

# **CSCI 3453 – Operating System Concepts**

## **Spring 2021 Final Exam**

**Name:** \_\_\_\_\_

Score: \_\_\_\_\_ / 87

This is a take home test. Please make a note of the following:

- This is open book / open notes exam.
- You can use a calculator.
- You must submit your work using the quiz on the Canvas
- PDF file is provided for your reference only.

**Due Date:** Saturday, May 15, 2021 @ 11:55 PM – You must submit the test before this deadline.  
I am not going to make any exception to this rule.

GOOD LUCK!

Multiple Choice Questions: Please select the best answer from the given list for the following statements/questions. **(1 point each)**

- 1) The mapping of a logical address to a physical address is done in hardware by the:  
**i) memory-management-unit (MMU)**  
ii) memory address register  
iii) relocation register  
iv) dynamic loading register
- 2) Name the dynamic storage-allocation algorithm which results in the smallest leftover hole in memory.  
i) First fit  
**ii) Best fit**  
iii) Worst fit  
iv) Smallest Fit
- 3) Name the dynamic storage-allocation algorithm which results in the largest leftover hole in memory.  
i) First fit  
ii) Best fit  
**iii) Worst fit**  
iv) Largest Fit
- 4) Consider a logical address with a page size of 8 KB. How many bits must be used to represent the page offset in the logical address?  
i) 10  
ii) 8  
**iii) 13**  
iv) 2
- 5) Assume a system has a TLB hit ratio of 90%. It requires 15 nanoseconds to access the TLB, and 85 nanoseconds to access main memory. What is the effective memory access time in nanoseconds for this system?  
i) 23.5  
ii) 15  
iii) 85  
**iv)  $100 = 108.5$**
- 6) Given the logical address 0xAEF9 (in hexadecimal) with a page size of 256 bytes, what is the page offset?  
**i) 0xAE**  
ii) 0xF9  
iii) 0xA  
iv) 0xF900

- 7) Modern operating systems use \_\_\_\_\_ to manage memory.
- i) paging
  - ii) holing
  - iii) bidding
  - iv) networking
- 8) The goal of memory manager is to:
- i) keep as many processes in memory as possible so to increase overall system performance.
  - ii) keep the creepy bugs out of the memory.
  - iii) keep processes and tasks out of the memory.
  - iv) create an unstable environment.
- 9) A(n) \_\_\_\_\_ page table has one page entry for each real page (or frame) of memory.
- i) inverted
  - ii) clustered
  - iii) forward-mapped
  - iv) virtual
- 10) An address generated by CPU is known as a logical address which is translated into \_\_\_\_\_ by memory management unit.
- i) postal address
  - ii) physical address
  - iii) IP address
  - iv) sector address
- 11) The benefit(s) of virtual memory include the following:
- i) a program can be larger than physical memory
  - ii) a program does not need to be entirely in memory
  - iii) processes can share memory
  - iv) processes can be created more efficiently
  - v) all the answers are correct
- 12) A page fault occurs when a page that is currently not in memory is accessed.
- i) True
  - ii) False
- 13) Thrashing occurs when a system spends more time paging than executing.
- i) True
  - ii) False
- 14) The \_\_\_\_\_ allocation algorithm allocates available memory to each process according to its size.
- i) equal
  - ii) global

iii) proportional

iv) slab

15) Hard disk drives is a \_\_\_\_\_ memory.

- i) volatile
- ii) nonvolatile
- iii) bubble
- iv) smart

16) A disk in a hard disk drive is divided into circular:

- i) tracks.
- ii) sectors. - and tracks are divided into sectors
- iii) clusters.
- iv) files.

17) Device drivers

- i) manage only the basic I/O hardware elements
- ii) manage only the newly emerging I/O devices that are unlike previous devices
- iii) present a uniform device- access interface to the I/O subsystem
- iv) All of the above

18) The basic hardware elements involved in I/O are buses, device controllers, and the devices themselves.

- i) True
- ii) False

19) The work of moving data between devices and main memory is performed by the CPU as programmed I/O or is offloaded to a DMA controller.

- i) True
- ii) False

20) DMA controllers:

- i) do not utilize an additional, special purpose, processor
- ii) are a nonstandard component in PCs of today
- iii) can steal memory access cycles from the main CPU
- iv) can access main memory at the same time as the main CPU

21) An I/O device is connected to a computer via a:

- i) keyboard
- ii) window
- iii) port
- iv) door

22) OS can recover from a disk read failure by retrying to read the data.

