

CS315-01 Processor Design Pipelining

Past scores and make up points

75% back on project02, project03, Project04

Address code quality: 10 additional points
per project

Greg's O/H 1pm - 2:30pm

Project06 Q&A

Single-cycle processor

Multi-cycle processor

Pipelined processor

Laundry

Laundry Steps

1) Wash W

2) Dry D

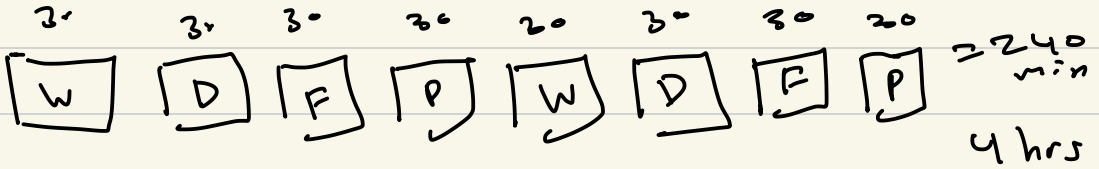
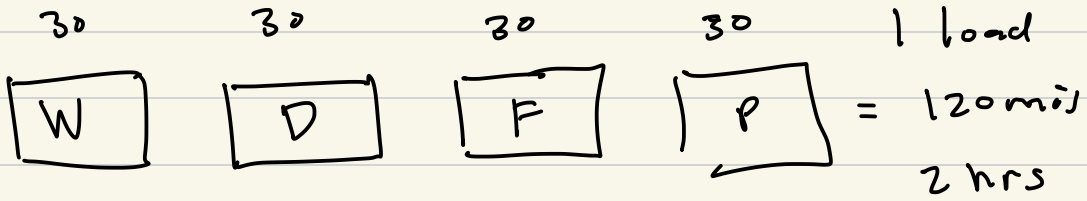
3) Fold F

4) Put away D

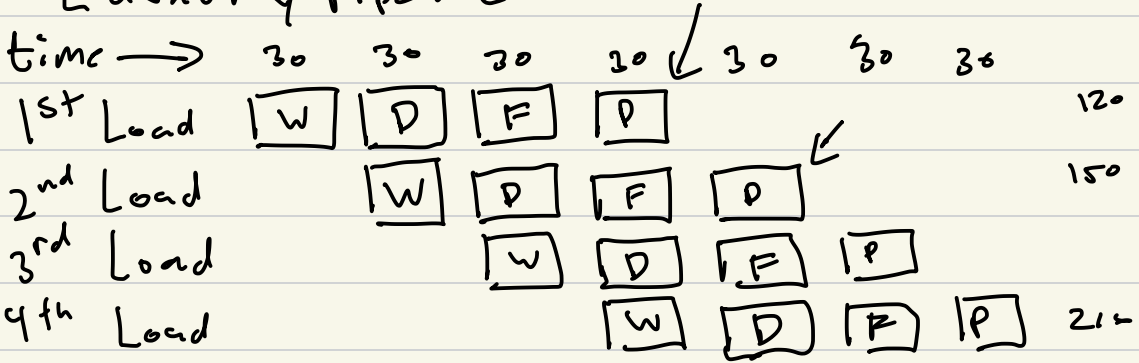
Assume:

Each step

takes 30 mins



Laundry Pipeline



1 load = 120 mins (2hr)

2 loads = 150 mins (2.5 hrs)

4 loads = 210 mins (3.5 hrs)

100 loads?

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

Pipelining:

