

CS 315-02 Processor Pipelining 2025-11-20

Project 06

Remaining work: lab 11 (Qs)
project 07
Final

single-cycle processor

multi-cycle processor

pipelined processor

Laundry

Laundry Steps

- 1) Wash [W]
- 2) Dry [D]
- 3) Fold [F]
- 4) Put Away [D]

Assume:

each step
takes 30 min

30
[W]

30
[D]

20
[F]

30
[P]

1 load
= 120 mins
2 hrs

[W] [D] [F] [P] [W] [D] [F] [P]

= 240 mins
4 hrs

Laundry Pipeline

time → 120 150 180 210
20 30 30 30 30 30 20

1st load [W] [D] [F] [P]

2nd load [W] [D] [F] [P]

3rd load [W] [D] [F] [P]

4th load [W] [D] [F] [P]

1st load = 120 mins (2 hr)

2nd load = 150 mins (2.5 hrs)

4th load = 210 min (3.5 hrs)

100 loads?

$$\text{Serial : } 100 \times 2\text{hrs} = \boxed{200 \text{ hrs}}$$

Pipelining:

1st load

$$4 \times (0.5) + (100-1) \times (0.5)$$

$$\begin{array}{rcl} 2\text{hrs} & + & 99 \times 0.5 \\ 2\text{hrs} & + & 49.5 = \boxed{51.5 \text{ hrs}} \end{array}$$

1000 loads?

$$4 \times (0.5) + (1000-1) \times 0.5$$

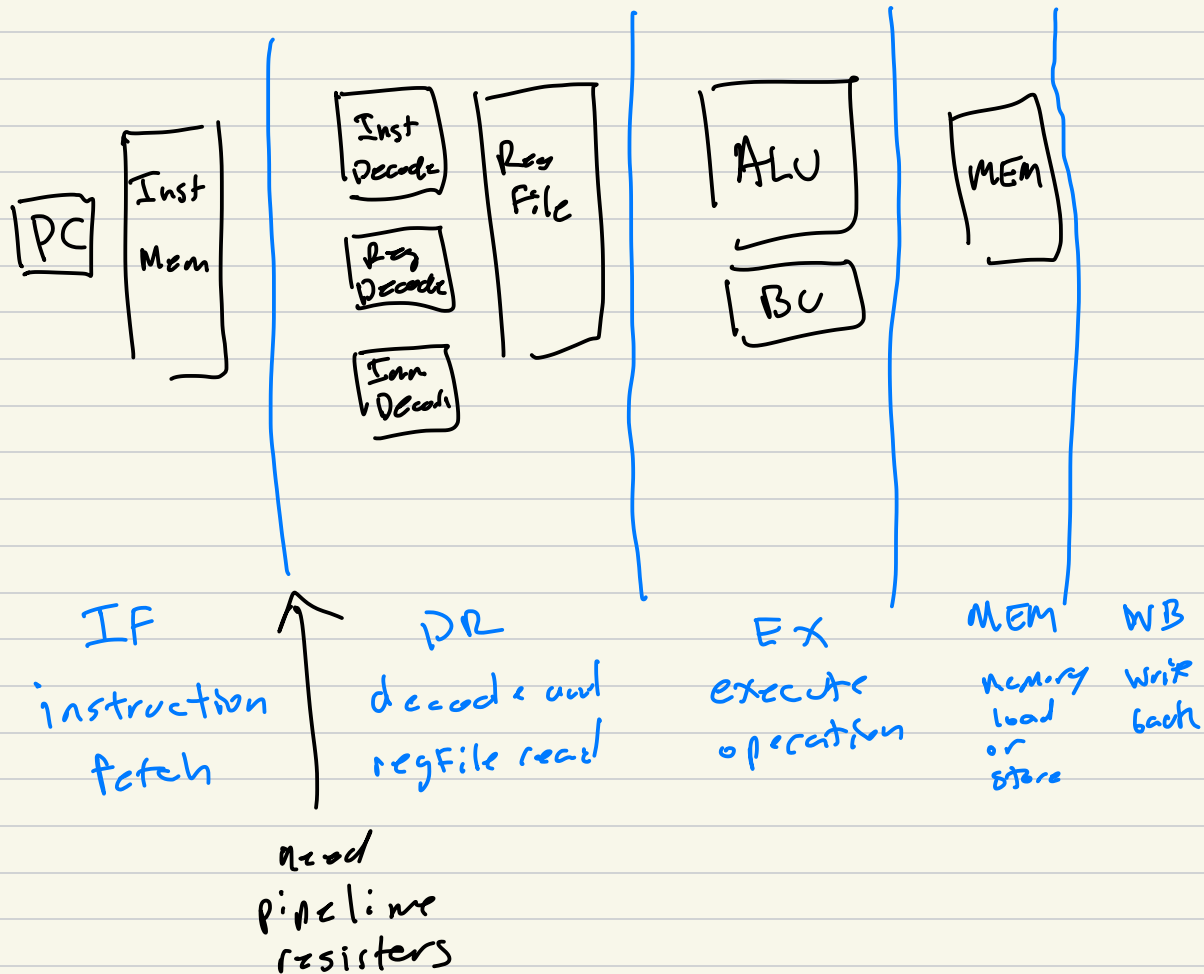
$$2\text{hrs} + 999 \times .5$$

$$2\text{hrs} + 499.5 = \boxed{501.5 \text{ hrs}}$$

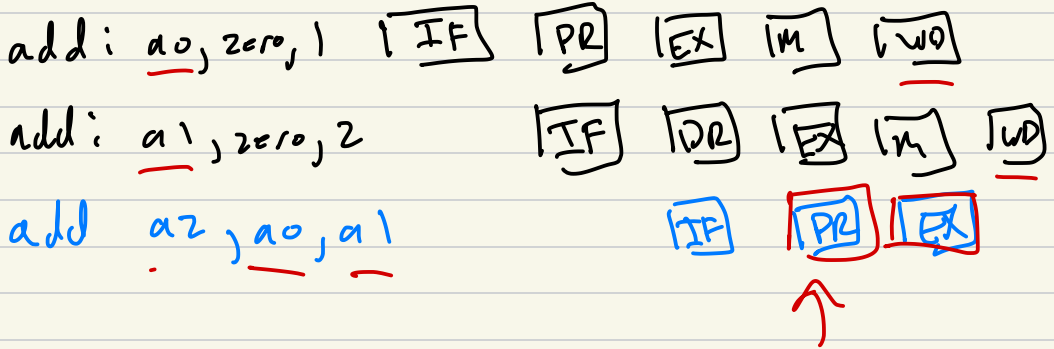
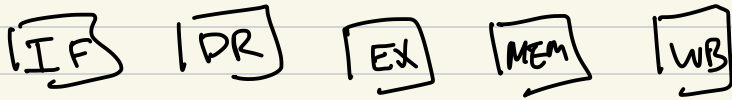
In principle

An n -stage pipeline can speed up
execution by $\frac{1}{n}$

Processor Pipelining



Instruction Pipeline stage



Pipeline Hazards

Data Hazards

Control Hazards