- i) True
- ii) False

23) A file is an abstract data type defined and implemented by the operating system.

i) True

ii) False

24) The simplest form of directory structure is having one(same?) directory containing all the files.

i) True - single level directory

ii) False

25) A file name is for convenience of human users.

i) True

ii) False

26) A file with an extension of .exe is an executable file.

i) True

ii) False

27) What is the name of attack that misleads user into providing sensitive information?

i) identity theft

ii) masquerading

iii) phishing

iv) session hijacking

28) Consider a logical address space of 64 pages of 1,024 words each, mapped onto a physical memory of 32 frames. Show your work. You can either type the solution or write & scan it. You can upload the solution using the upload button.

i) How many bits are required for the logical address? **(5 points)**

$$\begin{aligned}\text{logical address space} &= 2^m \\ \text{logical address space} &= \# \text{ of pages} \times \text{page size} \\ &= 64 * 1024 \\ &= 2^6 * 2^{10} \\ &= 2^{16} \rightarrow m = 16 \rightarrow 16 \text{ bits}\end{aligned}$$

ii) How many bits are required for the physical address? **(5 Points)**

$$\begin{aligned}\text{physical address space} &= 2^m \\ \text{physical address space} &= \# \text{ of frames} \times \text{page size} \\ &= 32 * 1024 \\ &= 2^5 * 2^{10} \\ &= 2^{15} \rightarrow m = 15 \rightarrow 15 \text{ bits}\end{aligned}$$

iii) What is the page number and offset for a logical address of 0x0ABCD. **(5 Points)**

$$\begin{aligned}\text{Page Number} &= \frac{\text{Logical Address}}{\text{Page Size}} \\ \text{Logical address} &= 0ABCD \rightarrow 43981 / 1024 = 42.95 \sim 42 \\ \text{Offset} &= \text{Offset} = 10 \text{ bits since } 2^{10} = 1024 \\ 0xABCD &\rightarrow \text{Binary} = 101010 \quad 1111001101 \\ \text{offset} &= 1111001101\end{aligned}$$

29) Given six memory partitions of 300 KB, 600 KB, 350 KB, 200 KB, 750 KB, and 125 KB (in order), how would the first-fit, best-fit, and worst-fit algorithms place processes of size 115 KB, 500 KB, 358 KB, 200 KB, and 375 KB (in order)? Indicate which—if any

—requests cannot be satisfied. You can either type the solution or write & scan it. You can upload the solution using the upload button. **(10 points)**

#### First Fit:

Process 115	→ 300 KB	185 leftover
Process 500	→ 600 KB	100 leftover
Process 358	→ 750 KB	392 leftover
Process 200	→ 350 KB	150 leftover
Process 375	→ 392 KB leftover from 750 KB	17 leftover

P1(M1), P2(M2), P3(M5), P4(M3), P5(M5)

#### Best Fit:

Process 115	→ 125 KB	10 leftover
Process 500	→ 600 KB	100 leftover
Process 358	→ 750 KB	392 leftover



Process 200 → 200 KB	0 leftover
Process 375 → 392 KB leftover from 750 KB	17 leftover

P1(M6), P2(M2), P3(M5), P4(M4), P5(M5)

**Worst Fit:**

Process 115 → 750 KB	635 leftover
Process 500 → 635 KB	135 leftover
Process 358 → 600 KB	242 leftover
Process 200 → 350 KB	150 leftover
Process 375 → cannot be allocated	

P1(M5), P2(M5), P3(M2), P4(M3), P5(M-none)

30) Consider the following page reference string:

7, 2, 3, 1, 2, 5, 3, 4, 6, 7, 7, 1, 0, 5, 4, 6, 2, 3, 0, 1.

Assuming demand paging with three frames, how many page faults would occur for:

i) LRU Replacement **(5 points)**  
18 page faults

ii) FIFO Replacement **(5 points)**  
17 page faults

iii) Optimal Replacement **(5 points)**  
13 page faults

You can either type the solution or write & scan it. You can upload the solution using the upload button.

LRU

	7	2	3	1	2	5	3	4	6	7	7	1	0	5	4	6	2	3	0	1
0	7	7	7	1	1	1	1	1	6	6	6	6	0	0	0	6	6	6	0	0
1		2	2	2	2	5	5	5	5	7	7	7	7	5	5	5	2	2	2	1
2			3	3	3	3	3	4	4	4	4	1	1	1	4	4	4	3	3	3

Faults

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

FIFO

	7	2	3	1	2	5	3	4	6	7	7	1	0	5	4	6	2	3	0	1
0	7	7	7	1	1	1	3	3	3	7	7	7	7	5	5	5	2	2	2	1
1		2	2	2	2	2	2	4	4	4	4	1	1	1	4	4	4	3	3	3
2			3	3	3	5	5	5	6	6	6	6	0	0	0	6	6	6	0	0