1st load

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

step

$$2 \text{ hrs} + 99 \times 0.5$$
$$2 + 49.5 = \boxed{51.5 \text{ hrs}}$$

approx 4x speed up

1000 loads

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

$$2 + 999 \times 0.5$$

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

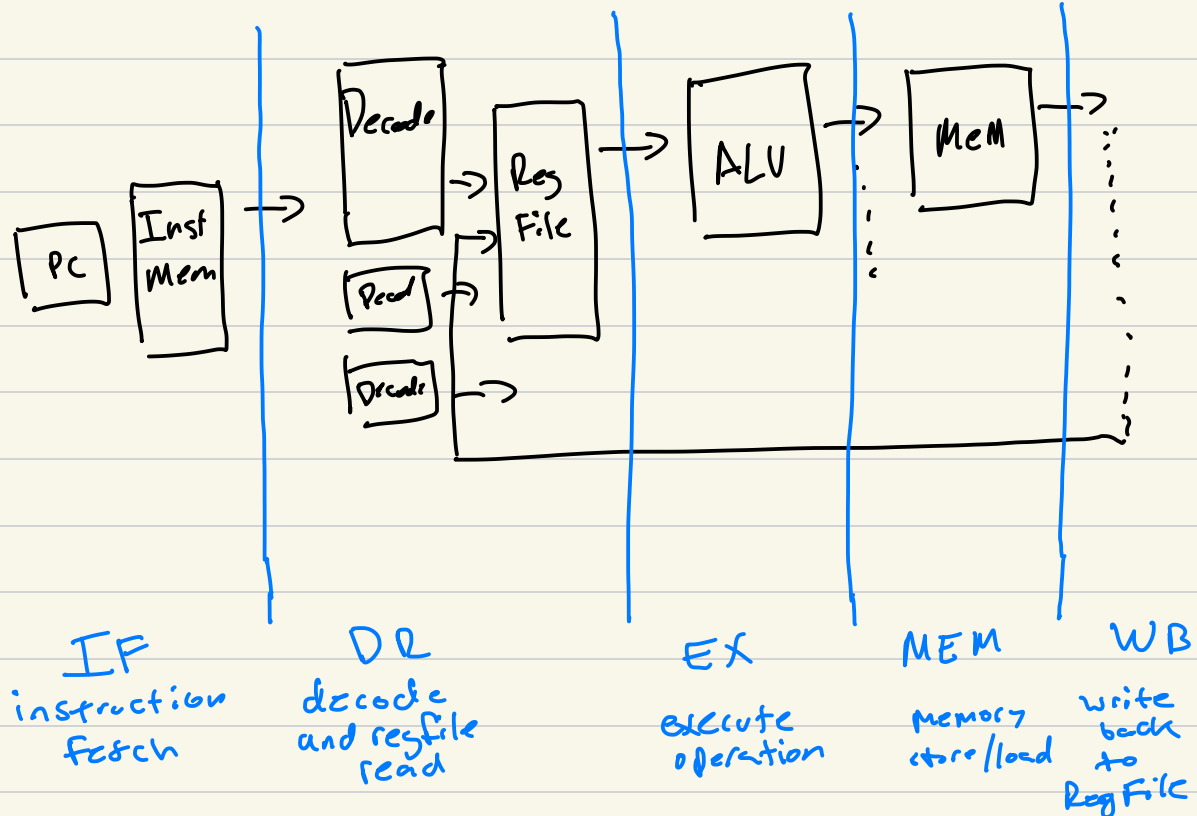
Throughput
vs
latency

In principle:

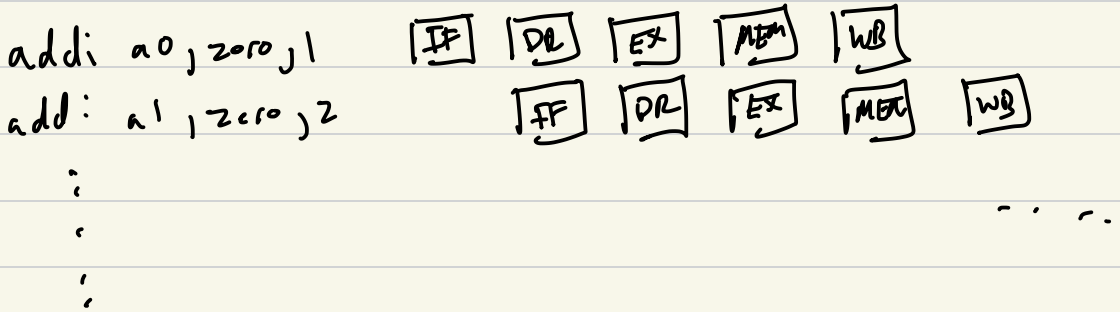
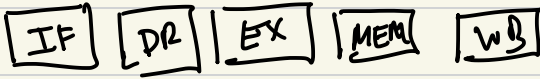
An n -stage pipeline
can speed up execution
by

$$\frac{1}{n}$$

Processor Pipelining



Instruction Pipeline Stages

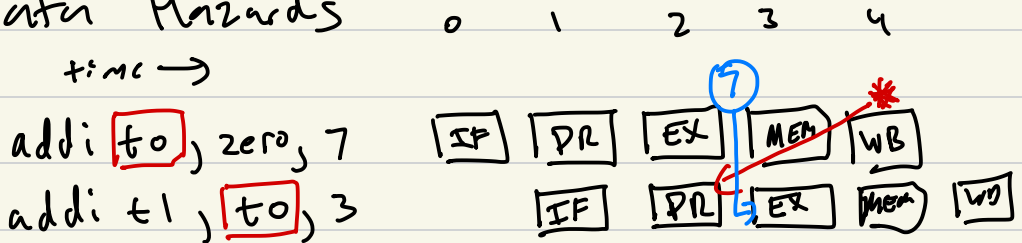


Pipeline Hazards

Data Hazards

Control Hazards (jumps and branches)

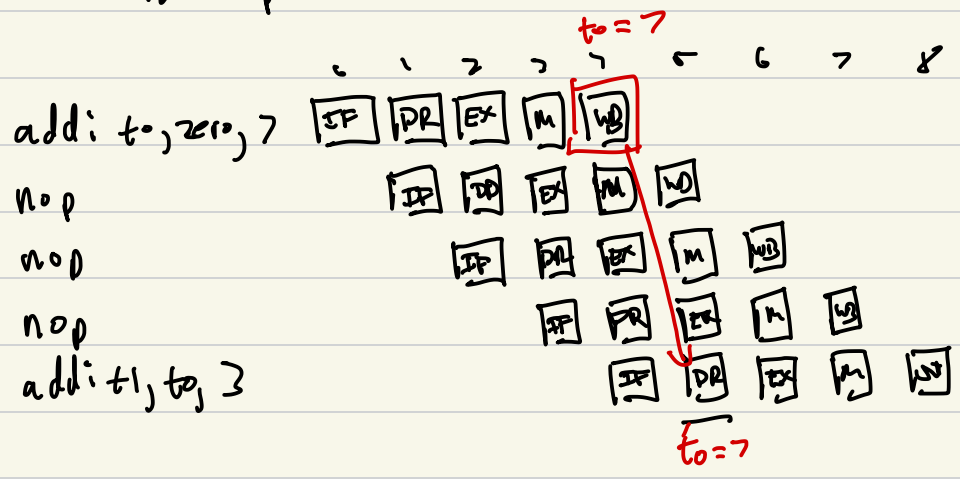
Data Hazards



nop = add zero, zero, zero

Solution #1 insert nops

no operation



Solution #2 Forwarding

