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CS 2042 – Operating Systems

16 Batch S3 – In class quiz

Time allowed 60 minutes.

This is a **closed** book examination. You should not use any notes or access resources on Internet. Answer in this sheet itself. You may attach your working sheet.

Q 1 [10 marks]

A system implements a paged virtual address space for each process using a one-level page table. The maximum size of an address space is 16 megabytes. The page table for the running process includes the following entries:

page	frame number
0:	4
1:	8
2:	16
3:	17
4:	9

The page size is 1024 bytes and the maximum physical memory size of the machine is 2 megabytes.

a. How many bits are required for each page table entry?

b. What is the maximum number of entries in a page table?

c. How many bits are there in a virtual address?

d. To which physical address will the virtual address 1524 translate to?

e. Which virtual address will translate to physical address 10020?

Q 2 [20 marks]

(i) Consider a virtual memory system that uses segmentation combined with paging, and has the following parameters:

(a) Each process has 16 segments.

(b) Each segment can be up to 4MB in size.

(c) Each page is 8KB in size.

Draw a diagram showing the different fields of a virtual address in this system. Make sure to label each field and indicate how many bits it contains. (Some useful information: $1K = 2^{10}$ and $1M = 2^{20}$). [4 marks]

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(ii) Consider a memory system with a cache access time of 10ns and a memory access time of 110ns – assume the memory access time includes the time to check the cache. If the effective access time is 10% greater than the cache access time, what is the hit ratio H? [5 marks]

(iii) Ring Inc hires you to design the virtual memory system for a new cell phone with 32-bit virtual and physical addresses, in which memory is allocated in 1 KB pages. Suppose that you decide to use a single-level page table, in which you also store three metadata bits for each page: Writable, Executable and Valid. [5 marks]

(a) Answer the following questions, briefly explaining your solution:

(i) How long, in bits, is a virtual page number?

(ii) How long, in bits, is a physical page number?

(iii) How long, in bits, is an offset within a page?

(iv) How much memory is needed to store the page table of each process?

(b) Your manager asks you to consider using a multi-level page table in your design. Explain one advantage and one disadvantage of multi-level page tables over single-level page tables. (Use no more than four sentences in total.) [6 marks]

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Q 3 [10 marks]

A system implements a paged virtual address space for each process using a one-level page table. The maximum size of an address space is 32 megabytes. The page table for the running process includes the following entries:

page	frame number
0:	4
1:	8
2:	6
3:	7
4:	9

The page size is 2048 bytes and the maximum physical memory size of the machine is 2 megabytes.

a. How many bits are required for each page table entry?

b. What is the maximum number of entries in a page table?

c. How many bits are there in a virtual address?

d. To which physical address will the virtual address 1524 translate to?

e. Which virtual address will translate to physical address 10020?

Q 4 [20 marks]

(i) Consider a virtual memory system that uses segmentation combined with paging, and has the following parameters:

(a) Each process has 8 segments.

(b) Each segment can be up to 8MB in size.

(c) Each page is 8KB in size.

Draw a diagram showing the different fields of a virtual address in this system. Make sure to label each field and indicate how many bits it contains. (Some useful information: $1K = 2^{10}$ and $1M = 2^{20}$). [4 marks]

Name:_____ Index No:_____

(ii) Consider a memory system with a cache access time of 10ns and a memory access time of 110ns – assume the memory access time includes the time to check the cache. If the effective access time is 10% greater than the cache access time, what is the hit ratio H? [5 marks]

(iii) Ring Inc hires you to design the virtual memory system for a new cell phone with 32-bit virtual and physical addresses, in which memory is allocated in 2 KB pages. Suppose that you decide to use a single-level page table, in which you also store three metadata bits for each page: Writable, Executable and Valid. [5 marks]

(a) Answer the following questions, briefly explaining your solution:

(i) How long, in bits, is a virtual page number?

(ii) How long, in bits, is a physical page number?

(iii) How long, in bits, is an offset within a page?

(iv) How much memory is needed to store the page table of each process?

(b) Your manager asks you to consider using a multi-level page table in your design. Explain one advantage and one disadvantage of multi-level page tables over single-level page tables. (Use no more than four sentences in total.) [6 marks]

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Q 5 [10 marks]

A system implements a paged virtual address space for each process using a one-level page table. The maximum size of an address space is 16 megabytes. The page table for the running process includes the following entries:

page	frame number
0:	3
1:	4
2:	6
3:	7
4:	9

The page size is 2048 bytes and the maximum physical memory size of the machine is 2 megabytes.

a. How many bits are required for each page table entry?

b. What is the maximum number of entries in a page table?

c. How many bits are there in a virtual address?

d. To which physical address will the virtual address 1524 translate to?

e. Which virtual address will translate to physical address 10020?

Q 6 [20 marks]

(i) Consider a virtual memory system that uses segmentation combined with paging, and has the following parameters:

(a) Each process has 16 segments.

(b) Each segment can be up to 8MB in size.

(c) Each page is 4KB in size.

