: CPU utilization 20% / Paging disk 97.7% / Other I/O devices 5%. For each of the following, say whether it will (or is likely to) improve CPU utilization.

a. Install a faster CPU (Y / N / Maybe)

b. Install a bigger paging disk (Y / N / Maybe)

c. Increase the degree of multiprogramming (Y / N / Maybe)

d. Decrease the degree of multiprogramming (Y / N / Maybe)

e. Install more main memory (Y / N / Maybe)

(VI-3) [10 points] Briefly define and explain the demand paging and page fault

_____

_____

_____

(VI-4) [5 points] Briefly define and explain the (Enhanced) second chance page replacement algorithm

_____

_____

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VII. Mass Storage

(VII-1) [20 points; 5 points each] Given a request queue to a magnetic disk with a sector range [0, 199],

90, 180, 30, 120, 10, 120, 60, 70

Head pointer 50. Calculate the total distance traveled for the following algorithms. For algorithms that require initial direction, consider the head was initially moving left to right (i.e., increasing sector number).

a) SCAN

_____

b) C-SCAN

_____

c) LOOK

_____

d) C-LOOK

_____

(VII-3) [5 points] Briefly discuss why RAID makes sense and how it works. Also explain the differences of some of the RAID models, RAID-0, RAID-1, and RAID-10.

_____

_____

_____

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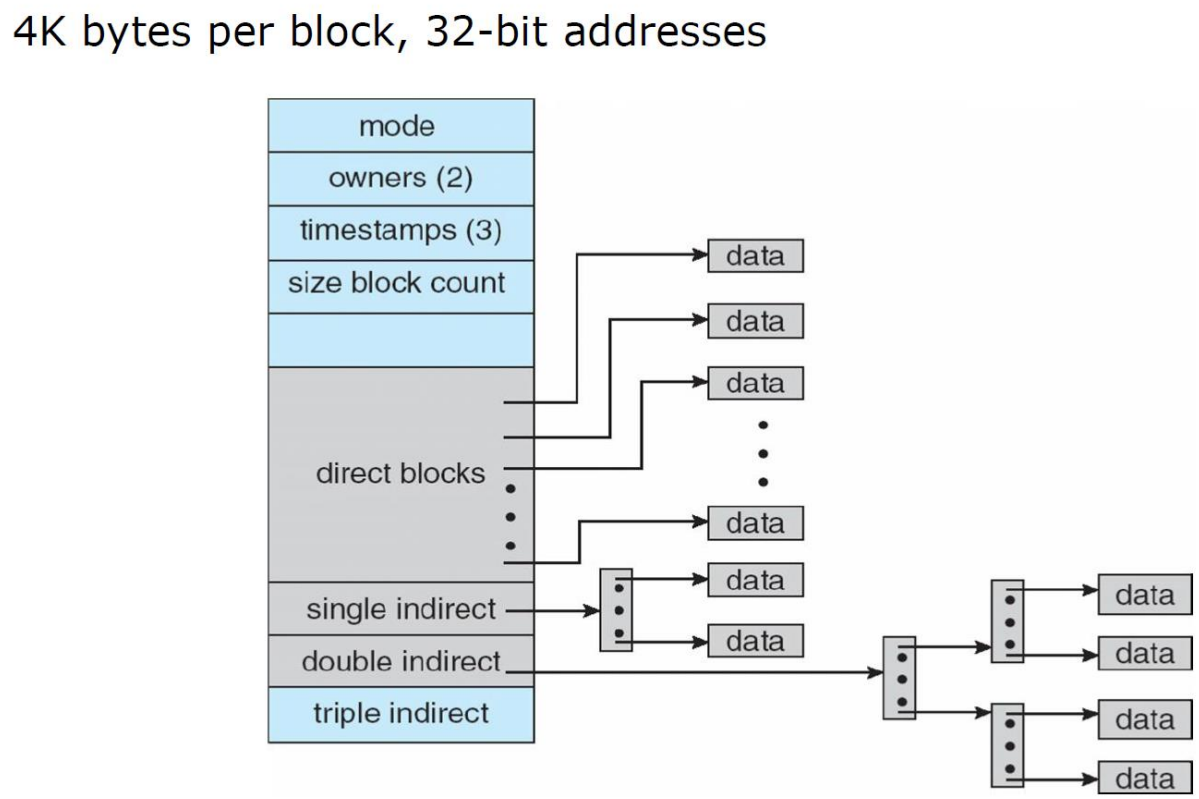
VIII. File System

(VIII-1) [10 points] Given the following inode-based Unix File System, how big a file can be? Assume that there are 10 direct block indices in the inode.



Answer: _____ GB (roughly, but should be accurate above decimal point)

(VIII-5) [5 points] Pick and briefly explain any one of the ways we discussed in class to **manage** (= keep track of) **empty blocks** in a file system.

_____

(VIII-6) [10 points; 5 points each] File Allocation Table is a variant of linked-list based allocation. Discuss the pros and cons of linked-list based allocation compared to inode structure we learned, which is an index-based allocation method.

Pros vs. inode: _____

Cons vs. inode: _____

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IX. I/O Support

(IX-1) [10 points; 5 points each] Consider the following I/O scenarios on a single-user PC. For each of these I/O scenarios, would you design the operating system to use *buffering*, *spooling*, *caching*, or a combination? Would you use polled I/O, or interrupt-driven I/O? Give brief reasoning for your choices.

a) A mouse used with a graphical user interface

Buffering? Y / N Spooling? Y / N Caching? Y / N

I/O? Polled / Interrupt-driven

b) A network interface card communicating over the internet

Buffering? Y / N Spooling? Y / N Caching? Y / N

I/O? Polled / Interrupt-driven

(IX-2) [10 points; 5 points each] Explain in detail the following concepts in I/O.

a) Memory-mapped I/O

_____

_____

_____

b) Device-control register

_____

_____

_____

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X. Virtual Machines, Network and Distributed Systems

(X-1) [5 points; **NO** partial credit] Describe the **four** different types of traditional hypervisors and briefly explain what they are.

a) _____

b) _____

c) _____

d) _____

(X-2) [10 points; **NO** partial credit] Briefly explain how **live migration** is done in virtualization, and why it is useful.

How: _____

_____

Why: _____

(X-3) [10 points; **NO** partial credit] Describe what are networked and distributed operating systems, focusing on *why* we need the distributed OS.

Networked OS:

_____

Distributed OS:

_____

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(X-4) [15 points; **NO** partial credit] There are three design questions we investigated when discussing distributed systems. What are the names of issues these questions are addressing? Also, briefly explain the ideas we discussed in class to accomplish these goals.

(a) _____: Can the distributed system withstand failures?

_____

(b) _____: Can the distributed system be _____ to the user both in terms of where files are stored and user mobility? (both blanks are same)

_____

(c) _____: Can the distributed system be _____ to allow addition of more computation power, storage, or users? (both blanks are same)

_____

(X-5) [5 points] Please evaluate your project partner throughout the semester. Either you had any issue or not, please state it here. While you are not dumping your partner under the truck, this may be used as an evidence to justify your partner(s)'s final letter grade. You need to say anything to get the 5 points. If you had no problem, just marking No would suffice.

a) Problem/Issues (circle one)? Yes / No

b) If Yes, please elaborate:

_____

_____

_____

_____

_____