Operating Systems (1401311-3)
HW #2 (Sol.)
Due Date: Monday, 20.6.1432 H

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1. Consider a paging system with the page table stored in memory.
   a. If a memory reference takes 110 ns, how long does a paged memory reference take? (Note: there is no TLB here).

      It takes $2 \times 110 = 220$ ns.

   b. If we add TLB, and 75 percent of all page-table references are found in the TLB, what is the effective memory reference time? (Assume that finding a page-table entry in the TLB takes 5 ns if the entry is there.)

      Effective Time $= 0.75 \times (5 + 110) + 0.25 \times (5 + 220) = 142.5$ ns.

2. Given the following Reference string: 1, 2, 3, 5, 4, 2, 4, 5, 3, 2. What is the number of page faults if only 3 frames are used with the following replacement algorithms:
   a. FIFO

	1	5	5	5	3
	2	2	4	4	4
	3	3	3	2	2
No. of Faults	3	1	1	1	1

      Total no. of faults is 7.

   b. Most Recently Used (MRU).

	1	1	1	1	1	1
	2	2	2	2	3	2
	3	5	4	5	5	5
No. of Faults	3	1	1	1	1	1

      Total no. of faults is 8.

3. Assume we have a demand-paged memory. Given that the Memory access time is 100 ns, the Effective Access Time (EAT) is 150 ns, page fault overhead is 20ns, the cost of swapping a page out is 120 ns, the cost of swapping a page in is 40 ns and the restart overhead is 20 ns, what is the page-fault rate?

   EAT = (1-p) × Memory Access + p × [page fault overhead + cost of swapping a page out + cost of swapping a page in + restart overhead]
   150 = (1-p) × 100 + p × [20 + 120 + 40 + 20]
   Accordingly, p = 0.5

Ethics Policy: All assignments are individual and only individual work will be accepted. Detected copies of assignments (written or programming assignments) will result in zeros for the whole group (including the student who actually solved the problem). Remember that if you cheat, you are cheating no one but yourself.