Draw a diagram showing the different fields of a virtual address in this system. Make sure to label each field and indicate how many bits it contains. (Some useful information: $1K = 2^{10}$ and $1M = 2^{20}$). [4 marks]

Name:_____ Index No:_____

(ii) Consider a memory system with a cache access time of 20ns and a memory access time of 220ns – assume the memory access time includes the time to check the cache. If the effective access time is 10% greater than the cache access time, what is the hit ratio H? [5 marks]

(iii) Ring Inc hires you to design the virtual memory system for a new cell phone with 32-bit virtual and physical addresses, in which memory is allocated in 1 KB pages. Suppose that you decide to use a single-level page table, in which you also store three metadata bits for each page: Writable, Executable and Valid. [5 marks]

(a) Answer the following questions, briefly explaining your solution:

(i) How long, in bits, is a virtual page number?

(ii) How long, in bits, is a physical page number?

(iii) How long, in bits, is an offset within a page?

(iv) How much memory is needed to store the page table of each process?

(b) Your manager asks you to consider using a multi-level page table in your design. Explain one advantage and one disadvantage of multi-level page tables over single-level page tables. (Use no more than four sentences in total.) [6 marks]

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Q 7 [10 marks]

A system implements a paged virtual address space for each process using a one-level page table. The maximum size of an address space is 32 megabytes. The page table for the running process includes the following entries:

page	frame number
0:	4
1:	8
2:	16
3:	17
4:	9

The page size is 2048 bytes and the maximum physical memory size of the machine is 4 megabytes.

a. How many bits are required for each page table entry?

b. What is the maximum number of entries in a page table?

c. How many bits are there in a virtual address?

d. To which physical address will the virtual address 1524 translate to?

e. Which virtual address will translate to physical address 10020?

Q 8 [20 marks]

(i) Consider a virtual memory system that uses segmentation combined with paging, and has the following parameters:

(a) Each process has 8 segments.

(b) Each segment can be up to 16 MB in size.

(c) Each page is 8KB in size.

Draw a diagram showing the different fields of a virtual address in this system. Make sure to label each field and indicate how many bits it contains. (Some useful information: $1K = 2^{10}$ and $1M = 2^{20}$). [4 marks]

Name:_____ Index No:_____

(ii) Consider a memory system with a cache access time of 10ns and a memory access time of 110ns – assume the memory access time includes the time to check the cache. If the effective access time is 10% greater than the cache access time, what is the hit ratio H? [5 marks]

(iii) Ring Inc hires you to design the virtual memory system for a new cell phone with 64-bit virtual and physical addresses, in which memory is allocated in 4 KB pages. Suppose that you decide to use a single-level page table, in which you also store three metadata bits for each page: Writable, Executable and Valid. [5 marks]

(a) Answer the following questions, briefly explaining your solution:

(i) How long, in bits, is a virtual page number?

(ii) How long, in bits, is a physical page number?

(iii) How long, in bits, is an offset within a page?

(iv) How much memory is needed to store the page table of each process?

(b) Your manager asks you to consider using a multi-level page table in your design. Explain one advantage and one disadvantage of multi-level page tables over single-level page tables. (Use no more than four sentences in total.) [6 marks]

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Q 9 [10 marks]

A system implements a paged virtual address space for each process using a one-level page table. The maximum size of an address space is 32 megabytes. The page table for the running process includes the following entries:

page	frame number
0:	3
1:	4
2:	6
3:	7
4:	9

The page size is 4096 bytes and the maximum physical memory size of the machine is 4 megabytes.

a. How many bits are required for each page table entry?

b. What is the maximum number of entries in a page table?

c. How many bits are there in a virtual address?

d. To which physical address will the virtual address 1524 translate to?

e. Which virtual address will translate to physical address 10020?

Q 10 [20 marks]

(i) Consider a virtual memory system that uses segmentation combined with paging, and has the following parameters:

(a) Each process has 4 segments.

(b) Each segment can be up to 16 MB in size.

(c) Each page is 8KB in size.

Draw a diagram showing the different fields of a virtual address in this system. Make sure to label each field and indicate how many bits it contains. (Some useful information: $1K = 2^{10}$ and $1M = 2^{20}$). [4 marks]

Name:_____ Index No:_____

(ii) Consider a memory system with a cache access time of 20ns and a memory access time of 220ns – assume the memory access time includes the time to check the cache. If the effective access time is 10% greater than the cache access time, what is the hit ratio H? [5 marks]

(iii) Ring Inc hires you to design the virtual memory system for a new cell phone with 64-bit virtual and physical addresses, in which memory is allocated in 2 KB pages. Suppose that you decide to use a single-level page table, in which you also store three metadata bits for each page: Writable, Executable and Valid. [5 marks]

(a) Answer the following questions, briefly explaining your solution:

(i) How long, in bits, is a virtual page number?

(ii) How long, in bits, is a physical page number?

(iii) How long, in bits, is an offset within a page?

(iv) How much memory is needed to store the page table of each process?

(b) Your manager asks you to consider using a multi-level page table in your design. Explain one advantage and one disadvantage of multi-level page tables over single-level page tables. (Use no more than four sentences in total.) [6 marks]