

## Homework 2

Due Friday, 04/03/2020 @ 11:59pm

**Part I. Multiple-Choice Questions: Choose the answer that best applies. (2 points each)**

Q1. Using the FCFS algorithm, which process is allocated the CPU first?

- A) The process that requests the CPU first.
- B) The process that requests the CPU last.
- C) Processes are allocated the CPU randomly.
- D) Processes that are blocked, waiting for I/O.

Ans: **A**

Q2. In systems that support virtual memory, \_\_\_\_.

- A) virtual memory is separated from logical memory.
- B) virtual memory is separated from physical memory.
- C) physical memory is separated from secondary storage.
- D) physical memory is separated from logical memory.

Ans: **D**

Q3. In a system resource-allocation graph, \_\_\_\_.

- A) a directed edge from a process to a resource is called an assignment edge
- B) a directed edge from a resource to a process is called a request edge
- C) a directed edge from a process to a resource is called a request edge
- D) None of the above

Ans: **C**

Q4. The path name /home/people/os-student/readme.txt is an example of

- A) a relative path name
- B) an absolute path name
- C) a relative path name to the current directory of /home
- D) an invalid path name

Ans: **B**

Q5. A microkernel is a kernel \_\_\_\_.

- A) containing many components that are optimized to reduce resident memory size
- B) that is compressed before loading in order to reduce its resident memory size
- C) that is compiled to produce the smallest size possible when stored to disk
- D) that is stripped of all nonessential components

Ans: **D**

### Part II. True or False (2 points each)

Q6. In a resource-allocation graph, there are two types of node, process and system resource. In a wait-for graph, there is only one type of node, process. (**T**)

Q7. Memory paging suffers from fragmentation, particularly external fragmentation. (**F**)

Q8. In general, virtual memory decreases the degree of multiprogramming in a system. (**F**)

Q9. If a resource-allocation graph has a cycle, the system must be in a deadlocked state. (**F**)

Q10. The circular-wait condition for a deadlock implies the hold-and-wait condition. (**T**)

### Part III. Fill in the appropriate word, phrase or value in the space provided (1 point each)

Q11. When memory allocated to a process is larger than the requested memory, space at the end of a partition is wasted or unused. This space which is getting wasted within the partition is called **internal fragmentation**. When enough total memory space exists to satisfy a request, but it is not contiguous storage is fragmented to into a large number of small holes. This wasted space not allocated to any partition is called **external fragmentation**.

Q12. A deadlock situation can arise if four necessary conditions hold simultaneously in a system. They are **mutual exclusion**, **hold and wait**, **no preemption**, and **circular wait**.

Q13. Paging is a memory-management scheme that permits the physical-address space of a process to be noncontiguous. With Paging, physical memory is broken into fixed-sized blocks called **frames**. Logical memory is also broken into blocks of the same size called **pages**. When a process is to be executed, its pages are loaded into any available memory frames from the backing store.

Q14. An address generated by the CPU is commonly referred to as a **logical** address, whereas an address seen by the memory unit is commonly referred to as a **physical** address.

Q15. If you were creating an operating system to handle files, there are six basic file operations that you should implement. They are **create**, **write**, **read**, **reposition within a file** (or **seek**), **delete**, and **truncate**.

**Part IV. Answer all of the following questions.**

Q16. Explain the sequence of events that happens when a page-fault occurs.

Ans:

First, the memory reference is checked for validity (1 point). In the case of an invalid request, the program will be terminated. If the request was valid, a free frame is located (1 point). A disk operation is then scheduled to read the page into the frame (1 point) just found, update the page table (1 point), restart the instruction that was interrupted because of the page fault, and use the page accordingly.

Q17. What is thrashing?

Ans: When there are far too many processes (i.e., memory is over committed) (1 point), the resident set of each process is smaller. This leads to higher page fault frequency (1 point), causing the system to exhibit a behavior known as thrashing. In other words, the system is spending its time moving pages in and out of memory and hardly doing anything useful.

Q18. Describe the elements of a hashed page table.

Ans: A hashed page table contains hash values which correspond to a virtual page number. Each entry in the hash table contains a linked list of elements that hash to the same location (to handle collisions). Each element consists of three fields: (1) the virtual page number, (1 point) (2) the value of the mapped page frame, (1 point) and (3) a pointer to the next element in the linked list (1 point).

Q19. What is the purpose of dirty bit in page table?

Ans: A dirty bit is associated with each page frame. If a frame is modified (i.e. written), the dirty bit is then set (1 point). The dirty bit is useful when a page is selected for replacement. If the bit is not set (the page was not modified), the page does not need to be written to disk (1 point). If the dirty bit is set, the page needs to be written to disk when selected for replacement. As a result, the overhead of page replacement can be reduced significantly (1 point).

Q20. Many newer file systems use a modified contiguous allocation scheme, aka Extent-based file systems. Extent-based file systems allocate disk blocks in extents. What is extent? What is extent called in NTFS?

Ans:

An extent is a contiguous block of disks. (2 points)

It is called called run (or cluster run) in NTFS. (2 points)

Q21. Access control protects directories and files by providing a means of specifying who is granted access. Suppose that the "ls -l file.txt" command shows the permissions for a file named file.txt in a Linux system is "rwxrw-r-x". What are permissions to the members of the group that owns the file?

Ans:

Read and Write (2 points)

Q22. What are the three security goals of the CIA triad?

Ans:

Confidentiality (1 point), Integrity (1 point) and Availability (1 point)

Q23. Suppose that we have a computer system using 32-bit logical address and 46-bit physical address. It also uses paging for memory management with a single-level page table organization. The page size is 4K bytes and each page table entry is 32 bits or 4 bytes in size. Calculate the number of bits in each field in the logical address, the size in bytes of the page table, and the number of frames.

Ans:

A logical address has two components, page number and page offset. Here the page size is  $4K = 2^{12}$  and so the page offset is **12 bits** (1 point), the page number is  $32 - 12 = \mathbf{20 \text{ bits}}$  (1 point).

Number of entries in the page table is  $2^{20}$ . Each page table entry is 32 bits or 4 bytes in size. So, total size of the page table in bytes is  $2^{20} * 4 \text{ bytes} = 2^{22} = \mathbf{4 \text{ MB}}$ . (2 points)

The frame size is 4k bytes since the page size is equal to frame size. The number of frames in physical memory =  $2^{46} / 2^{12} = \mathbf{2^{34}}$  (2 points)

Q24. What is slack space?

Ans:

Slack space is the leftover storage that exists on a computer's hard disk drive when a computer file does not need all the space it has been allocated. (2 points)

Q25. There are six basic operations for file manipulation defined in a modern OS. Give an approach for supporting file move in OS.

Ans:

Note that six basic operations include create, write, read, reposition within a file (a.k.a., seek), delete, and truncate.

One possible solution is  
create a new file (which is the destination file)

read the contents from the source file

write the data to the newly created destination file

delete the source file

(2 points)