Lecture 17 GPU Memory Exercises

Q1:
Assume a hypothetical GPU with the following characteristics:
- Clock rate 2.4 GHz,
- 64 simultaneous instruction streams,
- Contains 16 SIMD cores, each containing 64 single-precision floating-point units, each instruction performs one single-precision floating-point operation (either multiply or add),
- 2048 concurrent (but interleaved) instruction streams

What is the peak single-precision floating-point throughput for this GPU in GFLOP/sec, assuming that all memory latencies can be hidden?

Solution:
2.4 * 16 * 64 = 2457.6 GFLOPS

Q2:
Virtual addresses are 32 bits. Physical addresses are 28 bits. The page offset is 12 bits. Assume the only page currently in physical memory is the page where virtual memory address 0xFA301404 is located (this is always the only page—don't "bring in" any others as you solve this problem). Which of the following list of virtual memory address references would result in page faults (i.e., misses in DRAM)? Choose ALL that apply. Please show your work.

A. 0x00300404
B. 0xFA301042
C. 0x00400404
D. 0xFA300000
E. 0xFA302300
F. 0xFA301404

Answer: ACDE

"Always only one page" → you can imagine that all other other PTEs have a valid bit of 0 and are always fixed to 0, i.e., are permanently turned off.

Page offset is 12 bits. So the virtual page number of 0xFA301404 is 0xFA301. As a result, any virtual addresses that have different higher-order bit values will lead to a page fault.

Q3:
The first two entries (indexes) of a different page table are shown below (assuming the page table design has two columns -- valid bit and physical frame number). The page offset is 3 bits. (All numbers below are in binary.)

Valid	Physical frame number
0	00011
1	11100
…	…

Where in DRAM (i.e., physical address) should I look to find the data at virtual memory address: 0000001101 (base 2)? (If it is not in DRAM – say so.) Please show your work.

Solution:

Page offset is 3 bits. So the virtual page number is 0000001, i.e., index = 1. The page table entry with index 1 has a physical frame number of 11100. Page offset does not change. Therefore, physical address = 11100101