

ENGN2219/COMP6719
Computer Systems & Organization
Problem Set 4

Note: This problem set is optional for your practice only and not part of the assessment scheme.

Question 1:

Explain the difference between a latch and a flip-flop? Under what circumstances is each one preferable?

Question 2:

Explain the concept of pipelining, and what is the prime benefit of pipelining.

Question 3:

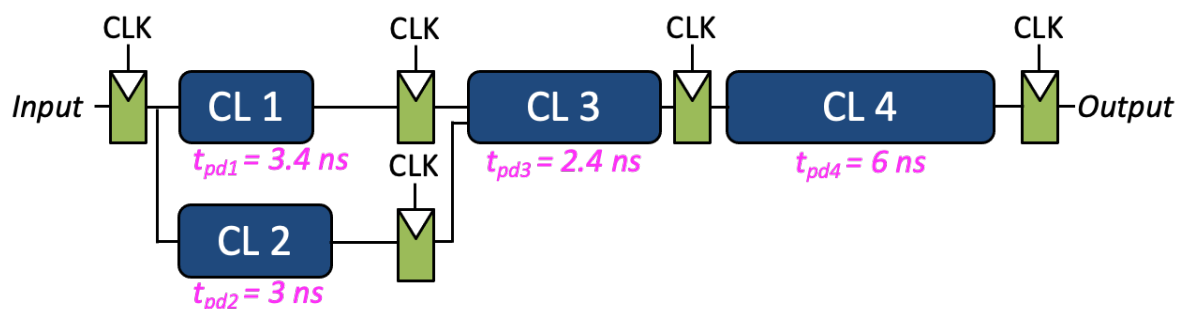
In the context of a flip-flop, explain the key difference between setup time and hold time.

Question 4:

Explain the key disadvantages of asynchronous sequential circuits. Why are synchronous sequential circuits preferred over asynchronous ones?

Question 5:

Consider the following 3-stage pipelined circuit. Each box labeled CL is a combinational block. The propagation delay of each CL block is listed in the figure (pink). Assume the setup time is 0.45 ns, and the clock-to-Q propagation delay is 0.5 ns. Assume the hold time is negligible.



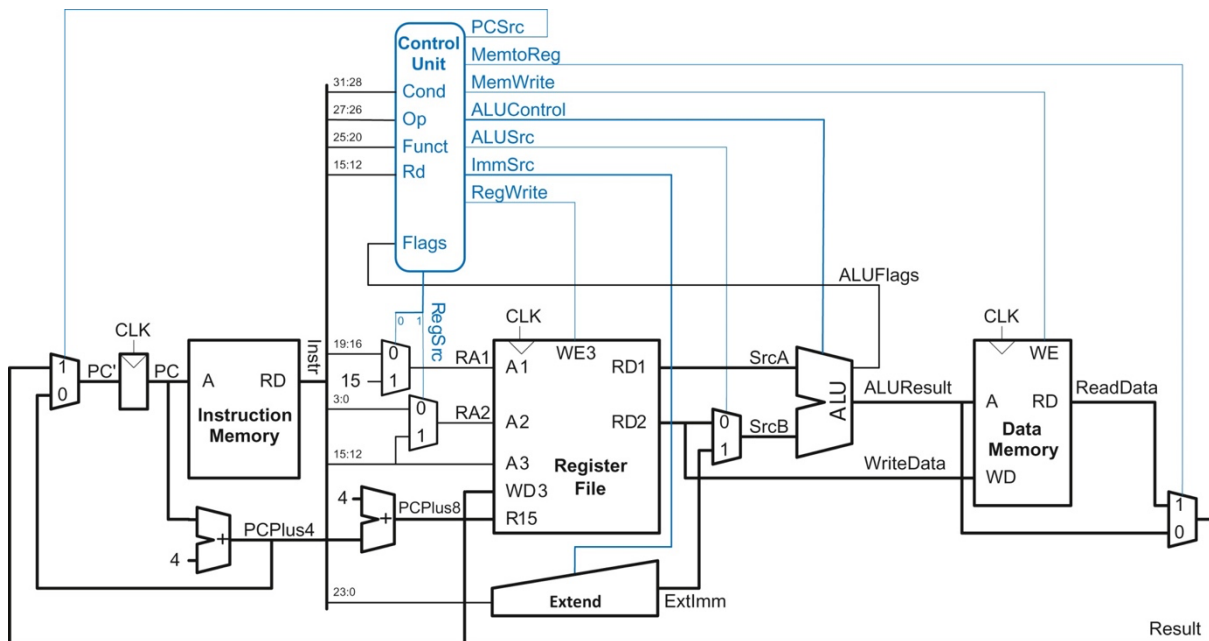
- A) What is the end-to-end latency of finishing one task using the pipelined circuit above?
- B) Find the (maximum) clock frequency at which it is safe to operate the pipeline?
- C) Suppose CL4 can be further pipelined into two stages that each take 3 ns. Find the new end-to-end latency of performing a single task. What is the new clock frequency?

Question 6:

Give three examples from the QuAC architecture of each of the architecture design principles: (1) regularity supports simplicity; (2) make the common case fast; (3) smaller is faster; and (4) good design demands good compromises. Explain how each of your examples exhibits the design principle.

Question 7:

Consider the following microarchitecture of the ARM ISA we have seen in lectures.



For the instruction, STR R0, [R1, #12], find the values of all the control signals in blue. Use the lecture slides or textbook or any other material as your aid.

Question 8:

Explain the purpose of the two adders in the figure in Question 7. Also, explain the need for each of the multiplexers in the same figure.