

Department: Computer Science
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Instructor: Dr. Ahmed Amer Shahin
Date: Thursday, November 14, 2019
Time: 10:00am – 11:00am (60 min)
Marks: 25

Mid-Term Exam Solutions

Answer the Following Questions

Question 1: (5 points)

1. What is(are) the difference(s) between logical and physical addresses?

The logical address is the address generated by the CPU

The physical address is the address seen by the memory

2. Compare the memory organization schemes of contiguous memory allocation, pure segmentation, and pure paging with respect to the following issues:
- External fragmentation
 - Internal fragmentation

	Contiguous Memory Allocation	Pure Segmentation	Pure Paging
External Fragmentation	Yes	Yes	No
Internal Fragmentation	No	No	Yes

Question 2: (12 points)

1. Assuming a 2-KB page size, what are the page numbers and offsets for the following address references (provided as decimal numbers):
- 103 → page# = 0, offset = 103
 - 4095 → page# = 1, offset = 2047
 - 82093 → page# = 40, offset = 173
2. Consider the following segment table:

Segment	Base	Length
0	402	400
1	4600	14
2	500	1000
3	1327	280

What are the physical addresses for the following logical addresses?

- 0,401 → physical address = invalid
- 1,14 → physical address = $4600 + 14 = 4614$
- 2,500 → physical address = $500 + 500 = 1000$

Question 3: (8 points)

1. Consider a logical address space of 64 pages of 2,048 words each, mapped onto a physical memory of 32 frames.
- How many bits are there in the logical address? 17 bits

- b. How many bits are there in the physical address? **16 bits**
2. Consider a paging system with the page table stored in memory.
- a. If a memory reference takes 60 nanoseconds, how long does a paged memory reference take?

Paged memory reference time = 60ns + 60ns = 120 ns

- b. If we add TLBs, and 85 percent of all page-table references are found in the TLBs, what is the effective memory reference time? (Assume that finding a page-table entry in the TLBs takes 3 nanoseconds, if the entry is present.)

Paged memory reference time = $0.85 * (3+60) + 0.15 * (3+60+60) = 72 \text{ ns}$