Faults

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

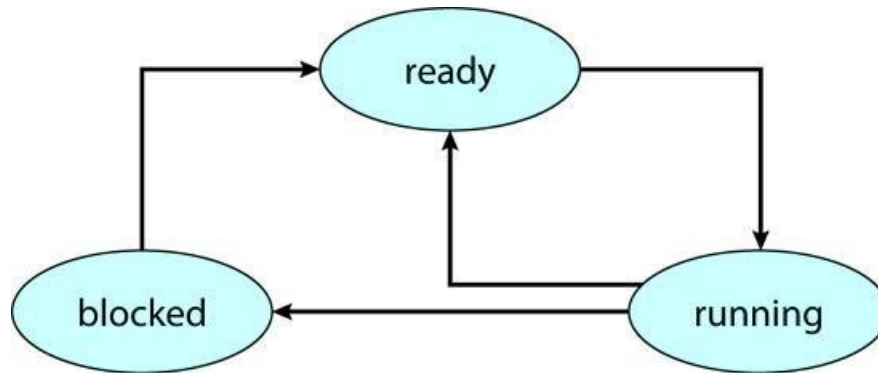
OPT

	7	2	3	1	2	5	3	4	6	7	7	1	0	5	4	6	2	3	0	1
0	7	7	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1		2	2	2	2	5	5	5	5	5	5	5	5	5	4	6	2	3	3	3
2			3	3	3	3	3	4	6	7	7	7	0	0	0	0	0	0	0	0

Faults

	1	2	3	4	x	5	x	6	7	8	x	x	9	x	1 0	1 1	1 2	1 3	x	x
--	---	---	---	---	---	---	---	---	---	---	---	---	---	---	--------	--------	--------	--------	---	---

- 31) A simplified view of thread states is ready, running, and blocked, where a thread is either ready and waiting to be scheduled, is running on the processor, or is blocked (for example, waiting for I/O). Show your work. You can either type the solution or write & scan it. You can upload the solution using the upload button.

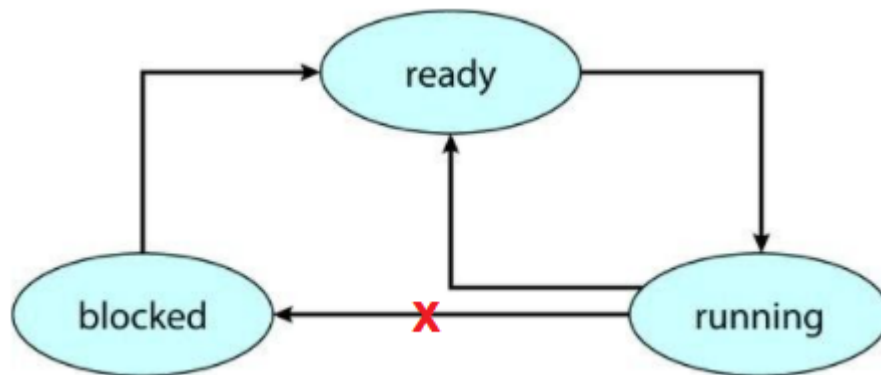


Assuming a thread is in the running state, answer the following questions, and explain your answers:

- i) Will the thread change state if it incurs a page fault? If so, to what state will it change?

**(5 points)**

It will change from running to blocked when a page fault occurs



- ii) Will the thread change state if an address reference is resolved in the page table? If so, to what state will it change?

**(5 points)**

No I/O is needed for an address reference so no state will be changed

- 32) Suppose that a disk drive has 5,000 cylinders, numbered 0 to 4,999. The drive is currently serving a request at cylinder 2,150. The queue of pending requests, in FIFO order, is: 1,245; 25; 75; 85; 90; 2,458; 2,900; 3,000; 4,965; 4,999. Starting from the current head position, what is the total distance (in cylinders) that the disk arm moves to satisfy all the pending requests for each of the following disk-scheduling algorithms? Show your work. You can either type the solution or write & scan it. You can upload the solution using the upload button.

i) FCFS

**(5 points)**

$$\begin{aligned} & - |2150 - 1245| + |1245 - 25| + |25 - 75| + |75 - 85| + |85 - 90| + |90 - 2458| + \\ & |2458 - 2900| + |2900 - 3000| + |3000 - 4965| + |4965 - 4999| = \\ & 905 + 1220 + 50 + 10 + 4 + 2368 + 442 + 100 + 1965 + 34 = 7098 \end{aligned}$$

ii) SSTF

**(5 points)**

minimum seek time from current position of head

$$\begin{aligned} & - |2150 - 2458| + |2458 - 2900| + |2900 - 3000| + |3000 - 1245| + |1245 - 90| + \\ & |90 - 85| + |85 - 75| + |75 - 25| + |25 - 4965| + |4965 - 4999| \\ & 308 + 442 + 100 + 1755 + 1155 + 5 + 10 + 50 + 4940 + 34 = 8799 \end{aligned}$$